

A Motivational Analysis of Project Work in Singapore Using Self-Determination Theory

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Abstract

Our students today face a knowledge-based economy, which requires the ability to learn independently, to be innovative in using and synthesizing knowledge, and to adapt fast to the changing world. Project Work (PW) is introduced as one of the instructional models for a more student-centered approach of learning in Singapore. The purpose of this study was to examine the impact of project work (PW) and study the motivational processes of PW using a self-determination theory (SDT) framework. A total of 435 students from Normal Academic stream (NA) and Normal Technical stream (NT) were recruited from four secondary schools in Singapore. Students' perceptions of the values of PW, basic psychological needs, relative autonomy, enjoyment, and grades were measured across three time points. Results showed that students valued the PW experience. However, their enjoyment, needs, and relative autonomy decreased significantly in the 10 to 12 weeks of PW experience. Multiple regression analyses revealed that post-PW enjoyment negatively predicted PW grades, while psychological needs, relative autonomy and pre-PW enjoyment positively predicted post-PW enjoyment. After 6-month PW, post-PW enjoyment emerged as a stronger predictor than grades in predicting the perceived skills learned from PW. The study applies self-determination theory to the PW context and highlights the importance of facilitating the three psychological needs in the PW context to enhance students' motivation and achievement in PW.

Keywords: Cooperative learning, groupwork, longitudinal study, psychological needs, self-determination theory.

Introduction

Our students today face a knowledge-based economy, which requires the ability to learn independently, to be innovative in using and synthesizing knowledge, and to adapt fast to the changing world. The educational focus needs to move away from teaching to learning where students have to be actively involved in the construction of knowledge (Liu, Wang, Koh, Tan, & Ee, 2007). This shift from the traditional teacher-centered approach to a more student-centered approach of learning has prompted many conceptual change in instructional models. One of the models proposed is project work (PW) or cooperative learning, where students work together in small groups on a project or a problem over a period of time that requires ideas and principles

from different subject areas or disciplines (Goodrich, Hatch, Wiatrowski, & Unger, 1995). The proponents of PW suggest this approach enhances students' intrinsic motivation towards the tasks. The purpose of this study was to examine the motivational processes involved in PW with a theoretical framework based on the Self-Determination Theory (SDT) and using a Singaporean sample.

The Ministry of Education (MOE) of Singapore has adopted the concept of 'Thinking Schools, Learning Nation' (TSLN) as its vision for educational reform (Goh, 1997). As part of the various strategies to promote innovative thinking and critical discussion in the classroom, the MOE made changes in its assessment procedures, moving away from traditional assessment methods towards alternative assessment. In the year 2000, PW was introduced in schools to improve standards of learning and achievement by fostering critical and creative thinking, self-directed inquiry, collaborative learning and communication skills (MOE, 1999).

There are three main academic streams in Singapore secondary schools: Express, Normal (Academic) and Normal (Technical). The Express stream is a four-year course leading to a Singapore-Cambridge General Certificate of Education Ordinary-Level (GCE-O Level) examination. The Normal stream is a four-year course leading to a Normal-Level exam, with the possibility of a fifth year to complete the GCE-O Level. The Normal Academic (NA) students take subjects similar to the Express students while the Normal Technical (NT) students take subjects that are more technical in nature, such as Design and Technology, and computer applications. Students are streamed based on their performance in the Primary School Leaving Examinations (PSLE).

PW is compulsory for all secondary schools and junior colleges in Singapore. PW is normally introduced at Secondary Two level (equivalent to Year 8 in the UK system or junior high schools in the US system) but the approaches vary from school to school. The variation is mainly due to the divergence in instructional framework, logistics and resources available. Most schools prefer an interdisciplinary approach to PW whereas some schools conduct PW within a subject. Curriculum time is allocated for the planning, implementation and assessment of the projects and lasts for at least 10 weeks (1 to 2 hours per week). Each school decides on its own theme for the PW and although the latter is considered as a non-examination subject, students are usually awarded a grade for their performance. However, at the junior college level, PW is a compulsory examination subject and a pre-requisite for admission to the local universities.

In a PW classroom, the students normally work in groups of four to six to select their own project idea, plan and execute their plan, and construct their own learning. The PW teachers' role is to facilitate their students' learning. Usually, the time frame and project deadlines are determined by the teacher. At the end of PW, students are expected to conduct an oral

presentation as a group, to showcase their final product, for example, an artefact, a report, a presentation or a performance (Liu et al., 2006). Table 1 shows an example of the time frame and project activity in a typical school.

