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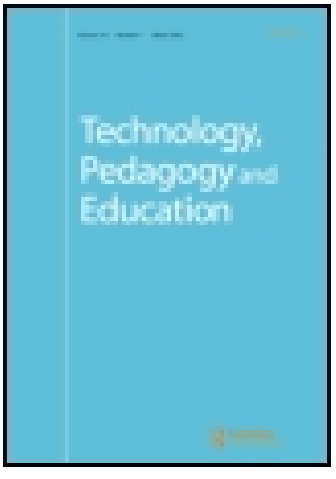




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The study aims to examine whether reflective writing using e-portfolios enhances high school students' self-regulated learning. Participants included two classes of eighth-graders majoring in Information Processing and taking a course called 'Website Design' at a vocational high school in Taiwan. There were 41 students, with 18 males and 23 females. The experiment lasted 10 weeks, and students used e-portfolios to reflect on their learning. The results showed that students after using e-portfolios to reflect on their learning had significantly better self-regulated learning than before. This indicates that using e-portfolios for reflection enhanced self-regulated learning. It also shows that high-reflection students had significantly better self-regulated learning than moderate-reflection and low-reflection students, which implies that reflective performance had a significantly positive effect on self-regulated learning.

**Keywords:** portfolio; e-portfolio; reflection; self-regulated learning



## 1. Introduction

### *1.1. E-portfolios and reflection*

Electronic portfolios (e-portfolios) have features of reflection, breadth, dynamics and sharing (Bartlett & Sherry, 2006) and can store the contents of students' reflections (Barrett, 2010). There are many kinds of content in e-portfolios, and reflection is one of the important activities (Abrami et al., 2008; Barrett & Garrett, 2009; Chang, Liang, & Chen, 2013; Chau & Cheng, 2010; Wade, Abrami, & White, 2006). E-portfolios not only help students deeply understand the intention of learning but also cultivate students' ability in active learning because students can reflect on and self-assess their selected projects and outcomes online during the development of portfolios (Linn & Miller, 2005). Some research also shows that using portfolios can cultivate students' reflective ability (Barrett, 2010; Carroll, Markauskaite, & Calvo, 2007; Jenson, 2011; Lopez-Fernandez & Rodriguez-Illera, 2009; Mansvelder-Longayroux, Beijaard, & Verloop, 2007; Tubaishat, Lansari, & Al-Rawi, 2009; Wang, 2009). McCready (2007)

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pointed out that reflection can change learning behaviour during the process of developing portfolios. In sum, reflection on the process of developing portfolios is not only an important learning behaviour but also a dynamic for improving learning behaviour.

### 1.2. E-portfolio and self-regulated learning

Some studies revealed that reflection can facilitate self-regulated learning, but these experiments were not done with e-portfolios (Anderson, 2009; van den Boom, Paas, & van Merrienboer, 2007; van den Boom, Paas, van Merrienboer, & van Gog, 2004; Zimmerman, 2008a). For example, Anderson (2009) enhanced students' self-regulated learning by reflective writing. Van den Boom et al. (2004, 2007) facilitated students' self-regulated learning through reflection prompts and teacher feedback. Some studies demonstrate that e-portfolios can help students improve their learning behaviour and facilitate self-regulated learning by self-review (Abrami et al., 2008; Carneiro, Lefrere, Steffens, & Underwood, 2011; Chang & Tseng, 2011; Gama & Idan, 2007; McCready, 2007; Wade et al., 2006). However, these studies did not confirm whether the results were caused by reflection or other factors. For instance, Jenson (2011) used e-portfolios to facilitate students' critical reflection and enhance self-regulated learning; Gama and Idan (2007) pointed out that e-portfolios can facilitate self-regulated learning and can be helpful for students' online reflection, teacher feedback, student feedback and storage of projects.

McCready (2007) stated that e-portfolios can be considered as a tool for reflection because reflection can stimulate learners to self-observe, self-judge, self-regulate and self-confirm repeatedly (Dysthe, Engelsen, & Lima, 2007). Self-observation and self-judgement are the constructs of self-regulated learning, so e-portfolios can facilitate the enhancement of different constructs for self-regulated learning. Zimmerman (2008a) suggested that reflection is a process for self-regulated learning and can be one of the factors that enhance self-regulated learning. Conversely, self-regulated learning can accelerate learners' reflection, which makes learners able to monitor the learning context (Gama & Idan, 2007). As a result, reflection and self-regulated learning can affect each other reciprocally. However, do students have better self-regulated learning when they reflect on their learning through e-portfolios? Can the constructs of self-regulated learning be enhanced? These questions were examined in the present study.

### 1.3. Reflection and self-regulated learning

Leung and Kember (2003) found that performance on reflection can be categorised into different levels. Yen and Chen (2008) pointed out that performance on reflection can influence students' academic performance and performance on meta-cognition and self-regulated learning. Performance on reflection can also affect learners' thinking process, learning diagnosis and evaluation as well as change their self-regulated learning behaviour (Mansvelder-Longayroux et al., 2007). Strijbos, Meeus, and Libotton (2007) stated that performance on reflection can affect performance on portfolio and regulation of learning behaviour. Folkesson and Swalander (2007) pointed out that the depth of reflection can influence reading and writing abilities on computers. Chang and Tseng (2011) believed that e-portfolios can make learners continuously self-regulate their learning and achieve the best learning performance

by introspection, teacher feedback and peer feedback. However, they did not examine whether learners' self-regulated learning can be facilitated through reflections by e-portfolios. Mansvelder-Longayroux et al. (2007) argued that through reflective writing in portfolios, students can review their learning experiences and compare them with current learning experiences. This way enables students to generate deep thinking or critical behaviour. Deep thinking can facilitate students' regulations of learning behaviour. In sum, performance on reflection has a certain effect on self-regulated learning. However, with e-portfolios, are there positive relationships between performance on reflection and self-regulated learning? This was a critical issue examined in the present study.

