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Promoting Female Students' Learning Motivation Towards Science by Exercising Hands-on Activities

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The purpose of this study is to design different hands-on science activities and investigate which activities could better promote female students' learning motivation towards science. This study conducted three types of science activities which contains nine hands-on activities, an experience scale and a learning motivation scale for data collection. Five hundred female students and three science teachers were recruited in this study. Three hundred students from all participants needed to fill out an experience scale about hands-on science activities and the other 200 students were divided into three groups and joined in different hands-on activities. All female students of three groups need to fill out the learning motivation scale before and after exercising hands-on activities. The results showed that all types of hands-on activities in this study could promote female students' learning motivation towards science, but the hands-on activities about daily life issues could better promote female students' learning motivation toward science than the others. This study suggested that hands-on activities should be considered in science teaching strategies. Science teachers and teaching material designers also need to design some science topics and activities which are closely related to daily life to promote female students' learning motivation towards science.

Keywords: female students, hands-on activity, learning motivation

Introduction

Learning motivation is one of the most important factors for promoting active learning and improving learning achievement (Hynd, Holschuh, & Nist, 2000; Pintrich, 2003; Polich, Ehlers, Otis, Mandell, & Bloom, 1986). However, in these few years, many previous studies indicated that female students showed lower learning motivation towards science and lower performance of science than male students (Matteucci & Mignani, 2011; Sáinz & López-Sáez, 2010). In 2009, the OECD (Organization for Economic Co-operation and Development) also indicated that the males performed better in mathematics and science than females did. The similar findings were also been found in Taiwan (Fan & Li, 2005). These findings which uncovered the gender differences on science learning are the important issues to explore in science education, especially in the learning motivation towards science. Hence, the main purpose of this study is to investigate how to promote female students' learning motivation towards science.

Many previous studies designed a lot of hands-on activities, such as craft productions and some chemistry experiments to promote students' learning motivation (Martinez-Jimenez, Pontes-Pedrajas, Polo, &

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Climent-Bellido, 2003; Simpson, 2003). But Colley (2003) mentioned that many activities or computer games of science learning were designed from boy's point of views, and it was difficult to induce girls' interesting. Fensham (2008) also reminded that the activities would be worked when the activities suited female students' fancy. To sum up, based on the past researches, it is useful to promote female students' learning motivation towards science by exercising hands-on activities, but the designs of hands-on activities should induce female students' interesting.

The purpose of this study is to design different hands-on science activities and investigate which activities could better promote female students' learning motivation towards science. The research question is based on the purpose of this study.

Research Design

Participants and Instruments

Five hundred female students from high schools (n = 500; mean age ± SD = 15.30 ± 1.65 years) and three science teachers (n = 3; mean age ± SD = 37.67 ± 4.51 years) in Taiwan participated in this study. Three hundred female students from all participants needed to fill out an experience scale about hands-on science activities (5-point Likert scale). This experience scale which was developed by this study (α = 0.92; total items = 9) contains three types of science activities. There are three hands-on activities in each type of science activities (see Table 1).

Table 1

The List of All Types of Science Activities and All Hands-on Activities

Types of science activities	Hands-on activities
DL (daily life issue)	A soap with hand made The theory of clean (To observe the clean phenomenon by using washing powder) Explore the macromolecular compounds through observing the diapers
CP (craft productions)	A motor with hand made Explore the theory of flight by manufacture an airplane toy Make the organic manure
Exp (experiments from textbooks)	The experiment of titration of acid and base The experiment of electroplate The experiment of solution dilution

The other two hundred female students from all participants were divided into three groups and participated in the hands-on activities (see Table 1). The first group joined the "daily life issue" activities (DL group; n = 66; mean age ± SD = 15.33 ± 1.67 years); the second group joined the "craft productions" activities (CP group; n = 67; mean age ± SD = 15.35 ± 1.66 years), and the third group joined the "experiments from textbooks" activities (Exp group; n = 67; mean age ± SD = 15.24 ± 1.66 years).

