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# A STUDY OF VOLUNTEERS' SCIENCE SERVICE SATISFACTION IN RELATION TO THEIR SELF-DIRECTED LEARNING AND MOTIVATION

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**Abstract.** *In Taiwan, the Science Volunteer Locomotive (SVL) Program has been in operation for the past ten years. During these years of its implementation, the SVL Program has continued to participate in and co-ordinate various national scientific activities. This study examined the relationships between volunteers' prime motivations, self-directed learning and satisfaction among Taiwanese science volunteers. To explore volunteers' perspectives on their involvement in science service, in this research, we developed three questionnaires to investigate the relationships among volunteers' motivation, self-directed learning and satisfaction with their science service. The study sample included 289 volunteers, taken from a project for science volunteers run by the Ministry of Science and Technology in Taiwan. The results indicate that the prime motivations and self-directed learning of science volunteers are focused on doing something meaningful for others and for society in general. It was found that the science volunteers' motivation, self-directed learning and satisfaction all had significant positive correlations. The findings suggest that science training programs may provide some motivational support to enhance satisfaction, so that science volunteers will be more inclined to participate in collaborative scientific projects.*

**Keywords:** *prime motivation, service satisfaction, science volunteers, self-directed learning.*

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## Introduction

Volunteers are considered as valuable human resources in a wide range of areas in today's society. To cite an example, some mega-events rely heavily upon volunteers because a large number of individuals are often necessary for creating and delivering various types of services. McBride, Johnson, Olate and O'Hara (2011) argued that it is possible to design volunteer service such that it channels people into activities which not only contribute to society, but which also allow them to develop their civic, educational and personal capacities. In addition to the positive links demonstrated between level of education and volunteering, some pioneering studies have also found that educational service projects are often labor intensive and may be implemented by a variety of labor sources such as teachers, students, and related volunteers (Cravens, 2006; Kwok, Chui, & Wong, 2013). This means that there is an increased possibility of some form of civic engagement among students due to service learning programs which encourage students to participate in volunteering and which benefit the organizations. In recent years, educational authorities which have invested in service learning and civic engagement have begun promoting the value of science education. For example, in Japan, based on the stimulation of science and technology activities, it is important to promote science and technology integrally with innovation, resulting in economic growth that will strengthen Japan's competitiveness (Japanese Ministry of Education, 2014). Hence, this project provides a scientific, educational, and community-volunteer domain context for society using science volunteer labor which can produce social and psychological benefits in concert with educational benefits. Therefore, volunteer science service has gained popularity in educational service projects, and is expected to be increasingly highlighted.

### *Research Problem*

Nowadays, citizen science projects are not only remarkably successful in advancing scientific knowledge, but are also prevalent in the social psychology literature (Widener, 2012). As a matter of fact, there is a range of studies

on volunteering in the psychology literature (Vecina, Chacón, Sueiro, & Barrón, 2012). One of the psychological factors that operates at the volunteer level is the motivation to engage in service learning. Dwyer, Bono, Snyder, Nov and Berson (2013) described that volunteer motivation can be defined as an individual's drive to seek out volunteer opportunities, to commit themselves to voluntary helping, and to sustain their involvement in volunteering over extended time periods. There are many volunteer studies on social services showing different kinds of motivation including altruism, social contact, personal interest, and emotional needs (Carpenter & Myers, 2010; Warner, Newland, & Green, 2011). It appears that those people who volunteer for mega-events do so as a result of a range of motivations including the chances it offers to socialize, their ability to gain material rewards, the possible enhancement of their status in the local community, the connection with their own hobbies and/or interests, as well as the opportunities it provides for expressing altruism. Although much is known about the motivations of volunteers (Pan, 2012; Yamamoto & Engelsted, 2014), little is known about specifically why volunteers participate in science-related tasks. Hence, this research explored the motivation factors of science volunteers as a way to provide a window into the culture of citizen science.

