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**Positive Social Climate for Enhancing Students’
Math Self-Concept:
Some research findings**

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Abstract

In Nov 2002, a research team in the National Institute of Education, NTU, launched a cross-discipline quasi-experimental study on “Positive Social Climate for Enhancing Students’ Math Self-concept”. Its main objective was to find the attributes (variables) in the social climate which are accountable for the increase of self-concept of Secondary Two students in the Math remedial classes in Singapore neighbourhood schools.

Phase I of this study (in 2003) was Instrumentation: validating the scales used in the measurement of treatment effect. H.W. Marsh’s Self-Description Questionnaire (SDQ-II, 1990), and B. Fraser’s “What Is Happening In This Class?” questionnaire (WIHIC) were validated together with the Motivational Orientation scale and Intellectual Achievement Responsibility (IAR) questionnaire. More than 700 Secondary Two students from four neighbourhood schools took part in this validating exercise.

Phase II was Intervention`in 2004): the teachers’ interactions with students, the enhancement of students’ capabilities and confidence. A training workshop for teachers in the experimental groups was conducted before the intervention. Two schools had the experimental groups and another two neighbourhood schools’ samples were held as the control groups of this study. Based on the results in Phase I, only two instruments: SDQII and WIHIC were selected to measure the effect of intervention. The total sample in this phase was close to 1000 Sec 2 students.

Background

This was a cross-discipline quasi-experimental study involving colleagues of the Psychological Studies and Math & Math Education Academic Groups of NIE. Its main objective was to find the attributes (variables) in the social climate which were accountable for the increase of self-concept of Secondary Two students in the Math remedial classes in Singapore neighbourhood schools.

Many students in the local secondary schools need to go to Math remedial classes for additional assistance in learning this subject. There are also many local studies on students' self-concept and academic achievement, school adjustment and school climate. However, not many research studies on the self-concept and social climate were conducted in Singapore. And it was the first of its kind to study the relationship of Math self-concept and social climate.

The Principal Investigator of this study was Lui Hah Wah Elena, and the Collaborators were Lim Kam Ming, Liu Woon Chia, and Toh Tin Lam. Their research proposal was officially approved, in late October 2002, for a grant from the Academic Research Fund of NIE / NTU. Permissions then were obtained from H.W. Marsh to use the Self-Description Questionnaire (SDQ-II, 1990), and B. Fraser (thro' S.C. Goh) to use "What Is Happening In This Class?" in this study. These scales were validated together with the Motivational Orientation scales and Intellectual Achievement Responsibility (IAR) questionnaire in Phase I. More than 700 Secondary Two students from four neighbourhood schools took part in the survey conducted in 2003. The three courses covered in this survey were Express, Normal Academic and Normal Technical. The official approval for data collection in schools was given by the Ministry of Education, Singapore, in November 2002.

Instruments

Phase I of this study used the survey method to collect data for the validation of four instruments: Motivational Orientation Scales (Nicholls, 1989, Duda & Nicholls, 1992), Intellectual Achievement Responsibility (IAR) questionnaire, Self-Description Questionnaire (SDQ-II, H.W. Marsh, 1990) and "What Is Happening In This Class?" (B. Fraser).

The Motivational Orientation Scales (Nicholls, 1989, Duda & Nicholls, 1992), is designed to ask students to complete the statement: "I feel really successful when..." with 16 sentences. They are advised to read each sentence carefully and decide to what extent they agree with it, then indicate how they feel most of the time by circling one number on a 5-point scale for each statement.

A 23-item modified version of the IAR (Intellectual Achievement Responsibility) Questionnaire was used in this study. The IAR (Crandall, Katkovsky & Crandall, 1965) was designed to measure children's beliefs regarding their locus of control related to intellectual achievements in school (Lefcourt, 1990). It is a 34 item self-report scale, with each item describing a positive or a negative achievement situation. Respondents

select between 2 choices (a & b) that indicate internal locus of control or external locus of control for each items. Scores are calculated in an internal locus of control direction.

The Self-Description Questionnaire “SDQ-II” (H.W. Marsh,1990) has 102 items in 3 areas of academic self-concept (Math, Verbal, General School) and 7 areas of non-academic self-concept (Physical Abilities, Physical Appearance, Opposite-sex Relations, Parent Relations, Honesty-Trustworthiness and Emotional Stability). The 11th scale: General Self-concept is derived from Rosenberg (’65,’79) self-esteem scale.