Every hands-on activity in each type of science activities was been held once a week and lasted 90 minutes. Every group joined one hands-on activity per week and completed whole activities for three weeks. In the period of a hands-on activity, each science teacher leaded a group and exchanged in every week. In other words, each teacher leaded each group once. These science teachers were been trained together before leading the activities, and they would use the same teaching strategies to lead these activities. The teachers needed to explain the steps of hands-on activity first, and then, make students to exercise products by themselves. At last, the teachers needed to explain the principle of this hands-on activity (see Figure 1).

All of these 200 female students need to fill out a learning motivation scale (5-point Likert scale) which

developed by this study (α = 0.92; total items = 14) before and after exercising the whole hands-on activities (see Figure 1).

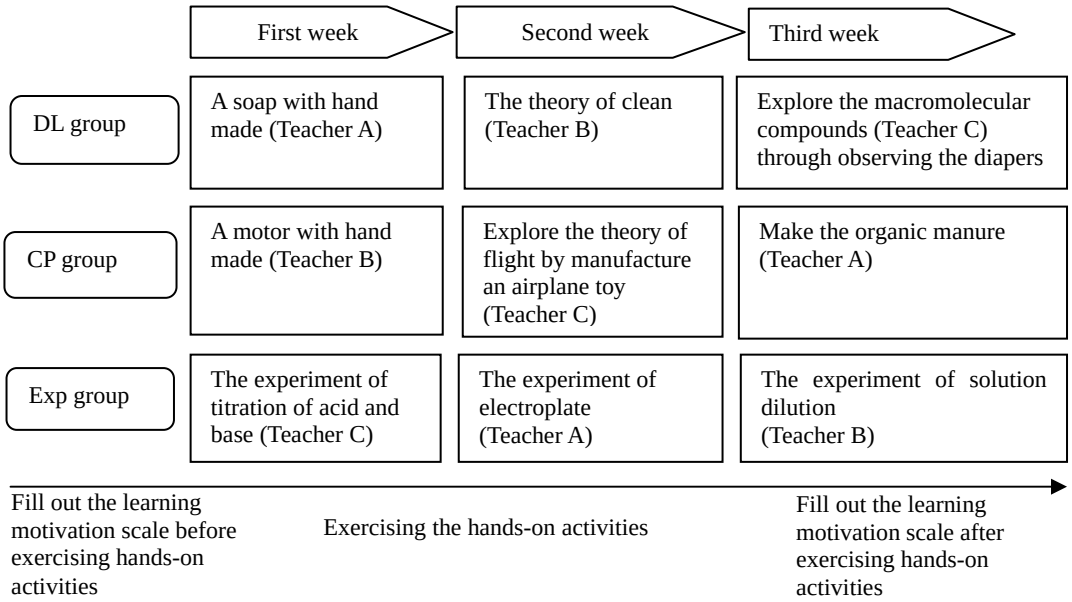

Figure 1. The research design of this study.

Data Collection and Analysis

The scores of experience scale and learning motivation scale were collected for analysis. The extracted data were analyzed using ANOVA (analysis of variance), MANOVA (multivariate analysis of variance), ANCOVA (analysis of covariance) and SPSS (Statistical Package for the Social Science) version 12.0.

Results and Discussion

Female students' Favorite Hands-on Activities Were all about the Daily Life Issue.

The results from the mean scores of experience scale showed that female students like the hands-on activities about daily life issues more than the hands-on activities about craft productions and experiments from textbooks (Table 2).

