



A self-determination approach to understanding students' motivation in project work

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ABSTRACT

The use of project work (PW) or project-based learning has escalated in Singapore since its inception by the Ministry of Education in the year 2000. There is however little information on students' motivation, and their experience of PW over time. This study sought to identify homogeneous groups of students with distinct perceived locus of causality (PLOC) profiles using a cluster analytic approach, and to examine group differences in their perceived psychological needs, emotions, metacognition, and perceived skills learned in PW over time. Four distinct clusters of students were identified. The "high self-determined/low controlled" group was the most adaptive cluster, and the "low self-determined/high controlled" group was the least adaptive cluster. The study affirms that the self-determination theory (SDT) can provide important insights into the motivational processes in PW. It establishes that students' motivational regulations and their perceived needs satisfaction at the start of PW are related to their experience of and learning in PW.

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Project work (PW) was introduced in Singapore schools to raise education standards and improve students' thinking and life-long learning skills (Ministry of Education, 1999). 'Project' is generally defined as 'long-term, problem-focused, and meaningful activities that bring together ideas and principles from different subject areas or disciplines' (Goodrich, Hatch, Wiatrowski, & Unger, 1995, p. viii). In the Singapore context, PW is essentially a form of Cooperative Learning (CL) because students work in groups to construct their own and each other's learning (Deutsch, 1949)(see Appendix A).

Evidence from a number of meta-analyses establishes that CL enhances the cognitive, affective and behavioral aspects in learning (Johnson, Johnson, & Smith, 1998; Springer, Stanne, & Donovan, 1999). However, the motivation processes involved are not clear. Many have posited that project-based learning is designed to maximize students' orientation toward learning because of its emphasis on choice, collaborative learning, and authentic assessment (Thomas, 2000). Others have contended that cooperative efforts are powered by extrinsic motivation to achieve rewards (Johnson, Johnson, & Smith, 1998). To have a clearer picture, the present study was undertaken to examine students' motivational processes in PW using self-determination theory (SDT).

SDT offers great promise to help advance understanding of students' motivation in CL pedagogies because of its focus on active ingredients of good CL pedagogies such as students' choice, competence and collaboration (Williams, Saizow, & Ryan, 1999).

The study of motivation begins with the 'why' question of behavior (Deci & Ryan, 1985; McClelland, 1985; Weiner, 1992). From SDT perspective, these goals or reasons for engaging are driven by three psychological needs (i.e., the needs for autonomy, competence and relatedness) that are crucial in the energization of human behavior (Deci & Ryan, 1985, 1987; Ryan & Deci, 2000a, 2000b). People are motivated to satisfy these needs because they are considered essential for personal growth and well-being.

Essentially, SDT distinguishes among four types of behavioral regulations with different degrees of self-determined motivation. *External regulation*, the least self-determined form of extrinsic motivation, refers to behavior that is controlled by external means, such as rewards or external authority. *Introjected regulation* refers to behavior that is internally controlled or self-imposed, such as acting out of guilt avoidance or ego-enhancements. *Identified regulation*, a more self-determined form of extrinsic motivation, refers to acting according to one's choice or values. Finally, *intrinsic motivation*, the highest level of self-determination, refers to behavior that emanates fully from the self and is undertaken solely for its own sake or enjoyment. These four behavioral regulations can be viewed as a continuum ranging from highly external to highly internal. Although Deci and Ryan (1985) included integrated regulation as the most self-determined form of extrinsic motivation in the continuum, it was excluded from this study because this regulation is mainly found in the adult population.

Using the Perceived Locus of Causality scale (PLOC), Ryan and Connell (1989) showed that the four types of behavioral regulations were correlated according to a simplex-like structure, supporting the underlying continuum of autonomy. Accordingly, a composite Relative Autonomy Index (RAI) can be computed by weighting each subscale. Positive scores indicate more autonomous regulations and negative scores indicate more controlling regulations.

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In addition to these four behavioral regulations, a state of *amotivation* exists where the person has no intention to act. Amotivated people perceive a lack of contingency between their own actions and outcomes, or a lack of competence. Consequently, amotivation also occupies a separate category at the external end of the continuum.

