**An Investigation of the Effect of Project-based Learning on Students’ Self-regulation and Self-Efficacy Perception in Face-to-Face, Hybrid and Online Learning Environment**

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**Abstract:**

The purpose of this study was to investigate the effect of project-based learning (PBL) on pre-service teachers’ self-regulation and self-efficacy skills in face-to-face, hybrid and online learning environment. The investigator employed a within-subject design with three dependent variables: pre-service’ self-regulation skills, self-efficacy skills and learning styles and one independent variable class activities using project-based teaching. Participants in this study were 66 students, 54 undergraduate, 12 graduate in a Midwest university. The projects used in this experiment were designed to teach pre-service technology integration strategies in three different learning settings: Face-to-face, hybrid and online. The results revealed that the use of the project-based teaching strategy does improve pre-service teachers’ self-regulation skills in a technology integration course. Furthermore, the results showed that students’ self-efficacy perception was significantly improved after engaging in PBL strategy and that pre-service teachers’ self-regulated skills improved equally in three different learning environments: face-to-face, hybrid and online. Finally, the results showed that the PBL activities improves pre-service teachers self-regulated skills, regardless to their learning preferences, either they prefer to use lectures/discussions, books/written material, video/movies/media, or hands-on activities. Findings and the scholarly significance of the study were also discussed.

**Introduction:**

Preparing pre-service teachers to integrate technology in teaching is becoming increasingly complex process. During training, pre-service are required to apply technology in their lessons by considering the three components of successful technology integration: the technology, pedagogy and content knowledge (Chai, Koh, & Tsai, 2013; Mishra & Koehler, 2006). Researchers have explored different teaching strategies to help pre-service to effectively integrate technology into their own practice. The common theme of these teaching strategies is to help teachers bridge theoretical knowledge with practice through hands-on projects. This teaching approach requires students to engage in independent learning practices, where they have to monitor their own progress, adopt strategies, and systematically reflect on their learning results. Researchers identified these skills as the self-regulated learning. Students’ self-regulation skills are considered by many researchers to be important for successful learning (e.g., Efklides, 2008; Flavell, 1979; Middlebrooks & Sommer, 2011). For example, early studies found that learners with better self-regulation skills are not only better prepared to engage in the learning process but also learn more efficiently (Butler & Winne, 1995; Carver & Scheier, 2001; Schunk, 1996). Furthermore, learners with better self-regulated processes tend to deploy a number of cognitive, motivational, and metacognitive methods that seem to not only support but improve their learning (Schraw, Crippen, & Hartley, 2006). Researchers classify self-regulated skills into three types: Procedural knowledge (how to accomplish a task), declarative knowledge (awareness of how to do a specific task), and conditional knowledge (information needed to complete a task) (i.e., Flavell, 1979). The majority of researchers identify metacognitive skills in terms of self-regulated learning, metacognitive knowledge or both. For example, Flavell (1976) described the metacognition as the awareness of one’s thought processes. Others identified metacognition as the ability to know about our knowing (Dunlosky & Bjork, 2013). Other researchers denoted metacognitive as self-regulated learning with a multidimensional construct that emphasizes the active role of the learner (Abar & Loken, 2010; Efklides, 2011; Winne & Nesbit, 2010; Zimmerman, 2008). Although all terms present different perspectives on self-regulated learning, they largely share a similar perspective that self-regulated learners are actively constructing knowledge and using various cognitive and metacognitive strategies to control and regulate their academic learning (Zimmerman, 2000). Therefore, students with lower self-regulated learning skills tend to lack the skills to manage these different knowledges at the same time.