Table 1
Example of Time Frame and Activity in PW

| Week | Activity |
|-------------|---|
| Week 1 | Orientation & introduction to PW |
| Week 2 | Teaching project work related skills (e.g., Good thinking habits, communication skills) Organisation of groups Group building |
| Week 3 | Teaching project work related skills (e.g. Research skills and organisation, report writing) Research for supporting materials Consolidation of materials Working out of draft for written report and IT component |
| Week 4 to 8 | Teaching project work related skills (e.g. IT skills, oral presentation skills) Individual and group work on project as allocated by group Data collection and analysis Keep research journal |
| Week 9 | Work on IT presentation and final report |
| Week 10 | Presentation of projects (IT presentation) Marking of presentations and projects |

A few studies have investigated the learning outcomes and students' perceptions of PW in Singapore. Generally, studies on the effects of PW showed that it had a positive impact on students' communication and teamwork (Tan, 2002), thinking and problem-solving skills (Chang & Chang, 2003), knowledge application and independent learning (Chua, 2004). A more recent study by Liu and her colleagues (Liu, Tan, Wang, Koh, & Ee, 2007) examined the impact of psychological needs based on the self-determination theory (SDT), on metacognition and enjoyment in a PW context. Specifically, they found that PW context is able to satisfy students' basic psychological needs for relatedness and competence more than a conventional mathematics or science classroom environment. In addition, satisfaction of the three psychological needs is related to higher enjoyment and metacognition. However, most studies were cross-sectional and therefore the long term impact of PW is not known. Moreover, given the variations in PW delivery between schools, academic streams and gender, there is a need to take into consideration these independent variables in the analyses. This study aims to

explore further into the motivational processes of students in PW using the SDT framework.

Self-Determination Theory

The central tenet of SDT (Deci & Ryan, 1985; 1991) is that human beings have three innate psychological needs: competence, relatedness and autonomy. Competence is the need to feel that one is effective in performing the requisite actions. Relatedness refers to the need to feel that one is connected to others and a sense of belonging to a social group. Autonomy refers to the need to express one's authentic self and to feel that self is the source of action. These three needs are assumed to be innate and universal to all humans. It is therefore expected that the processes that lead to intrinsically motivated behavior will be universal across gender, age, and culture. Although much of the SDT literature is based on North American and Western European studies, a recent study by Wang and his colleagues (Wang, Hagger, & Liu, 2009) comparing samples from Singapore and the Great Britain supports the validity of the 'universality hypothesis'. If the three needs are satisfied, an individual's motivation, growth and well-being will be enhanced. In contrast, if the three needs are not supported, motivation, growth and well-being will be diminished (Deci & Ryan, 2000). In other words, the satisfaction of these psychological needs will result in the formation of different motives, which can range from intrinsic to extrinsic.

Intrinsically motivated behaviors are evident when an individual chooses to engage in an activity for its own sake, whether for interest, pure enjoyment of the experience or for the opportunity to learn (Vallerand et al., 1992). Extrinsic motivation refers to situations in which individuals perform an activity as a means to an end. Within SDT, extrinsic motivation is defined as a multidimensional construct, according to different degrees of self-determination or behavioral regulations. Each of these regulations reflects a qualitatively different 'reason' for acting out the behavior chosen. There are four types of extrinsic motivation commonly studied in the classroom context (Vallerand et al., 1992). They are external regulation, introjected regulation, identified regulation, and integrated regulation.

External regulation represents the least self-determined kind of extrinsically motivated behaviors. Such behaviors are controlled by external means (interpersonally controlled), such as rewards or threats, and avoidance of punishment. For example, "I do PW because it is a compulsory component of the school curriculum". Introjected regulation refers to behaviors performed out of guilt avoidance or to attain ego enhancement. It is characterised by feelings of internalised pressure, for example, "I do PW because I want to show the teacher that I am a good student". Identified regulation includes behaviors that are acted out in accordance with one's choice or values and are more self-determined. For example, "I do PW

because I want to learn something useful". Integrated regulation is the most autonomous form of extrinsic motivation. It occurs when identifications have been assessed and integrated into the self. Researchers have suggested that full integration of a behavioral regulation is very unlikely to occur during childhood or adolescence (Deci & Ryan, 1985; Vallerand, 1997), therefore, we have excluded this regulation in the current study.

The different types of motivated behaviors mentioned above can be categorized along a self-determination continuum. From lower to higher levels of self-determination, they are external regulation, introjected regulation, identified regulation, and intrinsic regulation. An overall relative autonomy index (RAI) can be calculated by weighting each subscale to indicate the level of autonomy in the following way: external regulation (-2) + introjected regulation (-1) + identified regulation (+1) + intrinsic regulation (+2) (see Goudas, Biddle, & Fox, 1994). The final RAI measure serves as an indicator of a person's overall motivational orientation with positive scores representing more autonomous regulation and negative scores representing more controlled regulation.

Research indicates that more self-determined motivation was found to be associated with more engagement (e.g., Connell & Wellborn, 1991), better performance (e. g., Grolnick, Ryan, & Deci, 1991; Miserandino, 1996; Pintrich & De Groot, 1990), greater conceptual learning and better memory, (e.g., Grolnick & Ryan, 1987; Grolnick et al., 1991), as well as more positive emotions in the classroom, more enjoyment of academic work and school (e.g., Ryan & Connell, 1989; Vallerand, Blais, & Brière, 1989).