### *1.4. Research objectives and questions*

Based on the aforementioned research background, the purpose of the present study was to examine whether using e-portfolios for reflection processes can enhance self-regulated learning. The research questions are the following:

(1) Do learners have significantly better self-regulated learning after using e-portfolios for reflection processes?
(2) Do learners obtaining high scores on reflections have significantly better self-regulated learning than learners obtaining low scores on reflections?



## 2. Method

### *2.1. Participants*

Participants included two classes of eighth-graders majoring in Information Processing and taking a course called 'Website Design' at a vocational high school in Taiwan. There were 41 students, with 18 males and 23 females. The mean and standard deviation of the age of these students were 13.5 and 0.5. The experiment lasted 10 weeks, with students using e-portfolios to reflect on their learning. The course was related to design and creation, which required students to submit their computerised projects and to reflect on their learning processes, so it was appropriate for the implementation of an e-portfolio.

### *2.2. Research framework*

The approach using pretest–posttest of experiment design was adopted in the present study. The effect of e-portfolios on self-regulated learning was examined in the present study with performance on reflections as the independent variable and self-regulated learning as the dependent variable. During the experimental process, the students did not accept any other interventions that could have an impact on their improvements in self-regulated learning. If a student simultaneously accepted the other intervention, he or she would be requested to quit the experiment.

The measurement of students' self-regulated learning was administered before and after the experiment. The *t*-test was performed to examine students' differences in self-regulated learning before and after reflections. Pearson's correlation was used to identify the relationship between reflective performance and self-regulated learning. The simple regression was adopted to explore the effect of reflective

performance on self-regulated learning. Moreover, analysis of variance (ANOVA) was conducted to examine students' differences in self-regulated learning among different performances on reflection. A preliminary analysis on student e-portfolio contents was also conducted to be supportive and supplementary to statistical results.

Self-regulated learning refers to learners' performance on self-regulated learning including six constructs, which are self-efficacy, task value, learning anxiety, self-observation, self-judgement (e.g. peer model, teacher criteria and student self-set goals) and self-reaction (e.g. adaptive self-reaction and defensive self-reaction). Performance on reflection refers to scores that learners obtained from their reflections in e-portfolios. Learners' performance on reflection was assessed by the course instructor. Scores for reflections were categorised into three groups including high, middle and low.

### 2.3. Experimental process

The duration of the experiment was 10 weeks, consisting of two 90-minute classes each week, and students were required to complete two projects. Three stages of self-regulated learning, including forethought, performance and reflection, proposed by Zimmerman (2002), were incorporated into the processes of designing and creating the projects. E-portfolio assessments, including self-assessment, peer assessment and teacher assessment, and two reflective activities were performed after the completion of each project. The researchers hoped to enhance students' self-regulated learning behaviour by two self-regulated learning processes. The experimental procedures are shown in Table 1.

For the first week, students were given an orientation about the course including the conception of portfolios, learning-goal setting and reflective writing. Besides, the teacher demonstrated how to use the reflective mechanism in the e-portfolio system. Before the end of the class, the pre-test for self-regulated learning was administered to the students.

From the second week to the fifth week, the teacher taught students knowledge related to the first project. During the stage of forethought in the second week, the teacher explained instructional goals and showed sample work. Students set learning goals through the e-portfolio system based on course contents, instructional goals and their own learning abilities. The teacher gave students a guideline for goal setting, explained key points for learning goals and guided students in how to write learning goals. By the stage of performance in the third and fourth weeks, students designed and created the first project according to self-set learning goals. The project was uploaded to the e-portfolio system after the completion. At the stage of reflection in the fifth week, the teacher provided students a guideline for reflective writing, explained its key points and guided students in how to write about reflection. Students reflected on their achievement of learning goals, first project and learning progresses by using the reflective mechanism embedded in the e-portfolio system. Furthermore, students engaged in the observation of project, self-assessment, peer assessment and feedback online. The teacher also engaged in online assessment and feedback.

The learning tasks from the second week to the fifth week were repeated from the sixth week to the tenth week, except that the course contents and the projects were different. In the tenth week, students reflected on their project online, engaged in the observation of the project, self-assessment, peer assessment and feedback, and

Table 1. Experimental procedures.

| Week | Self-regulated learning process | Course unit | Instructional activity |
|---|---|---|---|
| 1 | | Orientation for the course | 1. Teacher introduced syllabus.<br>2. Teacher explained e-portfolios.<br>3. Teacher explained learning-goal setting.<br>4. Teacher explained reflection.<br>5. Teacher demonstrated how to use the e-portfolio system.<br>6. Students practised with the system.<br>7. Students filled in the questionnaire for self-regulated learning. |
| 2 | Forethought | Introduction of image processing | 1. Teacher explained instructional objectives.<br>2. Teacher demonstrated examples.<br>3. Teacher guided students how to set learning goals.<br>4. Students set learning goals online. |
| 3 | Performance | Design of desktop wallpaper | 1. Students designed and created the first project. |
| 4 | Performance | Design of main page | 1. Students designed and created the first project. |
| 5 | Reflection | Assessment on projects | 1. Students uploaded their project to the e-portfolio system.<br>2. Teacher guided students to reflect on their learning.<br>3. Students reflected on their learning online.<br>4. Students engaged in observation of project online.<br>5. Students engaged in self-assessment online.<br>6. Students engaged in peer-assessment and feedback.<br>7. Teacher engaged in assessment online. |
| 6 | Forethought | Introduction of FrontPage | 1. Students set learning goals online. |
| 7 | Performance | Development of background and frame | 1. Students designed and created the second project. |
| 8 | Performance | Design of uploading, menu and banner in a virtual space | 1. Students designed and created the second project. |
| 9 | Performance | Creation of marks and web visual effects, and application of table | 1. Students designed and created the second project. |
| 10 | Reflection | Assessment on projects | |