Volunteer satisfaction is a popular and extensively studied topic (e.g., Felver, Pierce, Judge, & Johnson, 2014; Fitzpatrick, Edgar, Remmer, & Leimanis, 2013). Compared to traditional work engagement, people who have performed volunteer work report higher life satisfaction than non-volunteers (Levy, Benbenishty, & Refaeli, 2012; Pavlova & Silbereisen, 2012). It is essential to determine why some individuals choose to volunteer, while others never even consider doing so. People also consistently report an increased sense of life satisfaction and perceived improvement in quality of life after participation in volunteer programs (Wilson, 2012; Chua & de Guzman, 2014). This indicates that volunteers enjoy the experience that recipients receive sustained help, and that organizations manage the process effectively. Furthermore, in the Three-Stage Model of Volunteers' Duration of Service (Vecina et al., 2012), satisfaction, commitment, and intention to remain are used in order to explain the duration of volunteer service over a tracking period of one year. There is a need to understand the reasons why some continue to volunteer over a long period of time, while others stop volunteering shortly after starting, often feeling dissatisfied or, on occasion, even deeply disappointed and having had enough.

However, research has shown that volunteer satisfaction, a favorable evaluation of an experience or behavior, can be better predicted by motivation (e.g., Garner & Garner, 2011; Finkelstein, 2008). It is vital that general event organizers understand volunteer motivation and their satisfaction with the volunteering experience such that they can respond effectively to the management needs in the areas of recruitment, retention, and daily operations. Much research has been conducted on volunteering motivations and their effects on satisfaction and future intentions related to social events (e.g., Bang & Ross, 2009; Wright, Underhill, Keene, & Knight, 2015). For example, Allen and Shaw (2009) found that volunteer motivation (e.g., altruism, value, extrinsic, and intrinsic factors) and satisfaction with the 2002 Winter Olympic and Paralympic Games were strongly positively correlated. In other words, if volunteers feel satisfied and if their motivational needs can be met, they are more likely to return to volunteer in the future. However, as far as the authors are aware, there has been no research to date focusing on the development of scales of volunteer motivation and volunteer satisfaction with science services. Therefore, the aim of this research was to investigate volunteers' motivation and satisfaction in this area.

Furthermore, some studies have also paid considerable attention to the factors that influence volunteers' satisfaction (Oostlander, Guentert, & Wehner, 2014; Luzurier, Damm, Lion, Daniel, Pellerin, & Tavolacci, 2015), one of which is self-directed learning. Knowles (1975) described 'self-directed learning' as an inborn potential utilized by human beings at various times in their life while encountering new and challenging situations. The development of SDL may help learners adapt to changing environments and enhance their creativity. Over the past decades, self-directed learning (SDL) has received considerable attention in the educational literature (Santhanam, Sasidharan, & Webster, 2008; Bearn & Chadwick, 2010), and the concept may be generally well accepted in the field of volunteering, despite limited evidence to support its value in science service programs.

There are many studies linking self-directed learning to positive personal characteristics, individual achievement, and satisfaction. For example, Gagnon, Gagnon, Desmartis and Njoya (2013) have emphasized that it is more important to evaluate the learner's acceptability and satisfaction with SDL rather than the outcomes. Recently in higher education, self-directed learning has been gaining greater attention than ever as it is believed that it improves comprehension, memory, critical thinking, inquisitiveness, good decision making, achievement satisfaction, enthusiasm, competency and self-reliance (Shen, Chen, & Hu, 2014). These supported studies mean that the SDL of those volunteers who are satisfied with volunteering is quite important. Therefore, it is also becoming increasingly interesting to encourage SDL by enhancing volunteers' satisfaction with their volunteering activities.



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In sum, the major purpose of this research was to predict volunteers' motivation, self-directed learning and satisfaction with their science service. To this end, three questionnaires for assessing volunteers' motivation, self-directed learning and satisfaction with their science service were developed. Moreover, the possibility of using volunteers' motivation and self-directed learning to predict their satisfaction with their science service was considered. Based on the questionnaire responses of 289 participants in the project for science volunteers in Taiwan, the following questions were addressed:

1. What motivation, self-directed learning and satisfaction with their science service do the volunteers have?
2. What are the relationships between the volunteers' motivation, self-directed learning and satisfaction with their science service?