**Theoretical Framework:**

*Self-regulated learning and Self-efficacy*

Researchers assume that students’ self-regulated skills toward their learning goals should have a direct impact on subsequent achievement (Boekaerts & Corno, 2005). For example, Schraw and Dennison (1994) conducted a study to assess students’ metacognitive awareness level using the metacognitive awareness inventory (MAI) survey and found that only knowledge of cognition factor (one of eight factors of the MAI) correlated with reading comprehension test performance. Other researchers investigated the correlation between metacognitions skills and adult students’ motivations in online learning environments. For example, Artino (2008) examined metacognition and its relation to students’ motivation and found that motivational components of self-regulation are positively related to student satisfaction between adult learners. Similarly, Puzziferro (2008) found that students’ self-regulation component in their metacognition is significantly and positively correlated with students’ motivation and satisfaction between college students in an online learning environment.

Researchers have also found that students’ self-regulated learning skills is closely linked to their self-efficacy (Bong & Skaalvik, 2003; Linnenbrink & Pintrich, 2003; Pintrich, 2004; Seifert, 2004) and many studies have found that students’ self-efficacy has a profound impact on their academic achievements (Ferla, Valcke, & Schuyten, 2008; Walker, Greene, & Mansell, 2006). For example, Chemers (2001) found that students who enter college with confidence in their ability to perform well academically often do perform significantly better and that the level of self-efficacy that students reported during the first year of university is frequently a strong predictor of their performance.

*Project-based Learning*

Project-based learning is a teaching strategy that focuses on student-directed investigation (Blumenfeld et al., 1991; English & Kitsantas, 2013). Through this strategy, students engage in projects by articulating questions for investigation, designing plans, collecting and analyzing information, and creating a product of their understanding (Blumenfeld et al., 1991). Through students’ enquiry and experience with the project under study, they are expected to identify information needed, locate resources and then integrate the collected resources into coherent projects. The core focus of PBL learning setting is allowing students to organize their learning around the investigation, explanation, and resolution of meaningful problems. Consequently, by allowing students to become responsible for their own learning, they engage in reflective and critical thinking about what is being learned (Barrows, 2000; Bereiter & Scardamalia, 1989; Torp & Sage, 1998). Therefore, project-based learning is considered as an important learning approach that may support students’ self-regulated learning through setting goals, selecting learning tasks and strategies, and monitoring progress toward goals (Blumenfeld et al., 1991; English & Kitsantas, 2013; Sungur & Tekkaya, 2006).

*Preferred learning styles*

The concept of learning style describes differences in learning based on student’s preference for employing different phases of the learning cycle. According to Gardner multiple intelligences theory (2011), students have different preferred learning styles and they have different approaches or ways of learning. Students’ preferred learning styles was defined in the literature as the way individuals seek to extract, process, and memorize information (Brown, Stothers, Thorp, & Ingram, 2006). The educational literature identified the types of learning styles as visual learners, auditory learners, kinesthetic learners, and tactile/kinesthetic learners. According to prior studies, different students have different perceptual learning styles or different sensor preferences for processing information.

Several studies examined the relationships between learning styles, motivation, teaching techniques, delivery modes and online learning environments (Cook, Thompson, Thomas, Thomas, & Pankratz, 2006; Halbert, Kriebel, Cuzzolino, Coughlin, & Fresa-Dillon, 2011). For example, many studies examined the relationship between students’ learning styles and academic work. Terrell and Dringus (2000) investigated graduate students in information science major in an online course using the Kolb Learning Style Inventory (Kolb, 1976). The study found that the majority of students can succeed in an online learning environment regardless of their learning style. Simpson and Du (2004) used the same Kolb learning style inventory to examine the effect of students’ learning styles on their online participation and the level of satisfaction in distributed learning environments. The results indicated that learning style had a significant impact on the students’ participation and students’ satisfaction level. Based on these and similar findings, many researchers have noted that it is important to identify student learning styles and adopt course design to accommodate these styles. For example, Michalski (2008) addresses students’ learning styles in online learning environment and how to develop materials to accommodate different learning styles. The results suggested that before develop learning materials; instructors have to know who their students learn and their learning styles. Other studies investigated the relationship between learning style and preference for delivery mode such as learning through classroom, computer, video, print, or audio-based delivery modes. For example, Buch and Bartley (2002) examined learning style and the delivery mode and found stronger preference for computer-based delivery and assimilators as well as an overall preference for classroom-based delivery for adults, regardless of their learning style.