Research has shown that more self-determined extrinsic motivation was associated with better performance, conceptual learning, and/or enjoyment of academic work and school (e.g., Grolnick & Ryan, 1987; Grolnick, Ryan, & Deci, 1991; Miserandino, 1996; Ryan & Connell, 1989). In contrast, less self-determined motivation was found to be related to anxiety and maladaptive behavior (e.g., Ryan & Connell, 1989). However, not much research has been done in the PW context using SDT framework, especially with a cluster analytic approach. Vallerand (1997) has recommended using cluster analysis to determine the role of motivational profiles in outcome variables. Recent studies have adopted this approach in educational settings (e.g., Boiché, Sarrazin, Grouzet, Pelletier, & Chanal, in press; Ratelle, Guay, Vallerand, Larose, & Sénécal, 2007; Wang & Biddle, 2001) but none in the PW context.

The purposes of the present study were (a) to identify homogeneous groups of students with distinct PLOC profiles using a cluster analytic approach, (b) to examine the group differences in their emotions, metacognition, and perceived skills learned in PW, and (c) to study the changes in pre- and post-measures of the students' PW experience.

1. Method

1.1. Participants

Seven hundred and sixty seven (430 males, 337 females) Secondary two (equivalent to Grade 7 in United States) students from five government schools participated in this study. The students (mean age 13.78, SD=0.77) were from three different ability streams, that is, Express (most academically inclined, $n=178$, 95 males, 83 females), Normal-Academic (NA) ($n=416$, 231 males, 185 females) and Normal-Technical (NT) (least academically inclined, $n=173$, 105 males, 68 females). They were likely to be representative of diverse racial and socio-economic backgrounds although such data were not formally assessed.

1.2. Procedure

The pre-survey was conducted during week 2 of PW, after the groups had been formed, and the post-survey was conducted at the end of PW (during week 10). Informed consent and ethical procedures conformed to guidelines of the British Psychological Society.

1.3. Measures

1.3.1. Perceived Locus of Causality (PLOC)

The PLOC (see Goudas, Biddle, & Fox, 1994) was used to assess the students' behavioral regulations and amotivation in the PW context.

1.3.2. Basic psychological needs

The competence and relatedness subscales of the Intrinsic Motivation Inventory (IMI, McAuley, Duncan, & Tammen, 1989), and the autonomy subscale of the Basic Need Satisfaction at Work questionnaire (Baard, Deci, & Ryan, 2004) were used to assess the students' basic needs.

1.3.3. Emotions

The enjoyment and value subscales of the IMI (McAuley, Duncan, & Tammen, 1989) were used to assess students' enjoyment and their perceived value of PW.

1.3.4. Metacognition

The metacognitive strategies subscale of the Motivated Strategies for Learning Questionnaire (Pintrich, Smith, Garcia, & McKeachie, 1993) was adapted to measure metacognitive strategies used in PW.

1.3.5. Perceived skills learned in PW

Students' perceived skills learned in PW were measured via a 15-item inventory that included communication skills, collaborative skills, and problem-solving skills.

Answers for the items in the abovementioned measures were given on a 7-point scale ranging from 1 (not true at all) to 7 (very true). The measures were all included in the pre-questionnaire but only *Emotions*, *Metacognition* and *Perceived skills learned in PW* were utilized in the post-questionnaire.

2. Results

2.1. Psychometric properties of the measures

Confirmatory Factor Analyses (CFA) were conducted with EQS for Windows 6.1 (Bentler, 2006) to examine the validity of the main measures followed by internal consistency tests. The results of the CFAs are shown in Table 1. All the measures showed satisfactory factorial validity.

Table 2 shows the means, standard deviations, and internal consistency coefficients of the variables, and Table 3 details the zero-order correlation matrix.

2.2. Cluster analysis

Before cluster analysis, the variables were standardized using z scores (mean of 0 and a standard deviation of 1) and cases with standard scores greater than three were classified as outliers and were deleted from further analyses. One such case was identified and deleted.