Table 2

The Sequence of Female Students' Favorite Hands-on Activities

Hands-on activity	Mean scores ± *SD* (Perfect score =5)	Type
A soap with hand made	4.34 ± 0.51	Daily life issues
The theory of clean (to observe the clean phenomenon by using washing powder)	4.30 ± 0.60	Daily life issues
Explore the macromolecular compounds through observing the diapers	4.30 ± 0.60	Daily life issues
Explore the theory of flight by manufacture an airplane toy	4.22 ± 0.69	Craft productions
The experiment of solution dilution	4.18 ± 0.72	Experiments from textbooks
A motor with hand made	3.94 ± 0.85	Craft productions
The experiment of titration of acid and base	3.68 ± 0.95	Experiments from textbooks
The experiment of electroplate	3.31 ± 1.03	Experiments from textbooks
Make the organic manure	2.92 ± 1.09	Craft productions

Table 2 indicated that the "hand made soap" could induce female students' interesting most, but most

female students do not like to make the organic manure. This finding is similar with the previous studies which mentioned that female students like the colorful and daily life hands-on activities, because these activities are closer to their life experiences (Gurian, 2006; Hayes, 1989).

Although the results of Table 2 demonstrated the sequence of female students' favorite hands-on activities, the influences of hands-on activities on female students' learning motivation towards science are not clear. Therefore, this study divided 200 female students who did not join to fill out the experience scales into three groups and exercised the different types of science activities. These female students needed to fill out a learning motivation scale before and after exercising the whole hands-on activities.

The Hands-on Activities About Daily Life Could Promote Female Students' Learning Motivation Towards Science

The results from mean scores of learning motivation before exercising hands-on activities through ANOVA analysis showed that there was no significant difference among the three groups (see Table 3).

Table 3

The ANOVA analysis of Learning Motivation Among Three Groups Before Exercising Hands-on Activities.

Group	Mean scores ± *SD* (Perfect score = 5)	*F* value	η^2
DL group	3.59 ± 0.96	0.066 (n.s.)	0.001
CP group	3.56 ± 0.99		
Exp group	3.53 ± 1.00		

Notes. n.s. means "no significant"; η^2 means effect size.

Table 3 showed that the three groups revealed similar low mean scores of learning motivation towards science before exercising hands-on activities. The finding was supported by the previous studies (Ding, Bosker, & Harskamp, 2010; Fan & Li, 2005).

Furthermore, all of the three groups revealed significant higher scores of learning motivation after exercising hands-on activities than before exercising activities individually through MANOVA test (see Table 4). The results were supported by past researches which mentioned that the hands-on activities could promote students' learning motivation towards science (Martinez-Jimenez et al., 2003; Simpson, 2003).

Table 4

The Scores of Learning Motivation of Three Groups Before and After Exercising Hands-on Activities Individually by MANOVA Test.

Group (Hands-on activity)	Mean scores ± *SD* (Perfect score = 5)		*SS*	*df*	*F* value	η^2
	Before	After				
DL group	3.59 ± 0.96	4.45 ± 0.45	41.64	65	50.73^{***}	0.438
CP group	3.56 ± 0.99	3.80 ± 0.78	91.90	66	9.79^{**}	0.118
Exp group	3.53 ± 1.00	3.89 ± 0.79	96.18	66	23.616^{***}	0.264

Notes. ** $P < 0.01$; *** $P < 0.001$; SS means Type III Sum of Squares; *df* means degree of freedom; η^2 means effect size.

Although all groups in this study promote the learning motivation towards science after exercising hands-on activities, this study wanted to further explore which activities could better promote female students' learning motivation towards science. Through ANCOVA analysis, there are significant differences in the scores of learning motivation among three groups (see Table 5). The results of Table 5 indicated that DL group got significant higher scores of learning motivation than CP group and Exp group. But, there was no significant

difference between DL group and Exp group.

Table 5

The ANCOVA Analysis of Learning Motivation Among Three Groups After Exercising Hands-on Activities (Covariance Factor: The Scores of Learning Motivation Before Excising Hands-on Activities)

Group	Mean scores ± SD (Perfect score = 5)	*SS*	*df*	*F* value	η^2	Post Hoc (Scheffe)
DL group	4.45 ± 0.45					DL > CP ***
CP group	3.80 ± 0.78	15.537	2	139.70***	0.001	DL > Exp ***
Exp group	3.89 ± 0.79					Exp > DL (n.s.)