**The purpose of the research**

In the light of prior research, the purpose of this study is to examine the effect of project-based learning (PBL) on pre-service teachers’ self-regulation and self-efficacy skills in face-to-face, hybrid and online learning environment.

**Research Questions**

Research questions guiding this study include:

1. Is PBL an effective teaching strategy for improving pre-service’ self-regulation skills?
2. Does PBL effect pre-service’ self-regulation differently in face-to-face, hybrid and online learning environment?
3. Is PBL an effective teaching strategy for improving pre-service’ self-efficacy to integrate technology in teaching?
4. Does PBL effect pre-service’ self-efficacy differently in face-to-face, hybrid and online learning environment?
5. Does PBL effect pre-service differently based on their learning style preferences?

**Method**

This study employed a within-subject design to examine the effect of project-based instruction on pre-service teachers’ self-regulation and self-efficacy skills in face-to-face, hybrid and online learning environment. The present study has three dependent variables: pre-service’ self-regulation skills, self-efficacy skills and learning styles and one independent variable class activities using project-based teaching. The projects used in this experiment were designed to teach pre-service technology integration strategies in three different learning settings: Face-to-face, hybrid and online. The participants were pre-service in three different sections: two undergraduate and one graduate section.

***Participants:***

Participants in this study were pre-service teachers in a Midwest university. The 66-participant demographics were as following: 54 undergraduate, 12 graduate, 5-male, 61-female, 2-Asian 6-Black / African American, 6-Hispanic / Latino, 51-White / Caucasian. All participants were fluent in English. Students reported that their preferred learning style is 7-Lectures/Discussions, 2-Books/Related Written Material, 4-Video/Movies/Media, 25-Hands-on activities, 26-Mixed method. Students reported that their age as the following: 44- age between 18-21, 10-age between 22-25, 6-age between 26-30 years, 2-age between 31-40 years, 3-age 41or over.

**Materials**

All learning materials and the assigned projects used in this study were designed or approved by the course instructors. The learning materials and projects were assigned to students every week. The instrumentations consisted of the following items: demographic survey, 10-question 11-level Likert scale to assess students’ perceived self-efficacy based on Bandura’ measure (Bandura, 2006) and 52-question true/false Metacognitive Awareness Inventory (MAI) adopted from Schraw and Dennison (1994) to collect students’ perception regarding their metacognitive knowledge and metacognitive regulation.

*Self-efficacy survey:*

The self-efficacy questionnaire was designed with 11-point scale ranges from "Cannot do at all" at zero to “Highly certain can do" at 100 and it was administered at both the beginning and the end of the study. Students were asked to answer how confident they were in their belief that they have this ability". For example, in survey question number three, students were asked the following question: “How certain are you that you can identify and use technology tools and information resources in your content area to increase productivity, promote creativity, and facilitate academic learning. Rate your degree of confidence by recording a number from zero to 100 using the scale given below”. Participants could rate their confident by selecting a number starting from zero "Cannot do at all" to 100 “Highly certain can do". The investigators developed the self-efficacy measure based on Bandura’s “Guide to the construction of self-efficacy scales” in Pajares & Urdan (2006). The measure is tailored to assess students’ ability to integrate technology in their teaching.

The initial ratings of the measure indicated that all items adequately reflect and assess the topics covered in all conditions and the scores averaged across the 10 items. Mean for the total sample M = 83.00, SD = 11.30, range = 8.38. The investigators calculated the inter-rater reliability of the measure by intra-class correlation coefficients to evaluate the consistency of the ratings. The reliability for the measure Cronbach’s alpha (an estimated of internal consistency) was .92 (across all sections). Furthermore, the investigators used this measure of self-efficacy assessments in other classes related to teaching pre-service teachers (face and construct validity). Finally, the investigators examined the measure’s scale results and scale results of other concepts in the courses such as computer- assisted instruction, virtual classroom and course management system, and found that the results of this measure significantly correlated with the results in other concepts and Cronbach’s alpha was .88 (criterion-related validity).