A two-stage clustering approach, that is, hierarchical cluster analysis followed by a k -means cluster analysis, was used (see Hair, Anderson, Tatham, & Black, 1998). A four-cluster solution was found to be an appropriate solution. A second k -means cluster analysis was conducted using random seed points. The result showed that more than 70% of the sample remained in the same clusters, thus the cluster solution was verified. Fig. 1 shows the graphical representation of the cluster profiles according to the clustering (PLOC and amotivation) and criterion (basic psychological needs) variables.

2.3. Clustering and criterion variables

One-way MANOVA was used to determine if there were cluster differences in the criterion variables (three psychological needs). The results revealed significant cluster effect, Roy's Largest Root=.290, $F(3, 686)=68.03$, $p<.001$, $\eta^2=.23$ (See Table 4), thus validating the cluster solution.

2.4. Profiles of cluster groups

Table 4 shows the unstandardized and standardized (z scores) means and standard deviations of the clustering and criterion

Table 1
Results of the CFAs of measurement models

Measures	χ^2	df	χ^2/df	NFI	CFI	GFI	SRMR	RMSEA (90% CI)
PLOC	286.52	109	2.63	.934	.955	.956	.056	.051 (.044–.058)
Basic psychological needs	211.63	51	4.15	.924	.941	.950	.053	.067 (.058–.077)
Emotions	76.70	19	4.04	.978	.983	.973	.022	.070 (.054–.086)
Metacognition	76.60	14	5.47	.956	.963	.969	.034	.082 (.064–.100)
Skills in PW	342.09	87	3.93	.934	.949	.932	.035	.068 (.061–.076)

Note: NFI=Normed Fit Index; CFI=Comparative Fit index; GFI=Goodness-of-fit Index; SRMR=Standardised Root Mean Squared Residuals; RMSEA=Root Mean Square Error of Approximation; CI=Confidence Interval for relevant point estimates.

Table 2
Descriptive statistics and internal consistency coefficients for all variables

Variables	α	Mean	SD
1. Intrinsic	.73	4.12	1.49
2. Identified	.61	4.65	1.38
3. Introjected	.74	3.20	1.25
4. External	.80	4.10	1.44
5. Amotivation	.74	3.10	1.59
6. Competence	.73	4.70	1.24
7. Autonomy	.85	3.92	1.21
8. Relatedness	.65	5.10	1.38
9. Enjoyment	.86	3.82	1.45
10. Value	.87	4.37	1.44
11. Metacognition	.85	4.50	1.06
12. Communication skills	.78	4.42	1.13
13. Collaborative skills	.81	4.65	1.14
14. Problem solving Skills	.84	4.40	1.08
15. Post-enjoyment	.87	3.50	1.37
16. Post-value	.89	4.03	1.41
17. Post-metacognition	.88	4.48	1.02
18. Post-communication skills	.82	4.49	1.14
19. Post-collaboration skills	.86	4.64	1.14
20. Post-problem solving skills	.88	4.45	1.10

variables for the four clusters. Cluster 1 ($n=218$), characterized by extremely high amotivation, and low intrinsic and identified regulations, was labeled as the “low self-determined/high controlled” group. This cluster also scored low in autonomy and relatedness.

Cluster 2 ($n=154$), with the highest z scores in intrinsic and identified regulations and extremely low scores in external regulation and amotivation, was labeled as the “high self-determined/low controlled” group. This cluster had high autonomy and relatedness, and moderately high perceived competence.

Cluster 3 ($n=161$), with a relatively flat profile in all the PLOC variables but distinctly low introjected and external regulations, was labeled as the “low self-determined/low controlled” group. This group had relatively low perceived competence, autonomy, and relatedness.

Finally, Cluster 4 ($n=233$), with high intrinsic, identified, and external regulations, and extremely high introjected regulation, was labeled as the “high self-determined/high controlled” group. This cluster had above average competence, autonomy, and relatedness.