The sum of these 11 scales are also summed to yield a Total Self-concept score, reflect an adolescent’s self-ratings in various areas of self-concept. In completing the SDQ-II, adolescents are asked to respond to simple declarative sentences with one of six responses: False, Mostly False, More False than True, More True than False, Mostly True or True. In 1985, Marsh & Shavelson postulated the multi-faceted hierarchical structure of self-concept. The various domains of self-perception: academic self-concept, non-academic self-concept and general self-concept contribute to a person’s global self-concept. Four of the SDQII scales were used in this study: Math (10 items), Parent Relations (8 items), General School (10 items) and General (10 items).

The “What Is Happening In This Class?” (WIHIC) questionnaire was validated in a local study “Classroom environment, self-esteem, achievement, and attitudes in Geography and Mathematics in Singapore” by Barry J. Fraser and Yan Huay Chionh in 2000. This study had a sample of 2310 students from 75 Secondary 4 (grade 10) classes, It brings together the best features of past classroom environment questionnaires and new dimensions of contemporary relevance. The 7 scales (with 70 items) are: Student Cohesiveness, Teacher Support, Involvement, Investigation, Task Orientation, Cooperation and Equity. Each item is responded on a 5-point scale: Almost Never, Seldom, Sometimes, Often and Very Often.

Phase I - Validation of Instruments

Reliability

This research paper focuses on the findings in self-concept and classroom environment. For the SDQII, the reliability of Math Self-concept and the other three scales are established in this study, alpha ranging from 0.79 to 0.87, and the total of the four scales is 0.90. The reliability alpha of “What Is Happening In This Class?” (WIHIC) questionnaire’s 7 scales range from 0.83-0.89, the total scale’s alpha is 0.96.

Table 1 Reliability of SDQII (4 Scales)

Scale	Alpha Reliability	No. of Items	Mean
SDQ II (11 scales)	.94	102	(6-point scale)
Math (Self-Concept)	.87	10	3.5
General (SC)	.79	10	3.9
Parent Relation (SC)	.81	8	4.5
General School (SC)	.80	10	3.9
Total of 4 Scales	.90	38	3.9

Table 2 Reliability of WIHIC

Scale	Alpha Reliability	No. of Items	Mean (5-point scale)
WIHIC (Total)	.96	56	3.3
Student Cohesiveness	.83	8	3.6
Teacher Support	.86	8	3.0
Involvement	.84	8	3.0
Investigation	.88	8	2.8
Task Orientation	.87	8	3.7
Cooperation	.89	8	3.6
Equity	.88	8	3.4

Inter-scale Correlation

The inter-scale correlation coefficients of the 4 SDQII scales and 7 WIHIC scales are all significant ($p < 0.05$, 2-tailed). The 4 scales of SDQII have correlation coefficients ranging from 0.24 to 0.75. The General and School scales have very strong relationship ($r = 0.75$). The Math scale's correlation with the 7 WIHIC scales range from 0.08 (Cooperation) to 0.24 (Investigation). Math Self-concept has the strongest relationship with Investigation ($r = 0.24$), next is Task Orientation ($r = 0.21$)

Table 3 Pearson Correlations of Self-Concept & Social Climate Scales

		MATHSC	GENSC	PARSC	SCHSC	SSCOHEN	TSUPPORT
GENSC	Correlation	.324					
	Sig. (2-tailed)	.000					
PARSC	Correlation	.235	.396				
	Sig. (2-tailed)	.000	.000				
SCHSC	Correlation	.244	.746	.309			
	Sig. (2-tailed)	.000	.000	.000			
SSCOHEN	Correlation	.099	.325	.248	.367		
	Sig. (2-tailed)	.010	.000	.000	.000		
TSUPPORT	Correlation	.174	.313	.179	.321	.427	
	Sig. (2-tailed)	.000	.000	.000	.000	.000	
INVOLV	Correlation	.085	.272	.127	.317	.514	.516
	Sig. (2-tailed)	.026	.000	.001	.000	.000	.000
INVEST	Correlation	.239	.314	.155	.291	.374	.470
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000
TASKOR	Correlation	.214	.420	.271	.422	.513	.519
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000
COOP	Correlation	.078	.304	.306	.325	.665	.478
	Sig. (2-tailed)	.041	.000	.000	.000	.000	.000
EQUITY	Correlation	.163	.338	.242	.311	.491	.562
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000

Phase I – Gender and Course Differences

Gender Differences

In this study, gender differences are found in both SDQ-II and WIHIC. Male students' Math SC mean score (3.75) is 0.41 higher than that of female students (3.34), $F=27.31$, $p=.000$. (Table 4). In WIHIC there are small yet significant gender differences in 3 scales: Investigation ($F=2.82$, $p=.009$), in favor of male students. However, in Cooperation ($F=3.56$, $p=.001$) and Student Cohesiveness ($F=9.03$, $p=.003$), Female students' mean scores are higher than the male's. (Table 5)

In the NIE 5-year longitudinal study of adolescents' cognitive & psycho-social development and school adjustment (led by Esther Tan, 1995-1999): Male students had

higher Self-Esteem Checklist mean scores than female students by 1.75 points in Sec 4, 2.5 points in Sec 3, 4.27 in Sec 2 and 2.47 in Sec 1. The differences were significant at 0.05, $F = 2.69$.