(*Continued*)

Table 1. (*Continued*).

| Week | Self-regulated learning process | Course unit | Instructional activity |
|---|---|---|---|
| | | | 1. Students uploaded their project to the e-portfolio system.<br>2. Teacher guided students to reflect on their learning.<br>3. Students reflected on their learning online.<br>4. Students engaged in observation of project online.<br>5. Students engaged in self-assessment online.<br>6. Students engaged in peer-assessment and feedback.<br>7. Teacher engaged in assessment online.<br>8. Students filled in the questionnaire for self-regulated learning. |

took the post-test for self-regulated learning. The teacher also engaged in online assessment and feedback.

### *2.4. Instrument*

#### *2.4.1. E-portfolio system*

The e-portfolio system and its reflective mechanism were designed and developed by the researcher. Students can login to the e-portfolio system for creating a personal e-portfolio including learning-goal setting, reflective writing and project uploading. Students can also participate in online observation, self-assessment and peer assessment. The system contains several functions. The main function is reflective mechanisms including (Figure 1): (a) reflective writing and editing which provide a text editor for students to write, add, delete and revise their reflections online conveniently and to write reflections regarding different learning topics; (b) guidance for reflective writing which provides learners an outline for writing reflections, a search tool and reflective hints; (c) observation of reflection which allows students to view peers' reflections online; (d) feedback which allows students and teachers to give feedback online; and (e) assessment on reflective performance which allows students to assess their own or peers' reflective performance.

#### *2.4.2. Scale of reflective performance*

The sub-scale for reflection, with a total of five items, in the e-portfolio assessment scale developed by Chang and Chou (2011) was employed in the present study. Items are related to reflections on learning goals, projects, learning achievements,

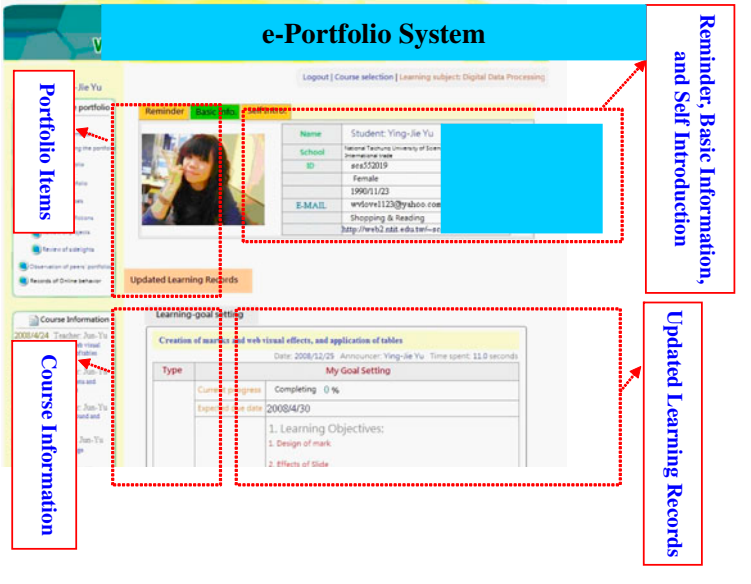


Figure 1. A page of a personal portfolio.

learning attitudes, observation of peer performance and peer feedback. The measurement is based on a 5-point Likert scale. Each point describes different levels of performance. The sub-scale was used and confirmed by Chang and Chou. The reliability coefficients of the scale in the present study were greater than 0.80, as measured by Cronbach's α, suggesting that the items had a relatively high reliability.

### *2.4.3. Scale of self-regulated learning*

The scale of self-regulated learning employed in the present study was developed by Wu (2005) based on self-regulated learning theory proposed by Bandura (1986), Schunk (2005) and Zimmerman (2002, 2008a, 2008b). The measurement is based on a 7-point Likert scale, with a total of 50 items. There are six constructs including self-efficacy (8 items), task value (5 items), learning anxiety (6 items), self-observation (6 items), self-judgement (12 items) and self-reaction (13 items). Among these constructs, a higher score of self-efficacy, task value and learning anxiety indicates a strong motivational belief. Self-judgement includes three sub-constructs, which are peer model (4 items), teacher criteria (4 items) and student self-set goals (4 items). Self-reaction includes two sub-constructs, which are adaptive self-reaction (8 items) and defensive self-reaction (5 items). A higher score of self-observation, self-judgement and self-reaction indicates better behaviour.