Vallerand and Losier (1999) propose that social factors, such as the PW classroom climate, teachers' expectations, success and failure, have a profound impact on individuals' thoughts, feelings, and behaviors. The effects of these social factors on motivation are mediated by perceptions of competence, autonomy, and relatedness (Blanchard & Vallerand, 1996; Vallerand & Reid, 1984; Whitehead & Corbin, 1991). The extent to which social factors foster perceptions of these three psychological needs will result in different types of behavioral regulation or motivation, or varying degrees of self-determination. Subsequently, this will lead to different cognitive, affective and behavioral consequences. For example, Ryan and Connell (1989) found that different types of extrinsic motivation did indeed produce different experiences and outcomes. Specifically, they found that externally regulated students tended to show less interest, value and effort toward achievement, and they were more inclined to disown responsibility for negative outcomes. Students with introjected regulation were willing to expend more effort but they tended to be anxious and coped poorly with failures. In contrast, students with identified regulation had more positive coping styles. They were more willing to expend effort, and they reported more interest and enjoyment of school. Other studies reiterated the findings, demonstrating the motivational benefit of more self-autonomous behavioral regulations in the

classroom (Grolnick & Ryan, 1987; Ryan & Connell, 1989; Vallerand & Bissonnette, 1992). Specifically, more self-determined extrinsic motivation (with greater internalisation) was found to be associated with more engagement (Connell & Wellborn, 1991), better performance (Miserandino, 1996), and higher quality learning (Grolnick & Ryan, 1987).

In the PW context, Liu and her colleagues (Liu, Wang et al., 2007) found that students' enjoyment and metacognition were enhanced by the satisfaction of the three needs through intrinsic regulation. In fact, many researchers have argued that project-based learning designs, because of their emphasis on student choice, collaborative learning, and authentic assessment are designed to maximize students' orientation toward learning and mastery (e.g., Thomas, 2000). Likewise, others have posited that project tasks that incorporate features such as student choice, variety and challenge should promote students' interest and perceived value (Blumenfeld et al., 1991). Studies looking at motivation in PW or project-based learning have generally provided support for this contention (e.g., Beneke, 2000; Blumenfeld et al., 1991; K. Liu & Chien, 1998; Wolk, 1994). Although the usefulness of PW is well endorsed, no study has tracked the perceived value of PW in line with the desired outcomes of PW in Singapore. The first purpose of the present study was to examine the perceived value of PW in terms of development of metacognition, communication skills, collaboration skills, and problem-solving skills across the time frame of PW period and six months after PW.

Secondly, this study sought to understand the underlying motivational processes in PW using the SDT framework, that is, how the context of PW promotes students' interest, needs satisfaction and autonomous regulation. Thirdly, the study examined the predictors of PW grades and students' interest. We included PW grade because this is the only objective outcome from the PW experience. Fourthly, the study examined whether PW grades and post-PW enjoyment predicted students' perceived value in PW six-month after. The final purpose of the present study was to examine academic stream, gender or school effects in the study variables. The findings might assist PW teachers in Singapore in providing positive experiences for students to maximize their learning in PW. In addition, the findings could be used to guide future interventions in motivating students in PW. Based on the findings of the previous studies, this study attempted to answer the following research questions:

- (1) Do the students value PW in terms of development of metacognition, communication skills, collaboration skills, and problem-solving skills at pre-PW, post-PW period and after 6-month PW period?? Are there any academic stream, gender or school effects?
- (2) How do students' self-reported enjoyment (outcome measure) changed from pre- to post-PW? Are there any academic stream, gender or school effects?

- (3) How do students' perceived needs satisfaction change from pre- to post-PW? Are there any academic stream, gender or school effects?
- (4) How do students' behavioral regulation change from pre- to post-PW? Are there any academic stream, gender or school effects?
- (5) What are the significant predictors of the PW grades? Are there any academic stream, gender or school effects?
- (6) What are the significant predictors of post-PW enjoyment score? Are there any academic stream, gender or school effects?
- (7) Would PW grades or post-PW enjoyment predict students' perceived value of PW in terms of development of metacognition, communication skills, collaboration skills, and problem-solving skills six months after PW? Are there any academic stream, gender or school effects?

Method

Participants and Procedures

A total of 435 students were recruited from four typical government funded co-educational secondary schools in Singapore (we used School A, B, C and D to represent the four schools). The sample consisted of Secondary Two students aged 12 to 14 years ($M = 13.29$, $SD = .94$). There were 259 males and 176 females. 295 students were from the NA academic stream and 140 students were from the NT academic stream.

The school principals granted consent for data to be collected in their schools. After which, the PW teachers in the 4 participating schools were contacted to design common PW tasks to be used by their students during the study based on a common theme of 'adaptation' before the beginning of the study (two months before start of PW). A package developed by the Ministry of Education was used as a resource pack for PW. As mentioned, a typical PW program usually lasts for 10 weeks followed by a scheduled presentation. The pre-survey was conducted at the initial stage of PW, that is, after the PW groups had been formed, this was around week 2 to 3. The post-survey was conducted immediately after the end of PW presentation week (which ranged from the 10th to 14th weeks). After 6-month PW, we administered the post 6-month surveys.

Administration of the questionnaires took place in quiet classroom conditions under the supervision of a researcher. Students were told that there were no right or wrong answers, assured of the confidentiality of their responses, and encouraged to be honest and to ask questions if necessary. Normal informed consent and ethical procedures were followed and conformed to guidelines of the British Psychological Society.

Measures

The pre- and post-surveys contain all the measures listed below. The post 6-month survey only had items for metacognition and perceived skills learned from PW.