Table 3
Zero-order correlation matrix for all variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
1. Intrinsic																				
2. Identified	.72**																			
3. Introjected	.20**	.30**																		
4. External	-.16**	.02	.40**																	
5. Amotivation	-.52**	-.47**	.06	.33**																
6. Competence	.30**	.32**	.17**	.00	-.17**															
7. Autonomy	.52**	.52**	.23**	-.05	-.31**	.30**														
8. Relatedness	.32**	.41**	.07*	-.01	-.32**	.21**	.34**													
9. Enjoyment	.80**	.63**	.22**	-.18**	-.49**	.33**	.62**	.34**												
10. Value	.68**	.72**	.23**	-.07	-.52**	.34**	.64**	.45**	.76**											
11. Metacognition	.46**	.45**	.15**	-.09*	-.29**	.65**	.37**	.30**	.47**	.50**										
12. Comm skills	.45**	.45**	.12**	-.12**	-.30**	.53**	.40**	.34**	.49**	.52**	.71**									
13. Collab skills	.38**	.42**	.13**	-.08*	-.28**	.57**	.40**	.41**	.44**	.50**	.68**	.80**								
14. Prob solv	.46**	.44**	.14**	-.12**	-.30**	.53**	.38**	.34**	.50**	.51**	.72**	.83**	.80**							
15. Post-enjoyment	.44**	.33**	.19**	-.10*	-.24**	.22**	.28**	.14**	.48**	.37**	.28**	.30**	.28**	.33**						
16. Post-value	.42**	.42**	.21**	-.06	-.32**	.29**	.32**	.28**	.45**	.49**	.36**	.39**	.38**	.39**	.78**					
17. Post-metacognition	.31**	.32**	.13**	-.03	-.22**	.43**	.31**	.30**	.34**	.36**	.53**	.46**	.47**	.48**	.39**	.47**				
18. Post-comm skills	.30*	.31**	.11**	-.05	-.26**	.35**	.29**	.26**	.33**	.36**	.43**	.45**	.43**	.40**	.48**	.77**				
19. Post-collab skills	.28**	.32**	.12**	-.03	-.24**	.35**	.31**	.33**	.30**	.34**	.45**	.46**	.50**	.45**	.39**	.49**	.77**	.82**		
20. Post-prob solv	.34**	.33**	.14**	-.07	-.26**	.40**	.32**	.27**	.36**	.37**	.46**	.45**	.45**	.48**	.42**	.51**	.81**	.87**	.83**	

2.5. Profiles of cluster groups in outcome measures

Figs. 2 and 3 show the cluster profiles of the pre- and post-outcomes variables for the four-cluster solution respectively.

Two repeated MANOVAs were conducted on the pre- and post-measures (emotion, metacognition and perceived skills learned in PW). The first repeated MANOVA, with enjoyment and value as the dependent variables, established significant between-subjects effects (Roy's Largest Root=.678, $F(3, 639)=144.38, p<.001, \eta^2=.40$), within-subjects effects (Roy's Largest Root=.092, $F(2, 638)=29.26, p<.001, \eta^2=.08$), and interaction effects (Roy's Largest Root=.150, $F(3, 639)=32.00, p<.001, \eta^2=.13$)(see Table 5).

Follow-up tests showed that the four clusters differed significantly in enjoyment ($F(3, 639)=121.34, p<.001, \eta^2=.36$) and value ($F(3, 639)=121.33, p<.001, \eta^2=.36$). Post-hoc Tukey HSD tests found that all pairwise comparisons were significant ($ps<.01$). That is, Cluster 2 reported the highest enjoyment and value amongst the clusters, followed by Cluster 4, Cluster 3 and Cluster 1. The follow-up tests showed that there were significant differences in enjoyment and value for all clusters over time. All clusters, with the exception of Cluster 1, registered significant decreases.

The second repeated MANOVA, with perceived skills learned in PW and metacognition as dependent variables, established significant between-subjects effects (Roy's Largest Root=.228, $F(4, 605)=34.43, p<.001, \eta^2=.19$) and within-subjects effects (Roy's Largest Root=.027, $F(4, 603)=4.13, p<.001, \eta^2=.03$), but no interaction effects (see Table 5).