**Methodology of Research**

This research is part of a research trend which recognizes the relationships for a more holistic approach of volunteers' prime motivation, self-directed learning and satisfaction with their science service. A quantitative analysis of volunteers' perceptions was used so as to define the volunteers' satisfaction. The methodology, data collection, analyses and results of the survey method that used questionnaires as the assessment tools will be explained individually in detail. The data obtained from the questionnaires were analyzed using the statistical program for social science (SPSS) in the study. A series of analyses including factor, correlation and regression analyses were carried out in this research. Firstly, factor analysis was performed to identify the scales of the instruments assessing the volunteers' MSS, SDL and SSS. Moreover, correlation analysis was utilized to examine the relationships between the volunteers' MSS and SSS as well as their SDL and SSS. Then, through a stepwise multiple regression analysis, the volunteers' motivation and self-directed learning were viewed as predictors to explain their satisfaction with science service.

*Sample*

In Taiwan, the National Science Council (NSC) has developed an original Science Volunteer Locomotive Program which is designed to promote the development of science, education and humanity. Generally, volunteer service programs in Taiwan have been institutionalized; for example, the science volunteer service program is jointly run by educational institutions and nonprofit organizations. This program is intended to serve as a resource for those wanting to bring the human and material resources of the scientific and engineering communities into beneficial and sustainable relationships with schools through science volunteer programs that use a team approach to develop comprehensive school-focused plans.

These plans bring together scientists, mathematicians and technology expert volunteers from business, industry, government and higher education to work with community volunteers, educators and students. The participants of this research were from a project for science volunteers run by the Ministry of Science and Technology in Taiwan. According to the official statistics, altogether more than 1,400 volunteers, including 41 service teams, have served at different sites in Taiwan. For the purpose of this research, the participants were randomly selected from over 40 Science Volunteer Groups in Taiwan. The final sample included 289 volunteers of which 96 (33.21%) were male, while the other 193 (66.79%) were female. Of these 289 volunteers, 148 (51.21%) were less than 30-years-old, 40 (13.84%) were 31-40-years-old, and 101 (34.95%) were 41-years-old and above.

*Instruments*

In order to assess the volunteers' motivation, self-directed learning and their satisfaction with their science service, three questionnaires were implemented in this research.

*The Motivation toward Science Services* (MSS) questionnaire administered in the current research was developed based on previous related studies (e.g., Lai, Ren, Wu, & Hun, .2013; Lee, Reisinger, Kim, & Yoon, 2014) such as the "volunteer motivation questionnaire." Initially, the questionnaire included 21 items in total, presented with a seven-point Likert mode (anchored at 1, "strongly disagree" and 7, "strongly agree"). Four scales were designed for MSS. The following is a description of the details of each of these four scales:

*Development scale*: the individual is seeking to grow and develop psychologically through involvement in volunteering.
*Social scale*: volunteering allows the person to strengthen his/her social relationships.
*Understanding scale*: the volunteer is seeking to learn more about the world and/or exercise skills that are often unused.
*Altruism scale*: the individual's behavior promotes the welfare of others without conscious regard for his/her own self-interest.

*The Self-Directed Learning (SDL)* questionnaire, based on Chang (2006), is a 20-item questionnaire designed to assess volunteers for self-directed learning that consists of five subscales: "Effective learning" (4 items), "Desire for learning" (4 items), "Active learning" (4 items), "Independent learning" (4 items) and "Creative learning" (4 items). The items are rated on a five-point Likert-type scale (1 = strongly disagree to 5 = strongly agree). This instrument was adapted for science program volunteers in this research.

*The Satisfaction with Science Service (SSS)* questionnaire was adapted from Vecina et al. (2012). They proposed two factors of satisfaction with science service; these factors included a total of 11 items which were presented as bipolar strongly confident/strongly unconfident statements using a seven-point Likert scale. Following is a description of the details of these two scales:

*Satisfaction with organization scale*: measuring volunteers' perceptions of satisfaction with their volunteering organization.
*Satisfaction with volunteer experience scale*: assessing volunteers' perceived meaningful experience and responsibility for outcomes.