Intentions and examples for each construct:

(1) Learning motivation: Learners' willingness and intention toward learning.
   (a) Self-efficacy: Learners' belief about whether they can achieve the preset goals. For example, I am confident of passing the course.
   (b) Task value: Learners' belief about the importance of a subject or task. For example, I think the course content is valuable.
   (c) Learning anxiety: Learners' belief about anxiety and pressure from their learning. For instance, I am worried about not doing well on my learning.
(2) Self-observation: Learners' records and monitoring on whether they achieve the preset goals. For example, I review after the course is over.
(3) Self-judgement: Learners' belief about whether they achieve preset goals based on the work of peers, criteria set by teachers and goals set by themselves.
   (a) Peer model: Learners' beliefs about whether they achieved preset goals based on the work of peers. For instance, I often compare my learning progress with peers.
   (b) Teacher criteria: Learners' beliefs about whether they achieved preset goals based on criteria set by the teachers. For instance, I will evaluate my learning progress to see if I achieve the standards set by the teacher.
   (c) Self-set goals: Learners' beliefs about whether they achieved preset goals based on goals set themselves. For example, I will evaluate my learning progress to see if I achieve the goals set by me.
(4) Self-reaction: Learners' feelings toward their progress on goal achievement.

(a) Adaptive self-reaction: Learners' positive feelings and acceptance toward their progress on goal achievement. For instance, I am satisfied by my current learning progress.
(b) Defensive self-reaction: Learners' negative feelings and acceptance toward their progress on goal achievement. For example, I am frustrated by my current learning progress.

*2.4.3.1. Item analysis.* For the discrimination of the scale, a test of criterion of internal consistency was performed in the present study. An independent samples *t*-test was conducted to compare differences between high scores and low scores in each item. Three items did not show a significant *t* value, which indicated that they should be deleted since the discrimination indexes were unacceptable.

Pearson's correlations were performed after the three items were deleted. The result showed that the relationships between the scores of each item and the overall scale were significant ($r > 0.6$), which showed a high association. This implied that the item internal consistency of the scale was high.

*2.4.3.2. Factor analysis.* The Kaiser-Meyer-Olkin Measures of Sampling Adequacy (KMO) for pre-test and post-test were greater than 0.7, meaning that it was appropriate to proceed to a factor analysis. Bartlett's Test of Sphericity was significant, which implied that there were common factors among items. Principal components analysis with direct oblimin method of oblique rotation approach was conducted for the factor analysis in order to allow relationships to exist among factors (or constructs).

For the first factor analysis, the result of the pre-test showed that the factor loading for item 9 (the first item in the construct of task value) in the scale was smaller than 0.3, therefore should be deleted. After item 9 was deleted, the result of the pre-test and post-test for the second factor analysis revealed that factor loading for each item was greater than 0.5, therefore no item was deleted in the scale. The eigenvalue of each construct was greater than 1, hence six constructs and five sub-constructs could be established. The total accumulated variances of all constructs in the pre-test and post-test were all close to 80%, implying that the validity of the scale was adequate.

*2.4.3.3. Reliability.* The reliability coefficients of the overall scale and the constructs for both pre-test and post-test were higher than 0.86, as measured by Cronbach's $\alpha$, suggesting that the items had a relatively high internal consistency.

## 3. Results

### *3.1. Effects of reflection on self-regulated learning*

The *t*-test was employed to examine differences in self-regulated learning before and after reflection. As shown in Table 2, there was a significant difference in self-regulated learning, and the post-test was significantly better than the pre-test. There were significant differences in the constructs of self-efficacy, task value, self-observation and self-judgement, and the post-test was significantly better than the pre-test. Based on the effect size, self-observation had the highest effect size ($\eta^2 = 0.227$), followed by self-judgement, task value and self-efficacy, which showed that the system had the greatest effect on self-observation. On the other hand, learning anxiety and self-reaction did not have significant results.

Table 2. The *t*-test for differences in self-regulated learning before and after reflection.

| Construct | Sub-construct | Pre-test | | Post-test | | | | Effect size |
|---|---|---|---|---|---|---|---|---|
| | | Mean | *SD* | Mean | *SD* | *t* | Sig. | |
| Self-efficacy | | 35.05 | 6.75 | 38.85 | 8.05 | –2.315 | 0.021* | 0.146 |
| Task value | | 23.40 | 5.82 | 26.37 | 6.06 | –2.717 | 0.010* | 0.178 |
| Learning anxiety | | 17.00 | 7.15 | 18.82 | 7.53 | –1.448 | 0.157 | 0.058 |
| Self-observation | | 21.22 | 6.37 | 24.57 | 5.40 | –3.162 | 0.003** | 0.227 |
| Self-judgement | | 48.14 | 12.35 | 52.80 | 11.81 | –3.133 | 0.004** | 0.224 |
| | Peer model | 14.40 | 5.99 | 15.91 | 6.74 | –1.925 | 0.063 | 0.098 |
| | Teacher criteria | 16.62 | 4.74 | 17.80 | 3.80 | –1.813 | 0.079 | 0.088 |
| | Self-set goals | 17.11 | 3.58 | 19.08 | .69 | –3.174 | 0.003** | 0.229 |
| Self-reaction | | 45.62 | 6.58 | 47.54 | 9.15 | –1.200 | 0.239 | 0.041 |
| | Adaptive | 16.80 | 4.17 | 19.17 | 6.04 | –2.549 | 0.015* | 0.160 |
| | Defensive | 28.82 | 4.43 | 28.37 | 5.40 | 0.477 | 0.636 | 0.007 |
| Overall | | 174.91 | 24.65 | 192.51 | 28.03 | –3.809 | 0.001** | 0.299 |

*$p < 0.05$, **$p < 0.01$.