Basic Psychological Needs. We used the Basic Psychological Needs questionnaire from Liu, Wang et al. (2007) to measure the three needs. There were three items each for competence and relatedness. An example item for competence is 'I think I am pretty good in PW', and for relatedness, is 'I feel close to my PW team-members'. There were 6 items for autonomy. An example item is 'I am free to express my ideas and options in PW'. Answers for all the 12 items were given on a 7-point scale ranging from 1 (not true at all) to 7 (very true). Cronbach's alphas for perceived competence ($\alpha = .72$ to $.75$), relatedness ($\alpha = .66$ to $.72$), and autonomy ($\alpha = .85$ to $.88$) for the present sample were satisfactory.

Enjoyment. We used the enjoyment subscale of the Intrinsic Motivation Inventory (McAuley, Duncan, & Tammen, 1989). to assess students' enjoyment in PW. An example item is 'When I do PW, I think about how much I enjoy it'. All the five items were measured on a 7-point scale ranging from 1 (not true at all) to 7 (very true). Internal consistency was satisfactory for the scale across two time point ($\alpha = .85$ to $.87$).

Behavioral Regulation. The Academic Self-Regulation Questionnaire (SRQ-A) developed by Ryan and Connell (1989) was used to assess four types of behavioral regulation in the project work context. The stem for all the items was 'I take part in PW ...'. Example items are "because I'll get into trouble if I don't" (external regulation, four items), "because I'll feel bad about myself if I didn't" (introjection, four items), "because it is important for me to do well in PW" (identification, three items), and "because PW is fun" (intrinsic regulation, three items). Answers for all the 14 items were given on a 7-point scale ranging from 1 (not at all true) to 7 (very true). Cronbach's alphas for the pre- and post-surveys for external, introjected, identified, and intrinsic regulations were satisfactory (.73 to .75 for external, .61 to .74 for introjected, .74 to .80 for identified, and .80 to .83 for intrinsic). An overall relative autonomy index (RAI) was computed to indicate the level of relative autonomy.

Metacognition. There were seven items in the metacognitive strategies subscale of the Motivated Strategies for Learning Questionnaire (Pintrich, Smith, Garcia, & McKeachie, 1993) to measure metacognitive strategies used in PW. One example item is 'I always ask myself questions to understand the PW problem better'. Response was given on a 7-point scale anchored by (1)

'Not at all true' to (7) 'Very true'. The scale was internally consistent (α ranged from .85 to .88).

Perceived Skills Learned in PW. Students' perceived skills learned in PW were measured with a 15-item inventory (Liu, Wang et al., 2007), which was included in the pre- and post 6-month surveys. The stem for the inventory was 'In doing PW, ...'. The inventory included communication skills (e.g., 'it teaches me negotiation skills in communication', four items), collaborative skills (e.g., 'I learn to share ideas and work with my peers', five items), and problem-solving skills (e.g., 'I develop research skills', six items). Answers for all the items in the three scales were given on a 7-point scale ranging from 1 (not true at all) to 7 (very true). Cronbach's alpha coefficients ranged between .78 to .82 for communication skills, .81 to .86 for collaboration skills, and .84 to .88 for problem-solving skills.

PW grades. At the end of the PW presentation, the students' grades were collected from the PW teachers. Each student could receive a different grade from his/her peers since marks were awarded on the basis of a student's contribution to the project task.

There was one school that failed to report the PW grades of the students and the post 6-month survey (School D). Therefore, the PW grades were only available for three schools.

Data Analysis

In the preliminary analyses, we computed the overall means, standard deviations and the zero-order correlations of the samples. In the primary analyses, we conducted two repeated-measures multivariate analysis of variance (MANOVA) to examine changes from pre- to post 6-month PW as well as the academic stream, gender, and school effects. The first MANOVA involved the PW skills (metacognition, communication, collaboration, and problem-solving skills) and the second MANOVA involved enjoyment, three psychological needs, and RAI. Follow-up ANOVAs were conducted if significant multivariate effects were found. We used post-hoc Tukey tests to determine the difference between schools. Next, we conducted hierarchical regressions to examine predictors of PW grades and post-PW enjoyment. Finally, a series of hierarchical regressions were conducted using PW grades and post-PW enjoyment as independent variables and metacognition and PW skills as dependent variables, while controlling for academic stream, gender and school effects.

Results

Values of PW in Developing Skills

Table 2 shows the means and standard deviations, and intercorrelations of the students' perception of the value of PW in terms of the development of metacognition, communication, collaboration, and problem-solving skills. Table 3 presents the descriptive statistics and intercorrelations of the main study variables in pre- and post-PW.

Two repeated-measures Multivariate Analysis of Variance (MANOVA) were conducted to examine whether stream, gender and school effects were evident. The first MANOVA dealt with the value of PW. The results showed that there were no significant differences between the students perceptions of the value of PW in terms of development of metacognition, communication, collaboration, and problem-solving skills from pre- to post 6-month PW, Pillai's Trace = 069, $F(8, 206) = 1.90$, $p = .06$, $\eta^2 = .07$. However, there were significant school effects [Pillai's Trace = .075, $F(8, 422) = 2.07$, $p < .05$, $\eta^2 = .04$. No gender or stream effects or interaction effects were found. Follow-up ANOVA showed that one particular school (School C) reported significantly higher scores in all the four PW skills compared to other schools.