Follow-up tests showed that the clusters differed significantly in all the perceived skills learned in PW and metacognition (all $ps<.01$). Post-hoc Tukey HSD tests found that Clusters 2 and 4 had significantly higher scores for metacognition, communication, collaboration, and problem-solving skills, compared to Clusters 1 and 3 (all $ps<.01$). There were no differences between Clusters 1 and 3 for the four variables but Cluster 2 had significantly higher metacognition and communication than Cluster 4. The follow-up tests for within-subjects effects revealed no significant changes over time for all four clusters in the outcome variables.

In summary, the MANOVAs results show that Cluster 2 was the most adaptive cluster, followed by Cluster 4, Cluster 3 and Cluster 1 respectively.

2.6. Gender and stream differences in cluster composition

A two-way contingency table analysis with gender and stream within each cluster showed no significant gender effect but there were

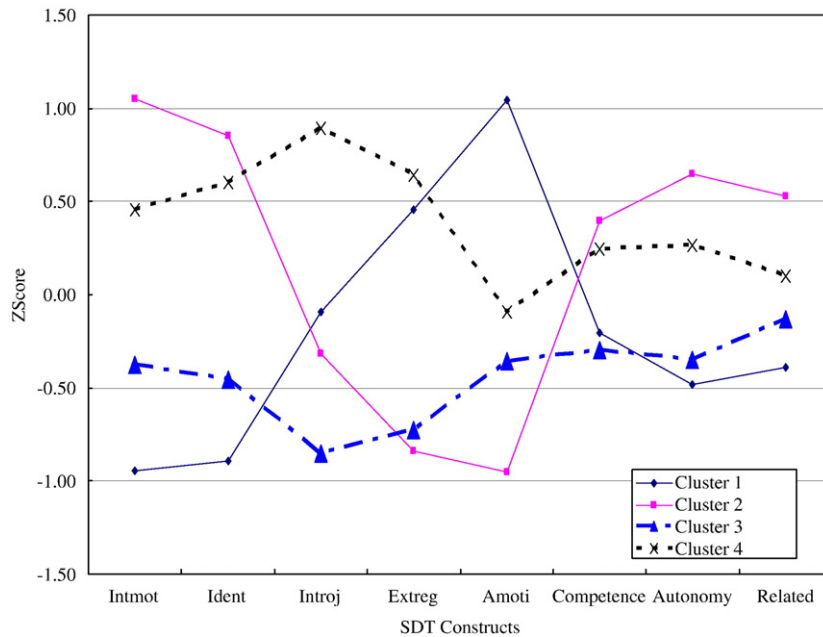


Fig. 1. Cluster profiles of the clustering and criterion variables for the four-cluster solution.

significant stream differences ($\chi^2(6, N=765)=47.81, p=.01$)(see Table 4). It is especially noteworthy that Cluster 1 had a disproportionately high percentage of NA students (69.6%).

3. Discussion

The study was designed to examine students' motivation in PW using SDT. With the PLOC and amotivation constructs as the clustering variables, four distinct clusters, found to be valid with the basic psychological needs as the criterion variables, were identified. Specifically, the students in the “high self-determined/low controlled” cluster reported highest needs satisfaction, whilst the “low self-determined/high controlled” cluster reported lowest needs satisfaction. Furthermore, the differences in the PLOC and amotivation constructs were linked to the students' enjoyment, value, metacognition, and perceived skills learned in PW. This shows that SDT is useful in providing an insight into the motivational processes in PW. It also establishes that PLOC has great potential in explaining students' experience and learning in PW, be it their enjoyment level, perceived value of PW or perceived skills learned in PW.

The second purpose of the study was to examine the differences in emotions, perceived skills learned in PW, and metacognition among the clusters. As noted earlier, the results show that the “high self-determined/low controlled” group was the most adaptive cluster, followed by the “high self-determined/high controlled” group, “low self-determined/low controlled” group, and the “low self-determined/high controlled” group respectively. As such, it seems that students who embark on PW with more autonomous forms of regulations tend to have more positive experience and perceive greater learning in PW. We will need further study to ascertain the causal direction but it would seem worthwhile for teachers to spend time and effort at the start of PW to explain its rationale to students. Presumably, if students are convinced that PW is important because it can equip them with valuable ‘lifewide’ skills, then we may have more students with ‘high self-determined/low controlled’ regulations at the start of PW.