### *Data Analysis*

The data obtained from the questionnaires were analyzed using the statistical program for social science (SPSS) in the study. A series of analyses including factor, correlation and regression analyses were carried out in this research. Firstly, factor analysis was performed to identify the scales of the instruments assessing the volunteers' MSS, SDL and SSS. Moreover, correlation analysis was utilized to examine the relationships between the volunteers' MSS and SSS as well as their SDL and SSS. Then, through a stepwise multiple regression analysis, the volunteers' motivation and self-directed learning were viewed as predictors to explain their satisfaction with science service.

## Results of Research

### *Exploratory factor analysis of the MMS, SDL and SSS Questionnaires*

To validate the MMS, SDL and SSS questionnaires, three EFAs with varimax rotation were performed to clarify their structure. The results of the exploratory factor analysis for the MMS questionnaire are displayed in Table 1. Through this analysis, 22 items were included in the final version of MMS, with a total of 80.47% of variation explained, and the items were grouped into four meaningful factors: 0.89 (Development, 4 items), 0.91 (Social, 4 items), 0.91 (Understanding, 4 items), and 0.95 (practical enhancement, 6 items), Therefore, these scales were deemed to be sufficiently reliable for assessing volunteers' motivation to engage in science service.



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**Table 1. Rotated factor loadings and Cronbach alpha values for the MSS scales.**

| Scale | Factor 1 | Factor 2 | Factor 3 | Factor 4 |
|---|---|---|---|---|
| Factor 1: Development, $\alpha$ =0.89, | | | | |
| D 1 | 0.752 | | | |
| D 2 | 0.738 | | | |
| D 3 | 0.623 | | | |
| D 4 | 0.595 | | | |
| Factor 2: Social, $\alpha$ =0.91 | | | | |
| S 1 | | 0.761 | | |
| S 2 | | 0.723 | | |
| S 3 | | 0.654 | | |
| S 4 | | 0.520 | | |
| Factor 3: Understanding, $\alpha$ =0.91 | | | | |
| U 1 | | | 0.745 | |
| U 2 | | | 0.723 | |
| U 3 | | | 0.673 | |
| U 4 | | | 0.550 | |
| Factor 4: Altruism, $\alpha$ =0.95, | | | | |
| A 1 | | | | 0.830 |
| A 2 | | | | 0.822 |
| A 3 | | | | 0.820 |
| A 4 | | | | 0.791 |
| A 5 | | | | 0.765 |
| A 6 | | | | 0.706 |
| Percentage of variance | 28.49 | 19.55 | 16.72 | 15.71 |

*Overall $\alpha$ =0.97. Total variance explained is 80.47 %*

Table 2 reveals the SDL EFA results. In all, 18 items were retained in the SDL questionnaire and were divided into five meaningful factors as suggested by Chang (2006): 'Effective learning,' 'Desire for learning,' 'Active learning,' 'Independent learning,' and 'Creative learning.' The total variance explained for SDL was 71.04%. The reliability coefficients for these factors ranged from 0.79 to .88, while the overall alpha was 0.87. Consequently, these values indicate that the SDL questionnaire is a reliable instrument for evaluating volunteers' perceptions of their skills and attitudes associated with self-directedness in learning during science service.

**Table 2. Rotated factor loadings and Cronbach's alpha values for the SDL questionnaire scales.**

| Scale | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 |
|---|---|---|---|---|---|
| Factor 1: Effective learning, $\alpha$ =0.912 | | | | | |
| EL1 | 0.794 | | | | |
| EL2 | 0.707 | | | | |
| EL 3 | 0.740 | | | | |
| EL4 | 0.620 | | | | |
| Factor 2: Desire for learning, $\alpha$ =0.906 | | | | | |
| DL1 | | 0.637 | | | |
| DL2 | | 0.790 | | | |
| DL3 | | 0.670 | | | |
| DL4 | | 0.839 | | | |
| Factor 3: Active learning, $\alpha$ =0.894 | | | | | |
| AL1 | | | 0.790 | | |
| AL2 | | | 0.678 | | |
| AL3 | | | 0.651 | | |