Among the sub-constructs of self-judgement, there was a significant result for self-judgement of comparison with student self-set goals, and the post-test was significantly better than the pre-test. There was no significant result for self-judgement of comparison with the peer model and teacher criteria. Among the sub-constructs of self-reaction, there was a significant result for adaptive self-reaction, and the post-test was significantly better than the pre-test. However, there was no significant result for defensive self-reaction.

### *3.2. Effects of reflective performance on self-regulated learning*

Pearson's correlation was used to identify the relationships between reflective performance and self-regulated learning. The results revealed that there was a significantly positive relationship between reflective performance and overall self-regulated learning ($r = 0.418$, $p < 0.01$). Specifically, for the constructs of self-regulated learning, there were significantly positive relationships between reflective performance and four constructs – learning anxiety ($r = 0.274$, $p < 0.05$), self-observation ($r = 0.396$, $p < 0.01$), self-judgement ($r = 0.384$, $p < 0.01$) and self-reaction ($r = 0.263$, $p < 0.05$). Moreover, there were significantly positive relationships between reflective performance and two sub-constructs – self-judgement of comparison with the teacher criteria ($r = 0.326$, $p < 0.05$) and self-judgement of comparison with self-set goals ($r = 0.425$, $p < 0.01$). However, there was a significantly negative relationship between reflective performance and one sub-construct – defensive self-reaction ($r = –0.443$, $p < 0.01$).

Simple regression analysis was used to find if reflective performance significantly influences self-regulated learning. The result revealed that reflective performance significantly and positively influenced overall self-regulated learning ($R^2 = 0.175$, $p < 0.01$). In other words, better reflective performance led to better overall self-regulated learning. Explained power of reflective performance on overall self-regulated learning was quite sufficient ($R^2 = 17.5\%$) and significant ($F = 9.357$, $p < 0.01$), indicating that in this regression model, it was proper to explain overall self-regulated learning by reflective performance.

Table 3. ANOVA for effects of reflective performance on self-regulated learning.

| Constructs | Sub-constructs | Reflective performance | Mean | *SD* | *F* | Sig. | Effect size | Post-hoc test |
|---|---|---|---|---|---|---|---|---|
| Self-efficacy | | H | 41.63 | 6.03 | | | | |
| | | M | 38.78 | 9.24 | 0.233 | 0.794 | 0.014 | |
| | | L | 38.20 | 9.54 | | | | |
| Task value | | H | 28.81 | 5.54 | | | | |
| | | M | 25.85 | 6.90 | 1.519 | 0.234 | 0.087 | |
| | | L | 24.40 | 4.88 | | | | |
| Learning anxiety | | H | 23.45 | 6.33 | | | | H > M, L |
| | | M | 16.00 | 7.07 | 3.673 | 0.037* | 0.187 | |
| | | L | 17.70 | 7.58 | | | | |
| Self-observation | | H | 29.00 | 5.63 | | | | H > M > L |
| | | M | 22.57 | 4.43 | 7.831 | 0.002** | 0.329 | |
| | | L | 17.50 | 3.40 | | | | |
| Self-judgement | | H | 62.63 | 9.69 | | | | H > M, L |
| | | M | 47.78 | 11.53 | 7.426 | 0.002** | 0.317 | |
| | | L | 49.00 | 7.58 | | | | |
| | Peer model | H | 19.81 | 5.17 | | | | |
| | | M | 14.07 | 7.11 | 3.005 | 0.064 | 0.158 | |
| | | L | 14.20 | 6.46 | | | | |
| | Teacher criteria | H | 20.54 | 3.01 | | | | H > M, L |
| | | M | 16.21 | 4.15 | 5.427 | 0.009** | 0.253 | |
| | | L | 17.00 | 2.40 | | | | |
| | Self-set goals | H | 22.27 | 2.64 | | | | H > M, L |
| | | M | 17.50 | 3.87 | 8.681 | 0.001*** | 0.352 | |
| | | L | 17.80 | 1.98 | | | | |
| Self-reaction | | H | 28.78 | 6.76 | | | | L > H, M |
| | | M | 30.09 | 6.22 | 3.658 | 0.037** | 0.186 | |
| | | L | 34.20 | 6.25 | | | | |
| | Adaptive | H | 21.00 | 5.58 | | | | L > H, M |
| | | M | 18.00 | 6.49 | 0.776 | 0.469 | 0.046 | |
| | | L | 18.80 | 5.99 | | | | |
| | Defensive | H | 12.63 | 4.73 | | | | L > H, M |
| | | M | 10.78 | 6.10 | 9.452 | 0.001*** | 0.371 | |
| | | L | 15.40 | 6.48 | | | | |
| Overall | | H | 216.00 | 23.43 | | | | H > M, L |
| | | M | 178.71 | 23.81 | 8.339 | 0.001*** | 0.343 | |
| | | L | 186.00 | 22.86 | | | | |

Notes: H: High reflective performance (27 students); M: Middle reflective performance (28 students); L: Low reflective performance (27 students).
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Reflective performance significantly influenced four constructs – learning anxiety ($R^2 = 0.075$, $p < 0.05$), self-observation ($R^2 = 0.157$, $p < 0.01$), self-judgement ($R^2 = 0.148$, $p < 0.01$) and self-reaction ($R^2 = 0.263$, $p < 0.05$) and three sub-constructs – self-judgement of comparison with the teacher criteria ($R^2 = 0.069$, $p < 0.05$), self-judgement of comparison with self-set goals ($R^2 = 0.181$, $p < 0.01$) and defensive self-reaction ($R^2 = 0.189$, $p < 0.01$). Except for negative effect on defensive self-reaction, reflective performance positively influenced other constructs. Better reflective performance led to lower defensive self-reaction.