Notes. *** $P < 0.001$; n.s. means "no significant"; SS means Type III Sum of Squares; *df* means degree of freedom; η^2 means effect size.

As Fensham (2008) and Kahveci, Southerland, and Glimer (2008) mentioned, the results of Table 4 and 5 indicated that although hands-on activities could promote female students' learning motivation, the activities which suit female students' fancy will promote female students' learning motivation towards science best.

To integrate Tables 2, 4, and 5, the results implied that female students preferred the hands-on activities about daily life issues most, and this type of science activities could promote female students' learning motivation better than the activities about craft productions and experiments from textbooks.

Conclusions

To promote students' learning motivation is a key to unlocking students' active learning (Hynd, Holschuh, & Nist, 2000). However, in general, the female students' learning motivation towards science is lower than that of male students (Matteucci & Mignani, 2011; Sáinz & López-Sáez, 2010). Hence, it is important and necessary to explore the learning or teaching strategies to promote female students' learning motivation towards science. The purpose of this current study was based on this reason.

There are two findings in this study. First, the result showed that all of the three types of science activities in this study which contains daily life issue, craft productions, and experiments from textbooks could promote female students' learning motivation towards science. Second, the hands-on activities about daily life issue could promote female students' learning motivation towards science better than the others.

This study provides a simple but deep and far implication for promoting female students' learning motivation towards science. The authors suggested that hands-on activities should be considered in science teaching strategies, and science teachers and teaching material designers need to design some science topics and activities which are closely related to daily life to promote female students' learning motivation towards science.

References

Colley, A. (2003). Gender differences in adolescents' perceptions of the best and worst aspects of computing at school. *Computers in Human Behavior, 19*, 673-682.

Ding, N., Bosker, R. J., & Harskamp, E. G. (2010). Exploring gender and gender pairing in the knowledge elaboration processes of students using computer-supported collaborative learning. *Computer & Education, 56*(2), 325-336.

Fan, T. S., & Li, Y. C. (2005). Gender issues and computers: college computer science education in Taiwan. *Computer and Education, 44*(3), 285-300.

Fensham, P. (2008). *Science education policy-making: Eleven emerging issues* (pp. 1-47). Paris: UNESCO.

Gurian, M. (2006). Learning and gender. *American School Board Journal, 193*(10), 19-22.

Hayes, E. (1989). *Insights from women's experience for teaching and learning*. San Francisco: Jossey-Bass.

Hynd, C., Holschuh, J., & Nist, S. (2000). Learning complex scientific information: Motivation theory and its relation to student perceptions. *Reading and Writing Quarterly, 16*(1), 23-57.

Kahveci, A., Southerland, S. A., & Gilmer, P. J. (2008). From marginality to legitimate peripherality: Understanding the essential functions of a women's program. *Science Education, 92*, 33-64.

Martinez-Jimenez, P., Pontes-Pedrajas, A., Polo, J., & Climent-Bellido, M. S. (2003). Learning in chemistry with virtual laboratories. *Journal of Chemical Education, 80*(3), 346-352.

Matteucci, M., & Mignani, S. (2011). Gender differences in performance in mathematics at the end of lower secondary school in Italy. *Learning and Individual Differences, 21*, 543-548.

Pintrich, P. R. (2003). A motivational science perspective on the role of student motivation in learning and teaching contexts. *Journal of Educational Psychology, 95*(4), 667-686.

Polich, J., Ehlers, C. L., Otis, S., Mandell, A. J., & Bloom, F. E. (1986). P300 latency reflects the degree of cognitive decline in dementing illness. *Electroencephalography and Clinical Neurophysiology, 63*(2), 138-144.

Sáinz, M., & López-Sáez, M. (2010). Gender differences in computer attitudes and the choice of technology-related occupations in a sample of secondary students in Spain. *Computers & Education, 54*, 578-587.

Simpson, T. W. (2003). Experiences with a hands-on activity to contrast craft production and mass production in the classroom. *International Journal of Engineering Education, 95*(4), 667-686.