It is noteworthy that the two high self-determined clusters differed on several outcomes and needs. In line with SDT, the result suggests that non self-determined motivation (which had a high component in the “high self-determined/high controlled” group) may produce some negative outcomes.

Table 4 Cluster means, standard deviations and z scores for the clustering and criterion variables in the four-cluster solution

	Cluster 1 (n=218)			Cluster 2 (n=154)			Cluster 3 (n=161)			Cluster 4 (n=233)			F _{3,686}
	M	SD	z	M	SD	z	M	SD	z	M	SD	z	
Intrinsic	2.71	.97	-.95	5.69	.81	1.05	3.56	1.01	-.38	4.80	1.07	.45	
Identified	3.41	.97	-.89	5.83	.78	.86	4.02	1.14	-.46	5.47	.86	.60	
Introjected	3.09	1.05	-.09	2.80	1.01	-.32	2.14	.75	-.85	4.31	.96	.89	
External	4.76	1.19	.46	2.89	1.00	-.84	3.05	1.15	-.73	5.02	.96	.64	
Amotivation	4.75	1.16	1.04	1.59	.70	-.95	2.53	1.03	-.36	2.95	1.28	-.10	
Competence	4.45	1.20	-.20	5.19	1.20	.40	4.33	1.20	-.30	5.00	1.13	.24	19.89**
Autonomy	3.33	1.08	-.48	4.70	1.12	.65	3.49	1.08	-.35	4.24	1.08	.26	52.33**
Relatedness	4.57	1.42	-.39	5.83	1.17	.53	4.92	1.35	-.13	5.24	1.25	.10	22.90**
Cluster characteristics													
Gender	Males		Females	Males		Females	Males		Females	Males		Females	
%	52.3	47.7		60.4	39.6		53.4	46.6		58.4	41.6		
Stream	Express		NT	Express		NT	Express		NT	Express		NT	
%	12.4	69.6	17.9	37.7	43.5	18.8	21.1	47.8	31.0	25.3	51.5	23.2	

Note: **p<.01.

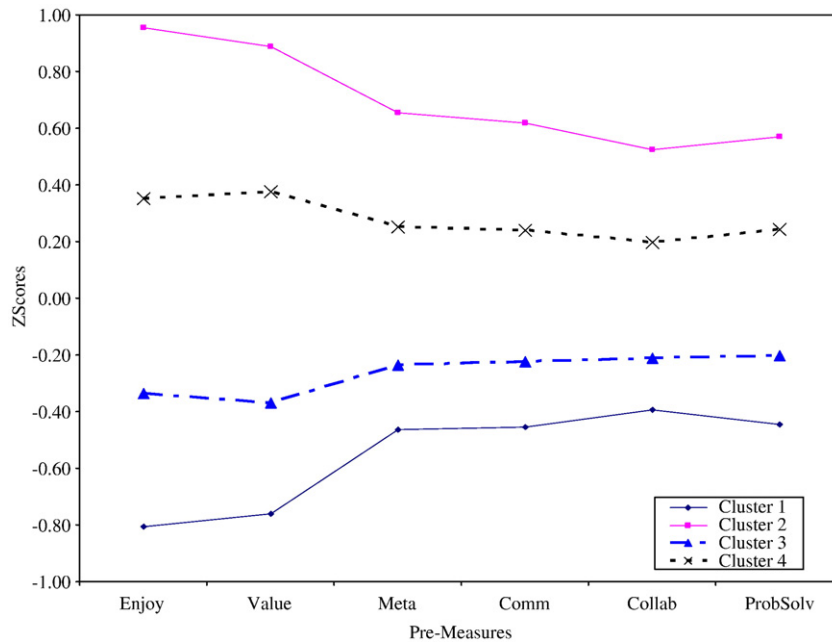


Fig. 2. Cluster profiles of the outcome variables (Pre-measures).

Considering that the “low self-determined/high controlled” students had such low perceived needs satisfaction, PW teachers may want to intervene by satisfying their needs for autonomy, competence and relatedness. They can perhaps fine-tune the way they craft their project tasks and facilitate their lessons. It is noteworthy that this group had a disproportionately high percentage of NA students. The finding is puzzling especially since NA students are not the least academically inclined students. More in-depth study would have to be conducted to determine possible reasons for this observation.