The ANOVA for effects of reflective performance on self-regulated learning is shown in Table 3. Reflective performance was equally divided into three

groups – high reflective performance group (27 students), middle reflective group (28 students) and low reflective group (27 students). There were significant differences in the overall self-regulated learning among three groups of reflective performance. Scheffe's post-hoc test was performed. The result showed that students with high reflective performance had significantly better self-regulated learning than students with middle and low reflective performance. Among the constructs of self-regulated learning, there were significant results for learning anxiety ($F = 3.673$, $p < 0.05$), self-observation ($F = 7.831$, $p < 0.001$), self-judgement ($F = 7.426$, $p < 0.001$) and self-reaction ($F = 3.658$, $p < 0.001$), revealing that reflective performance had significant effects on these four constructs. Moreover, among the sub-constructs of self-regulated learning, there were significant results for self-judgement of comparison with the teacher criteria ($F = 5.427$, $p < 0.001$), self-judgement of comparison with self-set goals ($F = 8.681$, $p < 0.001$) and defensive self-reaction ($F = 9.452$, $p < 0.001$).

Based on the effect size, self-observation had the highest effect size ($\eta^2 = 0.329$), followed by self-judgement, learning anxiety and self-reaction. On the other hand, there was no significant result for self-efficacy and task value. The result for the post-hoc test revealed that students with high reflective performance had significantly better self-observation, self-judgement and reduced learning anxiety than students with middle and low reflective performance, and students with middle reflective performance had significantly better self-observation than students with low reflective performance. Since students with low reflective performance had significantly better defensive self-reaction than students with middle and high reflective performance, students with low reflective performance had significantly better self-reaction than students with middle and high reflective performance.

## 4. Discussion

### *4.1. Amelioration in self-regulated learning after using e-portfolio for reflection*

The performance in the overall self-regulated learning after reflection was significantly better than the performance before reflection, revealing that using portfolios for reflection would be helpful for the enhancement of self-regulated learning. The result was consistent with the study results done by Chamber and Wickersham (2007), Gama and Idan (2007), Mansvelder-Longayroux et al. (2007), Masui and Corte (2005), Simpson and Courtney (2007), Strijbos et al. (2007), Wade et al. (2006), and Yen and Chen (2008). However, participants in these studies did not reflect on their learning by e-portfolios.

Students' self-efficacy after reflection was significantly better than before, showing that using e-portfolios for reflection was beneficial for the enhancement of self-efficacy. The result was consistent with the study results found by Hadwin, Wozney, and Pontin (2005), Hsieh (2009) and Yost (2006). Some study results also show that reviewing the performance on learning-goal setting in the stage of forethought based on the self-regulated learning in the stage of reflection was helpful for the enhancement of self-efficacy (Gama & Idan, 2007; Hadwin et al., 2005; Iannotti et al., 2006; Wade et al., 2006). However, participants in these studies did not reflect using e-portfolios.

Students' task value after reflection was significantly better than before, revealing that using e-portfolios for reflection was helpful for the enhancement of task value.

The result was consistent with the study results discovered by Cole, Bergin, and Whittaker (2008) and Kay, Li, and Fekete (2007). However, participants in these studies did not reflect using e-portfolios. Cole et al. (2008) stated that learning attitude is an important factor that affects self-efficacy and task value. Chang and Tseng (2011) pointed out that there is a positive relationship between reflection and learning attitude. Therefore, a learner's interest in a subject can be observed through reflection (Kay et al., 2007; Yost, 2006).

Students' learning anxiety after reflection was not significantly higher than before, which was consistent with the study result found by Silvia, Eichstaedt, and Phillips (2005). Struyven, Dochy, Janssens, Schelfhout, and Gielen (2006) stated that loadings accumulated from creating portfolios can lead to learning anxiety. In fact, the time required for students to spend on the development of portfolios and assessments was not too long, so there was not too much learning anxiety. Moreover, reflection did not generate learning anxiety, which can be further examined in the future.

Students' self-observation after reflection was significantly better than before, revealing that using e-portfolios for reflection was helpful for the enhancement of self-observation. The result was consistent with the study results, which indicated that reflection was a good way to cultivate self-observation (Berrill & Whalen, 2007; Chapman, 2006; Forneris & Peden-McAlpine, 2007; Kay et al., 2007; Linn & Miller, 2005; Mansvelder-Longayroux et al., 2007; Wade, Abrami, Meyer, & White, 2008; Yost, 2006). However, participants in these studies did not reflect using e-portfolios.

Students' self-judgement after reflection was significantly better than before, revealing that using e-portfolios for reflection was helpful for the enhancement of self-judgement. The result was consistent with the study results found by Beishuizen et al. (2006), Mansvelder-Longayroux et al. (2007), Smith and Tillema, (2007), Strijbos et al. (2007), van den Boom et al. (2007), Wade et al. (2008), and Yen and Chen (2008). However, participants in these studies did not reflect on their learning by e-portfolios. Among the sub-constructs of self-judgement, there was no significant result for teacher criteria and peer model, but there was a significant result for student self-set goals, revealing that using e-portfolios to reflect on learning was helpful for viewing students' own preset goals (Hadwin et al., 2005) and can facilitate self-judgement of student self-set goals. The reason for the insignificant results for teacher criteria and peer model might be that students reviewed more on their own behaviour during the process of reflections in the experiment. In other words, students participated in reflection and review mainly according to their self-set goals, which caused a small effect of using e-portfolios on self-judgement of teacher criteria and peer model. Therefore, the effect of using e-portfolios on self-judgement of teacher criteria and peer model can be enhanced if teacher-to-student and peer-to-peer activities, such as peer assessment and feedback, are emphasised in an instruction. Another reason might be that the reflective mechanisms, such as observation, feedback and assessment, did not produce the effect, which should be strengthened.