Significant gender differences in Self-Esteem, in favour of male students, were also found in Lui's 1987 study and other studies in recent years. A local 3-year (1998-2000) longitudinal study: "The effects of perceived home environment and classroom climate on male and female students' academic self-concept" (N=495) found female students academic self-concept more dependent on academic support, especially at the end of Secondary 2, and less depend on parent relations. (W.C. Liu, 2003)

Table 4 Math Self-concept Significant Difference of Mean Scores by Gender

SDQ II scales	Mean Scores		F
	M (N=322)	F (N=360)	
Math (Self-Concept)	3.75	3.34	27.31 Sig. .000
Total of 4 scales	4.02	3.89	5.81 Sig. .016

Table 5 WIHIC (3 scales) Significant Difference of Mean Scores by Gender

WIHIC Scale	Mean Scores		F
	M (N=321)	F (N=356)	
Student Cohesiveness	3.59	3.74	9.03 Sig.003
Investigation	2.89	2.81	2.82 Sig.009
Cooperation	3.50	3.81	3.56 Sig.001
Course Difference			

Significant difference of the 3 courses' mean scores are found in only one scale of SDQII: Parent Relations ($F=3.95$, $p=.02$). Express Course students' mean score (4.62) is the highest, followed by Normal Academic then Normal Technical. The WIHIC total mean score shows the same trend, Exp: 3.40, NA: 3.29, NT: 3.18 ($F=6.96$, $p=.001$).

Four scales of social climate have significant difference by course $\text{Exp} > \text{NA} > \text{NT}$: Cooperation ($F=13.49$, $p=.000$), Student Cohesiveness ($F=12.88$, $p=.016$), Task Orientation ($F=7.71$, $p=.000$), Equity ($F=17.53$, $p=.000$). (Table 6)

Table 6 Significant Difference of Mean Scores by Course

Scale	Mean Scores			F
	Exp	NA	NT	
Parent Relations (Self-Concept)	4.62	4.42	4.36	3.95 Sig. .020
Student Cohesiveness	3.79	3.66	3.42	12.88 Sig. .016
Task Orientation	3.82	3.72	3.52	7.71 Sig. .000
Cooperation	3.76	3.56	3.35	13.49 Sig. .000
Equity	3.61	3.33	3.15	17.53 Sig. .000

Phase II – Intervention

In Phase I, four instruments were validated in the survey conducted in four neighbourhood schools involving some 700 Secondary Two students. The research team was confident to use two of these instruments: SDQII (self-concept) and WIHIC (social climate) in the pre-test and post-test of Phase II – Intervention. The significant and positive relationship between the SDQII and WIHIC suggests that the Math self-concept enhancement should focus on the interaction between teacher and students, and among students. The findings on Math Self-concept's strong relationship with Investigation ($r = 0.24$) and Task Orientation ($r = 0.21$) indicated the stress should be on these two areas of classroom interaction.

In regards to the gender difference found in both SDQ-II and WIHIC: Male students' Math SC mean score is higher than that of female students. In WIHIC there is small yet significant gender difference in Investigation, in favor of male students, but in both Cooperation and Student Cohesiveness, female students' mean scores are higher than the male's. The research team suggested to teachers taking part in the intervention to pay attention to these variance, such as engaging the female students more in investigation activities and the male students more in cooperative and team building activities.

The findings in course differences suggested that teachers should also look into the impact of parent relations in student's self-concept and academic achievement. In addition, they might need to attend to their students' perception of equity, cooperation, task orientation and cohesiveness in the Normal Academic and Technical Courses.

Teacher's personal quality, relationship and communication with students could make a difference in student's learning. B.Kaur reported in the ERAS 2003 Conference the analysis of the responses to the question "*What do you think are the qualities of the best mathematics teacher you have ever had?*" in a questionnaire of the Kassel Project (1995), completed by 2276 Secondary Two pupils from 7 Singapore schools. "The seven qualities which pupils from all the three streams unanimously agreed upon were:

- ? Personal Quality – patient
- ? Relationship & Rapport – understanding and caring / kind
- ? Instruction & Pedagogy – good in mathematics, explains clearly, ensures pupils understand and provides individual help." (Kaur, 2003)

The findings of Phase I of "Positive Social Climate for Enhancing Students' Math Self-concept" and relevant studies such as Kaur & Yeap (1997) really helped the research team in designing the appropriate training package and intervention programme in Phase II of this study. The emphases were on the positive interaction and cooperative learning in the remedial classes for Mathematics.