*Metacognitive Awareness Inventory (MAI):*

The investigators utilized the MAI adopted from Schraw and Dennison (1994) to collect students’ perception regarding their metacognitive knowledge and metacognitive regulation (Hammann & Stevens, 1998; Sperling, Howard, Staley, & DuBois, 2004) and it was administered at the beginning of the study. The MAI consists of 52-true or false statements with number one (true) or zero (false). The MAI instrument represents eight component categories of metacognition: declarative, procedural, conditional, evaluation, information management strategies, comprehension monitoring, debugging strategies and planning strategy. Within the inventory the 52 questions were divided as follows: eight declarative questions, four procedural, eight conditionals, six evaluations, ten information management strategies, seven comprehension monitoring, five debugging strategies and seven questions in planning strategy. Mean for the total sample M = 41.67, SD = 8.09, range = 32.

The investigators conducted content validity of the MAI by consulting with experts in psychology department for their input and necessary corrections. The experts ensured the face and content validity of MAI. Furthermore, an internal consistency and reliability analysis of the MAI eight category measures was conducted through Cronbach's alpha and the analysis produced a total of .830 Cronbach's Alpha. The investigators calculated the inter-rater reliability of the measure by intra-class correlation coefficients to evaluate the consistency of the MAI. The reliability for the measure Cronbach’s alpha (an estimated of internal consistency) was .830 (across all class sections). Further, the MAI measure was used successfully in other studies since 1994 to measure students’ metacognitive knowledge and metacognitive regulations between college students (face and construct validity). Finally, the investigators examined the measure’s scale results and scale results of other studies and found that the results significantly correlated and Cronbach’s alpha was .83 (criterion-related validity).

*Materials*

The learning materials used in the present study intended to help preservice teachers integrate technology in teaching. The materials were alike in all sections and released to students with the related projects every week. The teaching methods was based on completing a project for every topic. Students read a chapter or online materials before class (at home) or watch a video or screencast. The instructor dedicated most of class time or the online activities for hands-on projects. Students worked through with the guidance of the instructor and the support of their peers. In this method, the instructor emphasized collaborative learning and students had the opportunity to post online questions to the instructor and their peers for help or clarification. For example, the instructor assigns the topic “Distance teaching and learning and the role of the Internet”, students were guided to complete project-based activities related to this topic. Students were asked to develop a WebQuest including: deciding the lesson to be taught through the WebQuest, using Google to collect the information web links, images and videos and finally creating a free website for the WebQuest that includes these pages: Introduction, Task, Process, Resource, Evaluation, Conclusion and Teacher Page. During the activity, students were free to ask for help or ask questions of their peers or instructor.

*Procedure*

At the beginning of the semester students in all sections completed demographic and self-efficacy and the Metacognitive Awareness Inventory (MAI) surveys. Second, the instructor used the project-based method to teach 10 topics in 10 consecutive weeks to all sections. At the end of the semester, students completed again self-efficacy and the Metacognitive Awareness Inventory (MAI) surveys.

**Results**

Prior to the main analyses, the data was screened for normality, out-of-range responses and systematic patterns of missing values. It was found that the data is normally distributed with no apparent patterns or clusters emerging.

*First question:* Is PBL an effective teaching strategy for improving pre-service’ self-regulation skills?

To answer this question, the investigators conducted one-sample t-test to determine if a statistically significant difference existed between students mean self-regulation scores before and after engaging in project-based class activities.

Pre-service teachers who engaged in project-based leaning strategy in all leaning environments (face-to-face, hybrid and online) reported higher metacognitive skills scores (M =45.56, SD = 5.61) compared to their scores before the PBL activities, *t*(60) = 63.37, *p* = .000.

These results suggest that the PBL activities does have positive effect on preservice teachers’ metacognitive skills in a technology integration course. Specifically, our results suggest that when students engage in the PBL activities, metacognitive skills scores improved. Table 1 summarizes the one-samples t-test results.