Self-Determination Theory Constructs

The results of the second repeated MANOVA showed that there were significant multivariate effects from pre- to post-PW in terms of the key study variables, Pillai's Trace = .215, $F(5, 305) = 16.71$, $p < .01$, $\eta^2 = .22$. The interaction effects between time and academic stream and between time and school were significant (see Tables 4 and 5). The follow-up ANOVAs showed that enjoyment, competence, relatedness, and RAI decreased significantly from pre- to post-PW (all $ps < .01$). The change in autonomy was not significant. An analysis of the time by stream effect found that the decrease in enjoyment and RAI among the NT academic stream was steeper compared to the NA academic stream. In terms of autonomy, the NA academic stream reported higher autonomy at post-PW while the NT academic stream reported a decrease in autonomy at post-PW. In terms of time by school interaction effect, we found that School B was the only school that reported an increase in enjoyment and RAI at post-PW. The decrease in competence in School B was also among the least compared to all other three schools (see Table 5).

Table 2
Students' Perception of the Values of PW

| Variable | M | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | |
|---------------------------------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | SD | | | | | | | | | | | | |
| 1. Metacognition (Pre) | 4.45 | 1.01 | 1.00 | | | | | | | | | | |
| 2. Metacognition (Post) | 4.38 | 1.02 | .48** | 1.00 | | | | | | | | | |
| 3. Metacognition (Followup) | 4.61 | 1.32 | .44** | .46** | 1.00 | | | | | | | | |
| 4. Communication (Pre) | 4.33 | 1.06 | .70** | .38** | .43** | 1.00 | | | | | | | |
| 5. Communication (Post) | 4.41 | 1.07 | .35** | .74** | .39** | .34** | 1.00 | | | | | | |
| 6. Communication (Followup) | 4.53 | 1.26 | .44** | .48** | .84** | .44** | .44** | 1.00 | | | | | |
| 7. Collaboration (Pre) | 4.51 | 1.08 | .67** | .43** | .39** | .78** | .38** | .43** | 1.00 | | | | |
| 8. Collaboration (Post) | 4.52 | 1.11 | .39** | .77** | .41** | .39** | .80** | .45** | .47** | 1.00 | | | |
| 9. Collaboration (Followup) | 4.64 | 1.22 | .43** | .46** | .81** | .43** | .40** | .86** | .44** | .50** | 1.00 | | |
| 10. Problem-Solving (Pre) | 4.29 | 1.03 | .69** | .39** | .35** | .77** | .31** | .33** | .77** | .37** | .32** | 1.00 | |
| 11. Problem-Solving (Post) | 4.33 | 1.05 | .38** | .79** | .39** | .34** | .86** | .45** | .38** | .80** | .42** | .38** | 1.00 |
| 12. Problem-Solving (Follow-up) | 4.52 | 1.22 | .45** | .47** | .85** | .44** | .41** | .91** | .42** | .41** | .89** | .34** | .44** |

Note. ** p < .01. 6 M = 6 month

Table 3
Means, Standard Deviations, and Intercorrelations of Major Study Variables

| Variables | Mean | SD | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|--------------------------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|
| 1. Competence (Pre-PW) | 4.07 | 1.19 | 1.00 | | | | | | | | | |
| 2. Competence (Post-PW) | 3.69 | 1.20 | .21** | 1.00 | | | | | | | | |
| 3. Autonomy (Pre-PW) | 3.94 | 1.22 | .24** | .31** | 1.00 | | | | | | | |
| 4. Autonomy (Post-PW) | 4.02 | 1.17 | .21** | .63** | .45** | 1.00 | | | | | | |
| 5. Relatedness (Pre-PW) | 5.04 | 1.33 | .17** | .19** | .25** | .16** | 1.00 | | | | | |
| 6. Relatedness (Post-PW) | 4.64 | 1.32 | .10 | .26** | .20** | .40** | .39** | 1.00 | | | | |
| 7. RAI (Pre-PW) | 1.61 | 5.33 | .30** | .46** | .61** | .38** | .25** | .17** | 1.00 | | | |
| 8. RAI (Post-PW) | .69 | 5.05 | .16** | .79** | .31** | .69** | .14* | .34** | .50** | 1.00 | | |
| 9. Enjoyment (Pre-PW) | 3.88 | 1.44 | .17** | .24** | .32** | .22** | .15** | .10 | .62** | .33** | 1.00 | |
| 10. Enjoyment (Post-PW) | 3.70 | 1.38 | .14* | .56** | .24** | .44** | .14* | .28** | .40** | .64** | .51** | 1.00 |
| 11. Grade | 3.65 | 1.11 | -.04 | .12 | .08 | .09 | .03 | .11 | .13* | .06 | .10 | .13* |