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| Scale | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 |
|---|---|---|---|---|---|
| Factor 4: Independent learning, $\alpha$ =0.893 | | | | | |
| IL 1 | | | | 0.901 | |
| IL 2 | | | | 0.912 | |
| IL 3 | | | | 0.753 | |
| IL 4 | | | | 0.894 | |
| Factor 5: Creative learning, $\alpha$ =0.878 | | | | | |
| CL 1 | | | | | 0.757 |
| CL 2 | | | | | 0.782 |
| CL 3 | | | | | 0.758 |
| CL 4 | | | | | 0.702 |
| Percentage of variance | 16.173 | 17.400 | 12.545 | 16.162 | 16.985 |

*Overall $\alpha$ = 0.876. Total variance explained is 79.265%*

Furthermore, as shown in Table 3, the EFA results of the SSS reveal two factors among the items. It should be noted that the same criteria as were used for the other instruments (i.e., the MSS and SDL Questionnaires) were adopted for SSS. Finally, 10 items were included in the final version of SSS, accounting for 83.68% of the total variance explained. The alpha reliabilities of this research's sample were 0.96 for 'Satisfaction with organization,' 0.95 for 'Satisfaction with volunteer experience,' and 0.96 for the overall reliability of the SSS questionnaire. Therefore, it appears that these scales are highly reliable for measuring the volunteers' satisfaction with their science service.

**Table 3. Rotated factor loadings and Cronbach alpha values for the SSS scales.**

| Scale | Factor 1 | Factor 2 |
|---|---|---|
| Factor 1: Satisfaction with organization, $\alpha$ =0.96, | | |
| SWO 1 | 0.726 | |
| SWO 2 | 0.852 | |
| SWO 3 | 0.848 | |
| SWO 4 | 0.831 | |
| SWO 5 | 0.776 | |
| SWO 6 | 0.811 | |
| Factor 2: Satisfaction with volunteer experience, $\alpha$ =0.95 | | |
| SWVE 1 | | 0.878 |
| SWVE 2 | | 0.866 |
| SWVE 3 | | 0.896 |
| SWVE 4 | | 0.863 |
| Percentage of variance | 44.57% | 39.11% |

*Overall $\alpha$ =0.96. Total variance explained is 83.68%*

*Correlation Analysis: the MSS and SDL to the SSS*

The results of the Pearson correlation analysis are indicated in Table 4. They show that all of the MSS factors are significantly positively correlated to each scale of the SSS ($r>0.51$, $p<0.01$). These results, in general, support that volunteers expressing higher satisfaction with their science service were likely to express stronger intentions to learn for the purpose of their own development, to make more social contact, to enhance cognition, and to promote the welfare of others through their science service. This implies that higher satisfaction with volunteer experience may help the volunteers attain higher motivation to engage in science service, particularly for promoting the welfare of others. However, it was also found that 'Effective learning,' 'Desire for learning,' 'Active learning'

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and 'Creative learning' had positive correlations with both scales of the SSS (r>0.45, p <0.01); however, there was no statistical correlation between 'Independent learning' and either of the SSS scales. In summary, it seems that volunteers with higher MSS and SDL in their science service might tend to perceive satisfaction with the organization and to see their experiences as being useful.

**Table 4. Correlation of the volunteers' MSS, SDL and SSS.**

| | SWO | SWVE |
|---|---|---|
| Development | 0.56*** | 0.66*** |
| Social | 0.53*** | 0.69*** |
| Understanding | 0.57*** | 0.72**** |
| Altruism | 0.51*** | 0.67*** |
| Effective learning | 0.57*** | 0.65*** |
| Desire for learning | 0.51*** | 0.66*** |
| Active learning | 0.54*** | 0.65*** |
| Independent learning | 0.03 | -0.004 |
| Creative learning | 0.45*** | 0.56*** |

**** p<0.001.*

*Stepwise Regression Model of Predicting Volunteers' SSS*

To explore the predictive effects of the MSS and SDL scales on the SSS scales, we performed stepwise multiple regression analyses in which the MSS and SDL factors were the predictor variables, and each of the SSS scales was an outcome variable, as shown in Table 5. As the table shows, the SWO factor has significant relations with 'Understanding' (β= 0.57, p>0.001), 'Effective learning' (β= 0.36, p>0.001) and 'Development' (β= 0.20, p>0.05). Also, the SWVE factor has significant correlations with 'Understanding' (β= 0.72, p>0.001), 'Effective learning' (β= 0.34, p>0.001), 'Social' (β= 0.25, p>0.001), 'Active learning' (β= 0.18, p>0.01) and 'Altruism' (β= 0.16, p>0.05). In summary, the regression analysis revealed that the 'Understanding' and 'Effective learning' factors were the most significant predictors for each of the SSS scales. More specifically, in general, both 'Understanding' (ß=0.57~0.72) and 'Effective learning' (ß=0.36~0.36) significantly and positively predicted the SWO and SWVE scales, and explained 41% and 59% of the volunteers' satisfaction, respectively.