*Table 1: Results of One-sample t-test and Descriptive Statistics for Students’ Metacognitive Scores Before and after the project-based teaching strategy*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Outcome | M | SD | n |  | 95% CI for Mean Difference | t | df |
| Students’ Metacognitive Before | 42.47 | 7.29 | 66 |  | 11.53, 41.22 | 47.328 | 65 |
| Students’ Metacognitive After | 45.56 | 5.61 | 61 |  | -0.08, 0.02 | 63.379\* | 60 |

\* p < .000.

*Second question:* Does PBL effect pre-service’ self-regulation differently in face-to-face, hybrid and online learning environment?

To answer this question, the investigators conducted an analysis of variance One-way ANOVA to compare effect of PBL strategy on the students’ self-regulation skills in three different learning environments: face-to-face, hybrid and online.

The analysis of variance showed that the effect of PBL strategy on students’ metacognitive skills in three different learning environments: face-to-face, hybrid and online was nonsignificant, F (2,58) = .378, p = .687.

These results suggest that the PBL activities does have equal effect on preservice teachers’ metacognitive skills in a technology integration course in three different learning environments: face-to-face, hybrid and online. Specifically, our results suggest that when students engage in the PBL activities in face-to-face, hybrid or online, metacognitive skills scores improved at the same level. Table 2 summarizes the analysis of variance results.

*Table 2: Results of analysis of variance for Students’ Metacognitive Scores in three different learning environments: face-to-face, hybrid and online*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Metacognitive Scores | Sum of Squares | df | Mean Square | F | Sig. |
| Between Groups | 24.327 | 2 | 12.163 | .378 | .687 |
| Within Groups | 1866.722 | 58 | 32.185 |  |  |
| Total | 1891.049 | 60 |  |  |  |

*Third question:* Is PBL an effective teaching strategy for improving pre-service’ self-efficacy to integrate technology in teaching?

To answer this question, the investigators conducted one-sample t-test to determine if a statistically significant difference existed between pre-service’ self-efficacy mean scores before and after engaging in project-based class activities.

Pre-service teachers who engaged in project-based leaning strategy in all leaning environments (face-to-face, hybrid and online) reported higher self-efficacy scores (M =869.51, SD = 115.47) compared to their scores before the PBL activities, *t*(60) = 58.81, *p* = .000.

These results suggest that the PBL activities does have positive effect on preservice teachers’ self-efficacy scores in a technology integration course. Specifically, our results suggest that when students engage in the PBL activities, self-efficacy scores improved. Table 3 summarizes the one-samples t-test results.

*Table 3: Results of One-sample t-test and Descriptive Statistics for Students’ self-efficacy scores Before and after the project-based teaching strategy*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Outcome | M | SD | n | 95% CI for Mean Difference | t | df |
| Self-Efficacy Before | 544.55 | 178.36 | 66 | 500.70 | 24.80 | 65 |
| Self-Efficacy After | 869.51 | 115.47 | 61 | 839.93 | 58.81\* | 60 |

\* p < .000.

*Fourth question:* Does PBL effect pre-service’ self-efficacy differently in face-to-face, hybrid and online learning environment?

To answer this question, the investigators conducted an analysis of variance One-way ANOVA to compare effect of PBL strategy on the students’ self-efficacy skills in three different learning environments: face-to-face, hybrid and online.

The analysis of variance showed that the effect of PBL strategy on students’ self-efficacy in three different learning environments: face-to-face, hybrid and online was nonsignificant, F (2,58) = .163, p = .850.

These results suggest that the PBL activities does have equal effect on preservice teachers’ metacognitive skills in a technology integration course in three different learning environments: face-to-face, hybrid and online. Specifically, our results suggest that when students engage in the PBL activities in face-to-face, hybrid or online, metacognitive skills scores improved at the same level. Table 4 summarizes the analysis of variance results.