Table 4
Descriptive Statistics of Enjoyment, Psychological Needs, and RAI by Gender and Academic Stream

| Variable | | Pre-PW | | Post-PW | |
|--------------------|-------|----------|-----------|----------|-----------|
| By Gender | | <i>M</i> | <i>SD</i> | <i>M</i> | <i>SD</i> |
| Competence | Boys | 4.75 | 1.18 | 3.76 | 1.18 |
| | Girls | 4.63 | 1.15 | 3.49 | 1.20 |
| Relatedness | Boys | 5.09 | 1.33 | 4.49 | 1.21 |
| | Girls | 5.16 | 1.29 | 4.75 | 1.44 |
| Autonomy | Boys | 3.94 | 1.30 | 4.05 | 1.14 |
| | Girls | 3.92 | 1.11 | 3.81 | 1.10 |
| Enjoyment | Boys | 4.12 | 1.41 | 3.83 | 1.35 |
| | Girls | 3.66 | 1.38 | 3.44 | 1.37 |
| RAI | Boys | 2.98 | 1.54 | 3.63 | 1.64 |
| | Girls | 2.98 | 1.54 | 3.63 | 1.64 |
| By Academic Stream | | | | | |
| Competence | NA | 4.72 | 1.12 | 3.68 | 1.25 |
| | NT | 4.61 | 1.31 | 3.52 | 1.02 |
| Relatedness | NA | 5.27 | 1.22 | 4.77 | 1.35 |
| | NT | 4.66 | 1.46 | 4.13 | 1.11 |
| Autonomy | NA | 3.85 | 1.19 | 4.03 | 1.19 |
| | NT | 4.20 | 1.25 | 3.81 | 1.11 |
| Enjoyment | NA | 3.85 | 1.36 | 3.69 | 1.39 |
| | NT | 4.08 | 1.55 | 3.51 | 1.30 |
| RAI | NA | 1.52 | 5.37 | .76 | 5.08 |
| | NT | 2.21 | 4.71 | .07 | 4.40 |

Table 5
Descriptive Statistics of Enjoyment, Psychological Needs, and RAI by School

| Variable | | School A | | School B | | School C | | School D | |
|-------------|---------|----------|-----------|----------|-----------|----------|-----------|----------|-----------|
| By Gender | | <i>M</i> | <i>SD</i> | <i>M</i> | <i>SD</i> | <i>M</i> | <i>SD</i> | <i>M</i> | <i>SD</i> |
| Competence | Pre-PW | 4.48 | .93 | 4.21 | 1.23 | 4.94 | 1.18 | 4.94 | 1.17 |
| | Post-PW | 3.70 | 1.34 | 3.64 | .87 | 3.53 | 1.18 | 3.74 | 1.28 |
| Relatedness | Pre-PW | 4.73 | 1.36 | 4.98 | 1.26 | 5.45 | 1.25 | 5.15 | 1.26 |
| | Post-PW | 4.42 | 1.30 | 4.57 | .99 | 4.92 | 1.51 | 4.35 | 1.19 |
| Autonomy | Pre-PW | 4.17 | 1.04 | 3.67 | 1.17 | 4.08 | 1.11 | 3.62 | 1.49 |
| | Post-PW | 3.98 | 1.20 | 3.96 | .85 | 4.06 | 1.21 | 3.84 | 1.31 |
| Enjoyment | Pre-PW | 4.16 | 1.42 | 3.48 | 1.35 | 3.81 | 1.33 | 4.14 | 1.51 |
| | Post-PW | 3.81 | 1.37 | 3.84 | .92 | 3.34 | 1.50 | 3.82 | 1.41 |
| RAI | Pre-PW | 1.52 | 5.21 | .90 | 4.53 | 1.69 | 5.34 | 2.58 | 5.51 |
| | Post-PW | .66 | 5.21 | 1.67 | 3.82 | -.02 | 5.70 | .65 | 3.76 |

In sum, all the students tended to agree that PW helped them in developing metacognition, communication, collaboration, and problem-solving skills (all scores were above the mid-point of the scales). This was consistent throughout the PW experience. The results were consistent for the two genders and two academic streams. Only one school (School A) reported

significant higher scores in metacognition and PW skills, compared to the other schools.

Regardless of gender or academic stream, students reported lower satisfaction of the needs for competence and relatedness, relative autonomy, and enjoyment in their 10 to 12 weeks of PW experiences. One school (School B) managed to increase the students' enjoyment and RAI at post-PW and was able to minimise the drop in perceived competence, compared to the other three schools.

Predictors of PW Grades

A hierarchical regression was conducted to predict the overall PW grades. In the first step, all the pre-PW variables (basic need satisfaction, RAI, and enjoyment) were entered together with gender, academic stream and school. In the second step, all the post-PW variables were entered into the model. The first step of the analysis revealed that pre-PW enjoyment, gender, and school predicted PW grades ($F = 9.40, p < .01$). In the second step, post-PW enjoyment was a significant negative predictor of PW grades ($t(172) = -.332, p < .01, \beta = -.38$), after controlling for the effects of the pre-PW variables and demographic variables. The results showed that 36.5% of the variance in PW grades was accounted for by the model. Girls tended to score higher grades in PW compared to boys. School B had significantly higher PW grades compared to Schools A and C.

Predictors of Post-PW Enjoyment in PW

The second hierarchical regression was conducted with post-enjoyment as the dependent variable. All the pre-PW variables (pre-PW enjoyment, basic need satisfaction, RAI) and demographic variables were entered together in the first step. In the second step, all the post-PW variables were entered into the model (need satisfaction and RAI). The first step of the analysis found that pre-PW enjoyment predicted post-PW enjoyment, and that there were stream and school effects. The second step revealed that the three needs satisfaction (competence, autonomy, and relatedness), as well as RAI, positively predicted post-PW enjoyment ($F = 73.39, p < .01$). A total of 72.8% of the variance in post-enjoyment was accounted for by the model.