The third purpose of this study was to examine the changes in students' perceptions over time. Our results showed no significant changes over time for all four clusters in perceived skills learned in PW and metacognition, but alarmingly, all the groups, with the exception

of the “low self-determined/high controlled” group, reported significant decreases for enjoyment and value. Since no reviewed studies on PW looked at similar pre- and post-measures, it is not known whether the finding is unique to this sample and/or to the Singapore context. Nonetheless, the finding is of great concern. A possible explanation is that the students were disappointed with their experience because they started PW with unrealistic expectations and perceptions. In this view, teachers should spend time at the start of PW to explain clearly to the students the instructional framework, and the aims and objectives of the different PW stages (see Koh, Tan, Wang, Ee, & Liu, 2007). Another speculation is that the decline in students' enjoyment and valuing of PW may be related to their perceived needs satisfaction. Perhaps, the students' basic needs were

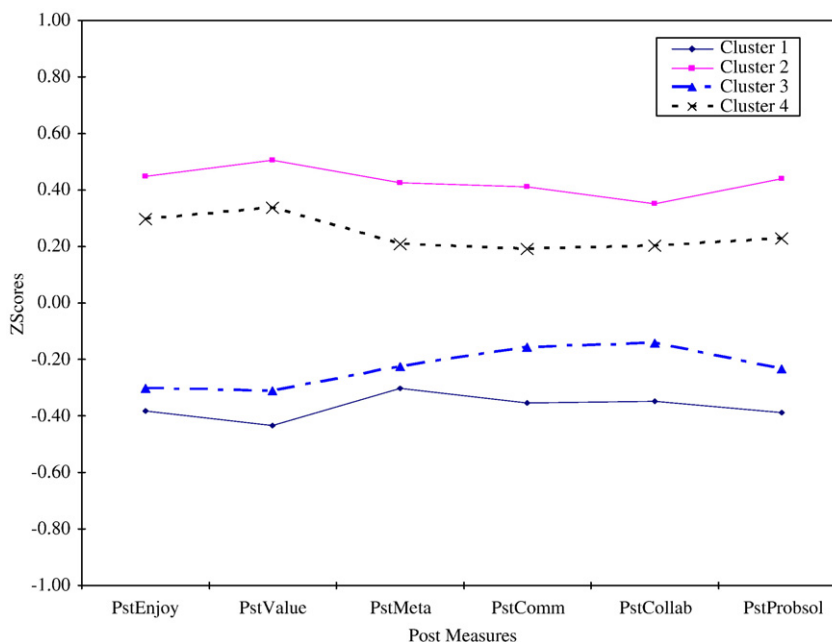


Fig. 3. Cluster profiles of the outcome variables (Post-measures).

Table 5
Outcome variables by cluster (pre- and post-measures)

	Pre-measures			Post-measures		
	M	SD	z	M	SD	z
<i>Cluster 1 (n=218)</i>						
Enjoyment	2.65	1.09	-.81	2.97	1.31	-.38
Value	3.27	1.17	-.76	3.41	1.39	-.43
Metacognition	4.01	.95	-.46	4.17	.96	-.30
Communication skills	3.90	1.00	-.45	4.09	1.09	-.35
Collaborative skills	4.21	1.00	-.39	4.24	1.00	-.35
Problem solving skills	3.91	.96	-.45	4.03	1.04	-.39
<i>Cluster 2 (n=154)</i>						
Enjoyment	5.20	1.06	.95	4.11	1.28	.45
Value	5.65	.99	.89	4.74	1.18	.50
Metacognition	5.19	.96	.66	4.91	1.11	.42
Communication skills	5.11	1.10	.62	4.95	1.11	.41
Collaborative skills	5.25	1.11	.52	5.04	1.18	.35
Problem solving skills	5.01	1.05	.57	4.94	1.10	.44
<i>Cluster 3 (n=161)</i>						
Enjoyment	3.33	1.03	-.34	3.08	1.21	-.30
Value	3.84	1.18	-.37	3.59	1.23	-.31
Metacognition	4.25	.96	-.24	4.25	.93	-.22
Communication skills	4.16	.93	-.23	4.31	1.11	-.16
Collaborative skills	4.41	1.07	-.21	4.48	1.16	-.14
Problem solving skills	4.18	1.01	-.20	4.20	1.06	-.23
<i>Cluster 4 (n=233)</i>						
Enjoyment	4.33	1.17	.35	3.90	1.29	.30
Value	4.91	1.12	.38	4.50	1.30	.34
Metacognition	4.76	.96	.25	4.69	.97	.21
Communication skills	4.69	1.06	.24	4.70	1.07	.19
Collaborative skills	4.88	1.08	.20	4.87	1.11	.20
Problem solving skills	4.66	.96	.24	4.71	1.05	.23