Students' self-reaction after reflection was not significantly better than before. However, among the sub-constructs of self-reaction, there was a significant result for adaptive self-reaction, but there was an insignificant result for defensive self-reaction. This showed that using e-portfolios for reflection was helpful for the facilitation of adaptive self-reaction. Similar to the study result found by Wu (2005),

there is a negative correlation between adaptive self-reaction and defensive self-reaction. In other words, students with high adaptive self-reaction had less defensive self-reaction, whereas students with low adaptive self-reaction had more defensive self-reaction. Yost (2006) also stated that reflective behaviour can represent students' willingness for continuous learning. Therefore, the study result was reasonable.

Wu (2005) pointed out that there is a positive relationship between self-efficacy and task value. The present study result showed that there was no significant outcome for self-reaction, but there was a significant outcome for adaptive self-reaction. This result might be due to the small effect sizes for self-efficacy and task value, which led to an insignificant result for self-reaction.

### *4.2. Effect of reflective performance on self-regulated learning*

Some studies revealed that the quality of reflection can affect self-regulated learning (Simpson & Courtney, 2007). Some studies also showed that the higher the level of reflection, the better the self-regulated learning (Aslan, Schmid, & Abrami, 2009; Mansvelder-Longayroux et al., 2007; van den Boom et al., 2007; Yen & Chen, 2008), which was similar to the present study result that reflective performance had a positive effect on overall self-regulated learning. Students with better reflective performance would have better self-regulated learning.

There was no significant difference in self-efficacy among students with different reflective performance, revealing that reflective performance did not have a significant effect on self-efficacy. Wu (2005) stated that there was a positive correlation between self-efficacy and self-reaction. In other words, when a student's self-reaction tended to be adaptive, his or her self-efficacy would be better. On the other hand, when a student's self-reaction tended to be defensive, his or her self-efficacy would be low. In the present study, students' self-reaction was defensive, so the insignificant result for self-efficacy was reasonable. The insignificant result for self-efficacy might be caused by students' lack of learning experiences, which led to low intrinsic motivation (Wu, 2005). Yost (2006) also believed that the reason why reflective performance did not affect self-efficacy was that reflective activities were not interesting to students, which led to low self-efficacy.

There was no significant difference in task value among students with different reflective performance, revealing that reflective performance did not have a significant effect on task value. A study done by Wu (2005) showed that there was a relationship between task value and self-efficacy which was consistent with the present study result that there was no significant result for self-efficacy, so there was also no significant result for task value. Therefore, based on the relationships between the two constructs, the insignificant result for task value could be affected by the insignificant result for self-efficacy.

Some studies revealed that more learning experiences and enjoyment in a learning process would enhance task value (Cole et al., 2008; Hsieh, 2009; Kay et al., 2007; Mansvelder-Longayroux et al., 2007; Schank, 2004). However, it was found from students' reflective writing that they had both positive and negative learning experiences. Students with high reflective performance had better learning experiences than students with low and middle reflective performance, but there was no significant result for task value. This result was confirmed by a study by Schank (2004) that students with enough learning experiences did not have better task value because they might be affected by other factors which would affect their intrinsic

motivations and interests toward the course. Furthermore, low task value might be due to negative learning attitudes because learning attitudes could represent the importance of task value (Cole et al., 2008).

There were significant differences in learning anxiety among students with different reflective performance, revealing that reflective performance had a significant effect on learning anxiety. Students with high reflective performance had significantly higher learning anxiety than students with middle and low reflective performance. This result also showed that students would have different levels of learning anxiety and fear based on reflective performance. In other words, students with better reflective performance would have higher learning anxiety (Silvia et al., 2005) and higher anxiety accumulated from creating a portfolio (Struyven et al., 2006).

There were significant differences in self-observation among students with different reflective performance, showing that reflective performance had a significant effect on self-observation. This result was consistent with the study results found by Chapman (2006) and Kay et al. (2007). However, participants in these studies did not reflect on their learning using e-portfolios. Students with high reflective performance had significantly better self-observation than students with middle and low reflective performance, and students with middle reflective performance had significantly better self-observation than students with low reflective performance. This result showed that students with better reflective performance not only had a better quality of reflection (Kay et al., 2007) but also had clear thoughts about their own learning problems and progress (Yen & Chen, 2008) and more expectations about their performance (Simpson & Courtney, 2007), implying that reflection was a good method for self-observation.

There were significant differences in self-judgement among students with different reflective performance, showing that reflective performance had a significant effect on self-judgement. This result was consistent with the study results found by Kay et al. (2007). However, participants in these studies did not reflect on their learning using e-portfolios. Students with high reflective performance had significantly better self-judgement than students with middle and low reflective performance. Van den Boom et al. (2007) stated that students could be easily affected by goals set by teachers and themselves, but rarely affected by goals set by peers. Among the sub-constructs of self-judgement, reflective performance had significant effects on teacher criteria and students' self-set goals, implying that reflective performance would be helpful for the enhancement of self-judgement based on teacher criteria and student self-set goals. This result was consistent with the study result found by van den Boom et al. (2007). Students with high reflective performance had significantly better scores on self-judgement of teacher criteria and student self-set goals than students with middle and low reflective performance, showing that students' self-judgement could be easily facilitated by high reflection, teacher criteria and student self-set goals. Students with high reflective performance could easily change their self-judgement by teacher feedback and self-review. However, reflective performance did not affect self-judgement of the peer model, which needed to be further examined.