Predictors of PW Skills 6-Month After PW

We conducted four hierarchical regressions to predict perceptions of the values of PW 6-month after (metacognition, communication, collaboration, and problem-solving) using PW grades and post-PW enjoyment. We entered gender, stream and school in the first step, PW grade was

entered in the second step and post-PW enjoyment in the third step. Table 6 shows the results of the regressions.

The value of PW in developing metacognition after a 6-month completion of the PW experience was significantly predicted by post-PW enjoyment. The model explained 25.3% of the variance in metacognition. There was significant school effect ($t = -4.40, p < .01$). Communication skills after 6-month PW was positively predicted by post-PW enjoyment, PW grades and school, with an overall model explaining 27.0% of the variance in development of communication skills. Post-PW enjoyment, grades and school were all significant predictors of the development of collaborative skills six months after PW. The model explained a total of 27.7% in collaborative skills. Problem-solving was also predicted by post-PW enjoyment, grades, and school. The model explained 24.5% of the variance of developing this skill.

Table 6
Hierarchical Regression Analysis Examining Effects of Grades and Post Enjoyment on Values of PW 6-Month After (Standardized Coefficients)

| | Metacognition | Communication | Collaboration | Problem-Solving |
|----------------------|---------------|---------------|---------------|-----------------|
| Metacognition | | | | |
| Step 1 | | | | |
| Gender | .051 | .031 | .061 | .014 |
| Stream | -.040 | -.135 | -.098 | -.131 |
| School | -.183* | -.142 | -.075 | -.187* |
| Step 2 | | | | |
| Gender | -.014 | -.043 | -.039 | -.059 |
| Stream | -.088 | -.191* | -.173* | -.186* |
| School | -.230** | -.195* | -.148 | -.241** |
| PW grades | .185 | .213* | .288** | .210* |
| Step 3 | | | | |
| Gender | .016 | -.013 | -.009 | -.033 |
| Stream | .015 | -.086 | -.069 | -.093 |
| School | -.347** | -.313** | -.267** | -.346** |
| PW grades | .159 | .186* | .262** | .187* |
| Post-PW enjoyment | .458** | .463** | .465** | .414** |

Note. * $p < .05$, ** $p < .01$

Additional Analyses

We conducted a series of exploratory regressions to test all potential two-way interactions among gender, academic stream and school, for the predictions of PW grades and post-PW enjoyment and PW skills. The results showed that none of the two-way interactions were significant.

Discussion

The Ministry of Education of Singapore is fully committed to PW in all schools. Currently, PW has been implemented in all primary and secondary schools at least at one level. PW is an integrated learning experience that aims to improve students' communication skills, collaborative skills, metacognition, problem-solving skills, self-directed inquiry and life-long learning skills. However, a pedagogical approach will not automatically lead to the desired outcomes. There is a need to understand the underlying mechanisms underpinning the motivational processes and experience of students in PW. The purpose of this study was to examine the impact of PW and to study the motivational processes of PW using a SDT framework.

Has PW succeeded or failed in the Singapore context? The first research question may shed light on this. The results of this study found that students perceived PW to be useful in terms of development of metacognition, communication skills, collaboration and problem-solving skills. The responses were consistently above 4.20 (on a 7-point scale) at pre-, post-, and after 6-month PW period. This is great news for the Singapore Ministry of Education which has been doing more than any other country to advance 21st Century Skills through PW and technology (ICT; Borja, 2004). These findings add to the current literature (e.g., Chang & Chang, 2003; Liu, Tan et al., 2007; Liu, Wang et al., 2007; Tan, 2002) in that PW has a positive long term effect on students' perceptions. Singaporean students do recognize the value of PW in developing metacognition skills and other lifeskills, even after 6-month PW. In fact, all the mean scores at after 6-month PW were much higher than the scores before- and after-PW. This is consistent across gender and academic stream. One exception is School C, which reported significantly higher scores in all four skills compared to other schools. School C was over-represented by NA academic stream students (112 NA students vs. 31 NT students) and this may have had an influence on the scores.

According to SDT, enjoyment in the target task is a form of intrinsic motivation (Deci & Ryan, 1985) and may lead to greater conceptual learning (Grolnick & Ryan, 1987) and more engagement (Connell & Wellborn, 1991). It is thus an important variable in motivation. The results of the present study over the two time points showed that the students reported a decrease in enjoyment level from pre-PW to post-PW. The students in the NT academic stream reported a steeper decrease in post-PW enjoyment compared to the NA students. In terms of school effects, one school reported an increase in post-PW enjoyment. The findings suggest that the PW experience of the students could be improved. Bearing in mind that enjoyment is an indicator of intrinsically motivated behaviors (Csikszentmihalyi & Nakamura, 1989; Deci & Ryan, 1985; Harter, 1978), it is important for students to gain interest and enjoyment in their first encounter with PW. Instead of increasing students' enjoyment in PW, the 10 to 12 weeks of PW experience had a

negative impact on students' enjoyment. It is thus imperative to examine the causes of this phenomenon.