**Table 5. Stepwise regression model of predicting volunteer' SSS.**

| Dependent variables | Predicting variables | S.E. | *β* | *t* | $R^2$ |
|---|---|---|---|---|---|
| SWO | Understanding | .068 | .573 | 11.618*** | .328 |
| | Effective | .067 | .358 | 6.274*** | .413 |
| | Development | .118 | .198 | 2.546* | .426 |
| SWVE | Understanding | .054 | .719 | 17.139*** | .516 |
| | Effective | .052 | .344 | 7.229*** | .594 |
| | Social | .080 | .247 | 3.879*** | .615 |
| | Active | .066 | .177 | 2.995** | .627 |
| | Altruism | .065 | .155 | 2.570* | .636 |

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

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**Discussion**

In order to advance science and education, it is argued that expanded efforts are needed to garner support for and recognition of citizen science as a discipline and an important form of volunteer service (Newman et al., 2012). From this perspective, science volunteers should be the central focus of the related studies. Additionally, the majority of prior studies have examined the mechanisms which link satisfaction to volunteers' motivation and which explain the relationships among them (Wang & Wu, 2014; Kwok, Chui, & Wong, 2013). In this research, we further tested and developed another predictor for the measurement of volunteer satisfaction, suggesting that self-directed learning through volunteering plays a crucial intervening role in connecting with volunteers' satisfaction. Therefore, this research was designed to predict science volunteers' satisfaction with their science service by the measures of three questionnaires: motivation toward science service (MSS), self-directed learning (SDL) and satisfaction with science service (SSS).

This research is quite helpful for facilitating understanding of volunteers' motivation, self-directed learning and satisfaction related to science services. By using these three questionnaires, researchers can assess and review volunteers' motivation and satisfaction with science services in a more effective way, with possibly higher validity. The results demonstrate that the MSS, SDL and SSS questionnaires developed in this research on volunteering can be deemed to be sufficiently reliable for investigating various motivations, self-directed learning and their effect on the satisfaction of volunteers. A contribution of this research is the further conceptualization and development of predictors for the measurement of volunteers' satisfaction with their science service. Using factor analysis, the MMS and SDL conceptualized as predictors of satisfaction with considerable reliability are presented. Moreover, the results of this research derived from the correlation and stepwise regression analyses demonstrate that some useful predictors for satisfaction with science service were also revealed.

First of all, the correlation analysis revealed that all volunteers' MSS related to satisfaction with the organization and with their volunteer experience of science service. The Development, Social, Understanding and Altruism factors of MSS show higher correlation with satisfaction. Volunteers with higher motivation expressed greater satisfaction with the organization and with their volunteering experience of science service. This research supports many earlier studies' findings that volunteer motivation is positively associated with volunteer satisfaction (Barron & Rihova, 2011; Pauline, 2011). This suggests that, to improve volunteers' satisfaction with their science service, their motivation to engage in science service should be highlighted. Moreover, some studies have revealed the positive effects of SDL and technology usage perceptions (Gagnon et al., 2013; Shen, Chen, & Hu, 2014). This research supports these relevant studies, showing that volunteers' SDL, except for 'independent learning,' is a good predictor of satisfaction with the organization and with their science service volunteer experience. That is, volunteers who had higher 'effective learning,' 'desire for learning,' 'active learning' and 'creative learning' expressed more positive SSS. The results seem to suggest that volunteers should attempt to find ways to engage in self-directed learning so as to increase their satisfaction with the science service program.