There were significant differences in self-reaction among students with different reflective performance, showing that reflective performance had a significant effect on self-reaction. Students with high reflective performance had significantly better self-reaction than students with middle and low reflective performance. Among the

sub-constructs of self-reaction, there were significant differences in defensive self-reaction among students with different reflective performance, implying that reflective performance had a significant enhancement on defensive self-reaction. Students with high reflective performance had significantly better defensive self-reaction than students with middle and low reflective performance. This result revealed that self-reaction was defensive, and students with low reflective performance tended to be more defensive. Wu (2005) stated that students with low self-efficacy and low task value tended to have defensive self-reaction. Thus, students' defensive self-reaction in the present study was probably caused by self-efficacy and task value. Students with low reflective performance had more defensive self-reaction than students with high reflective performance because they were afraid of learning or unwilling to learn. Moreover, high reflection could lower defensive self-reaction because students could engage in self-review and enhance learning experiences through reflection and then further affect self-reaction.



### *4.3. Preliminary analysis on student e-portfolio contents*

Based on the contents of reflections, using portfolios for reflection is helpful to enhance the quality of reflection and convenient for students to handle their reflections, which facilitates self-regulated learning. Using e-portfolios for reflection has the best effect on self-observation, revealing that students get used to reflecting on their learning based on their learning progress and learning performance. However, according to the contents of reflections, self-efficacy and task value were the most important elements for the enhancement of self-observation; therefore, the enhancement of motivational beliefs (e.g. self-efficacy, task value and anxiety learning) was a factor that facilitated self-observation. If e-portfolios pervade in schools, students should be encouraged to reflect on their learning using e-portfolios. The reflective mechanisms in the system which are convenient for students can enhance students' quality and effectiveness of reflections and positively affect self-regulated learning. This result of the study can be a reference for teachers who want to use the reflective mechanisms in the system as a tool for reflection in future instruction.

According to the contents of reflections, students with high reflection perceived that portfolio assessment would make them anxious. Grossman (2009) and Silvia et al. (2005) also had similar findings. Students with high reflection had high self-expectation and were concerned about their reflective performance. Zimmerman (2002) pointed out that as long as there is a test or homework in the process of learning, learning anxiety will exist. Students who had better performance in reflection would generate more anxiety because they were afraid of bad performance or assessments, which teachers should pay attention to. Students who did not perform well in reflection would generate defensive self-reaction because they had fewer experiences of reflection. Most teachers believed that time and energy spent in reflective activities was an extra burden, plus there was pressure of achieving course goals, so they were unwilling to include reflective activities in the course (Aslan et al., 2009). Therefore, most students were unfamiliar with reflection. Without training on reflection, students with low reflection could easily generate defensive self-reaction, which was negative learning behaviour that the teacher should pay attention to.

## 5. Conclusion and implication

### 5.1. Implication for teaching practice

Unfortunately, reflective performance did not decrease learning anxiety. Thus, perspectives about the effect of learning anxiety on self-regulated learning have still been inconsistent. However, according to Struyven et al. (2006), different methods of assessment will generate different levels of learning anxiety. Anxiety generated from the portfolio assessment was probably due to extra burdens accumulated from creating portfolios and assessments. The researcher believed that the generation of learning anxiety was a phenomenon of self-awareness for a learner. Accordingly, appropriately providing students with rewards and assistances for reflection was one of the strategies for decreasing anxiety. Therefore, it is suggested that reflective reward mechanisms can be added into the system by providing an incentive for good portfolios and reflections. Students should be appropriately given encouragement during the development of portfolios and reflection in order to decrease their anxiety about reflective learning and assessment.

Although reflection was an efficient learning method for students, students generally did not have high willingness to reflect on their learning during reflective activities in e-portfolios (Aslan et al., 2009; Chang & Tseng, 2011; Gama & Idan, 2007). According to Schank (2004), defensive self-reaction frequently results from students' spurious willingness or behaviours. However, students are actually unwilling to react in their deep minds. Students with low reflective performance tend to have defensive self-reaction, and to muddle their reflections. Therefore, it is suggested to enhance students' willingness, habit and adaptation toward reflection and use of reflective mechanisms. It is also suggested that teachers should look after students who do not participate in reflection in order to weaken their defensive self-reaction behaviour and enhance their adaptive self-reaction.

### 5.2. Limitation and future study

In the present study, the course was 'Website Design', which was appropriate for the implementation of e-portfolio research and practice because the projects required for the course were all web page products which were suitable to be included in students' e-portfolios. It is recommended that a future study might try different types of courses for multiple applications in e-portfolios. The same students were examined for their differences before and after using the reflective mechanisms in the system. According to the intervention of the quasi-experimental research, the explanatory power was not sufficient, which was one of the limitations of the present study. Therefore, for the future study, a control group (without using portfolios) can be added in the experiment for examining differences in self-regulated learning between students using e-portfolios to reflect on learning and students without using e-portfolios to reflect on learning, which will make the study results persuasive.



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