According to the motivational sequence proposed by Vallerand and Losier (1999), the three psychological needs are important mediators of motivational regulations and enjoyment. Liu and her colleagues (Liu, Tan et al., 2007) revealed that perceived satisfaction of the three psychological needs positively predicted more autonomous regulation towards PW, which in turn positively predicted enjoyment and metacognition. A total of 87.9% of the variance in enjoyment and 36.2% of the variance in metacognition were accounted for by their model. The finding supports the SDT's overarching proposition (Deci & Ryan, 2000). The present study extended the literature by examining the changes in the needs satisfaction over the two time points of PW experience. The results suggest that there were significant decreases in competence and relatedness from pre- to post-PW. For autonomy, there was an increase from pre- to post-PW in one school but not in the other three schools. In the light of these results, it seems that the PW context may satisfy students' needs for autonomy, if implemented in an appropriate manner.

Within SDT, there is a sub-theory named Cognitive Evaluation Theory (CET) which states that any event that promotes autonomy and perceived competence will enhance intrinsic motivation (Deci & Ryan, 1985). In the PW context, although students may have a sense of autonomy, the increase in autonomy may not compensate for the decrease in competence. Therefore, enjoyment for the task decreased.

Although advocates of cooperative learning suggest that group work should enhance teamwork or friendship, our results showed otherwise. Again, this could be due to the decrease in the students' perceived competence over time and their lack of a sense of achievement that could have affected the friendship among the group members.

Interestingly, the findings of this study show that the decrease in competence and relatedness among students in PW across the two time points coincided with the decrease in RAI, regardless of gender, stream and school. According to the meta-analysis done by Deci, Koestner and Ryan (1999), which examined the effects of extrinsic rewards on intrinsic motivation, it was found that externally set deadlines, surveillance, evaluations, directives, and competition pressure undermined intrinsic motivation. What could possibly have happened is that, as the students worked through their PW tasks, the pressure of deadlines and evaluation might increase and this undermined their feeling of self-determination. For example, the lower ability students might start to feel that they were not competent enough to complete the tasks well.

According to CET, significant others' behaviors can also impact upon the intrinsic motivation of individuals (Deci & Ryan, 1985, 1991; Vallerand & Losier, 1999). In a classroom context, the teacher is probably the most influential person in the environment. The ways teachers interact with

students in the classroom can either facilitate or undermine the intrinsic motivation of the students. Specifically, the teacher can either communicate with a controlling style, such as giving directives, exerting pressures, controlling the students' behaviors, or interacting in an autonomy-supportive way that enhances students' autonomy and choice. If the teachers focus mainly on meeting deadlines or communicate to the students in a controlling manner, this will thwart the needs of the students and lead to a decrease in intrinsic motivation. One recent study by Koh and her colleagues (Koh, Wang, Tan, Liu, & Ee, 2008) found that PW teachers were more concerned about the performance of the students, namely in terms of the quality of the project deliverables such as presentations and reports. The findings suggest that PW teachers need to create an autonomy-supportive classroom climate in which students feel respected and cared for, and have a sense of choice and competence. They need to model their concern for their students and encourage them to care for each other, especially within their project group.

The speculation that the pressure of evaluation caused the decrease in enjoyment was supported by the results. Post-PW enjoyment emerged as a negative predictor of PW grades and accounted for 36.5% of the variance in PW grades. This shows that as the students worked hard towards achieving higher grades, the focus might have shifted to extrinsic ego goals. This has been shown to undermine intrinsic motivation (Rawsthorne & Elliot, 1999).

What are the factors that would increase post-PW enjoyment? If the aims of PW are to foster long term learning, critical thinking, and self-directed inquiry, there is a need for PW to move beyond assessment and look into cultivating the intrinsic interest for PW. In accordance to the SDT framework, the results suggest that pre-PW enjoyment, the three psychological needs, and relative autonomy positively predicted post-PW enjoyment. These findings may offer some guidance for practice. For example, the teachers may arouse students' interest by showcasing previous PW products and video clips of the PW processes. In addition, teachers may allow students to make decisions such as grouping and choice of PW tasks. Teachers should be more autonomy-supportive in PW and provide positive feedback. The benefits of promoting enjoyment in PW beyond the grades are evident after 6 months of their PW experience. The results showed that post-PW enjoyment positively predicted metacognition, communication, collaboration, and problem-solving skills, in addition to PW grades. In fact, post-PW enjoyment was a stronger predictor of the perceived values in PW, as compared to PW grades. This shows that the focus on providing a positive PW experience may reap more benefits than the focus on performance outcomes. Reviews in the achievement goal theory literature (Biddle, Wang, Kavussanu, & Spray, 2003) have revealed that mastery goals encourage students to learn and acquire more effective and creative problem-solving skills, while the focus on performance may encourage student to rely on

familiar knowledge and strategies. Therefore, it is important to focus on the process, rather than the product in PW.

In sum, this study adds to the literature in that SDT is applicable to the PW context. By using a sound theoretical framework, a deeper understanding of the underlying motivational process has been achieved. The theory has also provided directions for interventions and improvement to the PW process. Overall, the cooperative learning environment in PW may be ideal for the satisfaction of the three psychological needs. However, more needs to be done in order for this to be achieved in the current practice of PW in Singapore. Future research should focus on other social factors, such as group dynamics, school culture, motivational climates or classroom structure affecting the needs satisfaction and behavioral regulations in the PW context.

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