Furthermore, the stepwise regression analysis displayed that 'understanding' and 'effective learning' were the most significant positive predictors of satisfaction with the organization and with their volunteer experience of science service. SSS can be enhanced by developing higher MSS understanding. This claim is supported by the research of Warner et al. (2011) who found that those volunteers who already understood more about learning useful skills were more satisfied with their experience, and intended to further extend their time with the organization. Additionally, the added value of this particular finding is the confirmation of the important role of volunteers' SDL within a broad range of variables and processes influencing satisfaction with the organization and with the volunteer experience. The implication of this finding is that, if volunteers adopt more effective learning regarding volunteering in science service, they are likely to be more satisfied with the organization and with their volunteer experience, which echoes the findings of previous studies (e.g., Dunlosky, Rawson, Marsh, Nathan, & Willingham, 2013; Garrett, MacPhee, & Jackson, 2010).

With the growth in the popularity of volunteering, it is suggested that future studies focus on issues relating to volunteers' perceptions. This current study was an initial attempt to investigate the relationships among volunteer motivation, self-directed learning and satisfaction with science service. The majority of the former studies on volunteer motivation and satisfaction were set in the context of social welfare volunteering, and proposed that motivation and self-directed learning are the major influences on volunteer satisfaction (Gagnon et al., 2013; Garner & Garner, 2011). This study, which was carried out in the context of science service, reveals that the MSS factor of Understanding and the SDL factor of Effective learning played significantly positive roles in the satisfaction of

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volunteers performing science service. This finding is consistent with the findings of previous studies carried out in the context of social welfare volunteer work, and also shines a light on the nature of science service volunteer work.

**Conclusions and Implications**

The research findings offer two important managerial implications. Firstly, the present research clearly supports a positive effect of motivation on both of the SSS factors. The findings suggest important implications that should be considered in both the design and the management of science service projects; it is therefore recommended that the designers and leaders of projects such as these focus their efforts regarding the recruitment and retention of volunteers on those motivational factors which are more salient and which have a positive relationship with the satisfaction and participation of the volunteers. Enhancing motivation in the design of the assemblage of volunteers is one approach to supporting scientific goals which are motivating, while well-designed participant support features can also help to create a more satisfying experience for participants. When promoting training courses and camp activities for science service projects, motivational factors have to be addressed and built into the satisfaction, so that science volunteers will be more inclined to participate in collaborative scientific projects when given the proper motivational impetus at the right time. As such, this popular science education promotion modulus can contribute to creating a sustainable environment for public science learning in Taiwan.

Second, along with the rapid growth of social welfare institutes and groups, the demand for volunteers is increasing. Some organizations suffer from a lack of volunteer participants. Corresponding to the research findings, organizations should provide clear and achievable goals for volunteers. Volunteers need to be given missions or tasks with specific meanings and clear instructions. In this way, the science volunteers will benefit greatly and will be capable of accomplishing the goals set by the organization. In addition, a high degree of collective motivation seems to suggest that science service projects should aim to enhance volunteer satisfaction with the project and with its goals. One way of doing this is by clearly communicating the project's mission and achievements to the volunteers (e.g., through the Internet, including social media). In general, science volunteers' motivation is pre-eminent, but satisfaction-oriented functionality is also just as prevalent in existing projects. These valuable results reveal that the science service project is a desirable education methodology that not only promotes popular science education but also cultivates the scientific literacy of the general public, which will motivate people to have more fun and to enjoy learning science.

Finally, this research was conducted with the involvement of volunteers from a variety of volunteer service programs, and the results indicate that the scale of the organization was an influencing factor on the volunteers' feedback. Bigger organizations tend to have a more positive reputation, and are likely to have greater access to resources compared with smaller organizations, while also tending to be more systematic in their management of volunteers. It is therefore suggested that future studies compare organizations of various sizes in order to identify whether the scale of the organization does in fact influence the attitudes and experiences of volunteers. It is also suggested that future studies focus on advancing the understanding of volunteer management and retention issues in order to clarify or compare the impacts of organization scale. The age of the volunteers should also be considered, as people of different ages tend to have different points of view, and different generations have different backgrounds and were raised in different ways. It is likely that these factors lead them to think in completely different ways, and therefore impact their volunteering attitudes. A better understanding of such generational differences would be an important contribution to the literature in this field.

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