*Table 4: Results of analysis of variance for Students’ self-efficacy Scores in three different learning environments: face-to-face, hybrid and online*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Self-efficacy Scores | Sum of Squares | df | Mean Square | F | Sig. |
| Between Groups | 4478.02 | 2 | 2239.01 | .163 | .850 |
| Within Groups | 795607.22 | 58 | 13717.37 |  |  |
| Total | 800085.25 | 60 |  |  |  |

*Fifth question:* Does PBL effect pre-service differently based on their learning style preferences?

To answer this question, the investigators conducted an analysis of variance One-way ANOVA to compare effect of PBL strategy on the students’ learning styles Lectures/Discussions, Books/Related Written Material, Video/Movies/Media, Hands-on activities and Mixed method in three different learning environments: face-to-face, hybrid and online.

The analysis of variance showed that the effect of PBL strategy on students’ learning styles in all learning environments was nonsignificant, F (4,54) = .391, p = .814.

These results suggest that the PBL activities does have equal effect on preservice teachers in a technology integration course in all different learning environments regardless of their learning preferences. Specifically, our results suggest that when students engage in the PBL activities in face-to-face, hybrid or online, metacognitive skills scores improved at the same level either they prefer any of the following learning styles: learning styles Lectures/Discussions, Books/Related Written Material, Video/Movies/Media, Hands-on activities and Mixed method. Table 5 summarizes the analysis of variance results.

*Table 5: Results of analysis of variance for Students’ metacognitive Scores with preferred learning styles*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Self-efficacy Scores | Sum of Squares | df | Mean Square | F | Sig. |
| Between Groups | 51.98 | 4 | 12.996 | .391 | .814 |
| Within Groups | 1796.67 | 54 | 33.272 |  |  |
| Total | 1848.64 | 58 |  |  |  |

**Scientific or scholarly significance of the study or work:**

The present study adopted project-based teaching strategy to help pre-service teachers integrate and apply technology in teaching. The purpose of the study was to examine the effect of project-based instruction on pre-service teachers’ self-regulation and self-efficacy in face-to-face, hybrid and online learning environment. The main finding of this study is that the use of the project-based teaching strategy does improve pre-service teachers’ self-regulation skills in a technology integration course. This benefit demonstrated by the statistically significant differences in pre-service teachers after engaged in PBL strategy and reported higher self-regulation and self-efficacy scores in all learning environments (face-to-face, hybrid and online). Furthermore, the results suggest that students engaged in the PBL viewed their learning activities as more personal curiosity to discover new tools to use in teaching and offered them internal motivation. According to Blumenfeld (1991), students are more likely to take part in technology project-based learning when projects focus on questions that they perceive as valuable, are challenging, include a variety of activities, are realistic and result in authentic products. Furthermore, as students generate learning goals or problems, they seek new information when they find themselves unable to proceed without deepening understanding of what is already known Therefore, PBL environment offers students the opportunity to identifying and generating a "need to know" and leading to meaningful integration of information (Moore, 1995).

Another significant finding of this study is that students’ self-efficacy perception was significantly improved after engaging in PBL strategy. This benefit demonstrated by the statistically significant differences in the reported self-efficacy scores after the project-based activities. A possible interpretation for this result is that the project-based activities promote students’ cognitive engagement and help them to interact more efficiently with learning content and consequently improved and promoted their self-efficacy perception. This interpretation is consistent with prior self-efficacy research. According to Bandura (2006), self-efficacy reflects what individuals believe they can do with the skills they possess and they can accomplish.

Additionally, the findings of this study revealed that the PBL activities does improve pre-service teachers’ self-regulated skills equally in a technology integration course in three different learning environments: face-to-face, hybrid and online. These results suggest that regardless of learning environment, students will improve their self-regulated skills when they engage in the PBL activities.

Finally, the results showed that the PBL activities improves pre-service teachers self-regulated skills, regardless to their learning preferences, either they prefer to use lectures/discussions, books/written material, video/movies/media, or hands-on activities.

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