not sustained over the course of PW, thus leading to undermining of students' enjoyment of their experience. Clearly, more research would have to be conducted to determine the reasons for the finding.

Although the "low self-determined/high controlled" students registered significant increases in enjoyment and value over time, it is difficult to read too much into the finding because the pre-measures were already extremely low.

In conclusion, the present study establishes four homogeneous subgroups of students with distinct PLOC profiles. From a theoretical perspective, the finding affirms that SDT can provide important insights into the motivational processes in a collaborative setting like PW. It shows that students' motivational regulations and their perceived needs satisfaction at the start of PW is related to their experience of and learning in PW. Although this study cannot infer causal relationship between PLOC and changes in PW context, other interventions and laboratory studies that took PLOC into consideration showed a marked maintenance of behavioral change during post-treatment periods (e.g., Deci, Koestner, & Ryan, 1999; Williams, Freedman, Ryan, & Deci, 1996). Taken together, if PW is to be used as a vehicle to improve students' learning in schools, it will be beneficial if students can embark on PW with intrinsic or more autonomous forms of motivation. In this respect, SDT, especially with regards to needs satisfaction, provides us with an idea of what teachers can strive to do in their PW classrooms.

Although the results are interesting, the study has its limitations. For instance, the current sample was from government coeducational schools; hence we cannot generalize the findings to students from schools with distinctly different cultures. In addition, since Singaporean students work in groups during PW, it is not possible to separate their perception of PW experience from that of their group experience. Another limitation is that although the questions in the survey were specific to the PW context, we cannot preclude the possibility that the students' responses might be a reflection of their attitudes towards schooling in general. A mixed method of combining qualitative and

quantitative research designs would help to triangulate the quantitative data and would offer more insights into students' perceptions, and changes in their perceptions over time. Future research should also make use of a longitudinal research design that includes post-measures of students' perceived needs satisfaction so that we have more definitive answers as to what caused the decline in students' enjoyment and value of PW over time. Finally, further studies may consider manipulating different levels of needs satisfaction to explain the differential effects of the resultant motivational regulations and behavioral outcomes.

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Appendix A

PW implementation in Singapore schools

At secondary level, most schools make students go through PW for one school year. This means that although the pedagogy is not new to the teachers facilitating it, the experience is novel for the students. Like the schools in this study, schools tend to select Secondary 2 level out of convenience. They also tend to follow the Ministry of Education's guidelines (Ministry of Education, 1999) in their implementation of PW. Specifically, two periods (1^{1/4} h) of curriculum time is set aside per week as PW periods for 10 weeks. The theme of PW is decided by each school's PW coordinator and is generally interdisciplinary in focus. Project themes can be as varied as 'innovation and you' to 'saving the earth'. Students work in groups of four to six to complete their project tasks. The role of the teacher is that of a facilitator or a resource person, rather than that of an instructor. At the end of the PW, students need to do a group presentation, and submit a product, for example, an artifact, a report, a presentation or a performance (see Quek et al., 2006 for details).

For this study, the project theme adopted by the schools was 'adaptation'. Students were guided to come up with their own project task with the help of guiding questions such as 'what do you want to adapt?', 'why do you need to adapt?', 'how do you assess the adaptations?', and 'what can others learn from this project?'.

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