Phase II – Training Workshop for Teachers in the Experimental Groups

- ? At the beginning of Phase II, on 29 May 2004, a one-day workshop at NIE was specially designed and conducted for the Experimental Groups teachers in Coral Secondary School and Westwood Secondary School. The trainers were Mr Lee Ngan Hoe, Dr Chong Wan Har and team members of this study. The instructional design of this workshop were based on the data analysis of Phase I which indicated that amongst the subscales of the classroom climate instrument, the significant predictors of Math Self-concept were investigation, task orientation and cooperation; the predictors of School Self-concept were task orientation, student cohesiveness and teacher support; and General Self-concept: task orientation, investigation, student cohesiveness, equity and cooperation. The contents of this workshop covered:
 - ? Briefing on the research projects in "Positive Social Climate" and "Self-Concept"
 - ? Cooperative Learning: Concepts & Application
 - ? Helping students who're weak in Math
 - ? Group discussion and sharing on helping strategies in "Positive Social Climate for Enhancing Students' Math Self-concept"

Phase II - Intervention

While the experimental group teachers in Westwood Secondary implemented the intervention with 24 Sec 2 students in their remedial lessons, the experimental group teachers in Coral Secondary planned and carried out activities to enhance all Sec 2 (except the best class) students' capabilities and confidence in learning Math. The intervention included:

- As a team, teachers identified appropriate sub-topics and took ownership in developing lesson plans and activities.
- Leveraged on the school's professional sharing scheme to share, refine and reflect upon lesson plans.
- Mixed-ability, same-gender groupings were formed. Teachers created the initial groupings, pupils allowed to request for change.
- Guided by the lesson planning template provided by NIE trainers.
- Lesson resources and pedagogy were developed to meet instructional objectives in five domains: Content, Affective, Social Skills, Cognitive and Meta-cognitive. These are in line with the focus of the research study.
- Lesson resources were stored in intranet folders for future use.

Phase II – Data Collections and Analyses

In May 2004, around 1000 Secondary Two students from four neighborhood schools participated in the pre-test, using the SDQII and WIHIC. And the same samples took part in post-test conducted in Oct 2004 to help measure the effect of invention on these students' Math Self-concept and related variables. These 4 schools were Coral Secondary, Westwood Secondary, Jurongville Secondary and Greenridge Secondary.

Intervention (treatment) was carried out in July Semester. Post-test data collection in Coral Secondary was done in mid Oct '04, Westwood Secondary and the two control groups in end Oct '04. The overall sample comprised 939 students (519 male and 420 female). The reliabilities of SDQII and WIHIC subscales were above .70, and consistently higher in the Post-test.

Table 7 Cronbach alphas

Scale	N items	Pre-test - Alphas	Post-test - Alphas
SDQII			
General self-concept	10	.76	.82
School self-concept	10	.81	.84
Maths self-concept	10	.89	.91
Parent relations	8	.79	.84
WIHIC			
Student cohesiveness	8	.71	.83
Teacher support	8	.87	.88
Involvement	8	.81	.84
Investigation	8	.89	.91
Task orientation	8	.78	.86
Cooperation	8	.86	.88

Equity	8	.88	.90
SDQII & WIHIC scales	56	.94	.96

Phase II – T-test findings of Pre-test and Post-test

The test of significant difference between the pre-test and post-test in all the subscales (factors) in all the four schools resulted in a rather inconsistent pattern. Only one subscale: Investigation had an increase of mean score at $p < 0.01$ in both the experiment and control samples. This might due to the subject “Math” has a strong link to investigation.

Paired-sample t-test – Control schools only

There were significant increases from pre-test to post-test results for the following variables:

- 1) student cohesiveness (pretest: 3.66, $sd = .64$; post-test: 3.72. $sd = .62$), $t(464) = 2.02$, $p < .05$
- 2) investigation (pretest: 2.67, $sd = .76$; post-test: 2.8. $sd = .79$), $t(464) = 3.35$, $p < .01$
- 3) equity (pretest: 3.26, $sd = .84$; post-test: 3.45. $sd = .78$), $t(449) = 4.31$, $p < .001$

Paired-sample t-test –Experimental schools only

There were significant increases from pre-test to post-test results for the following variables:

- 1) general scale (pretest: 3.79, $sd = .92$; post-test: 3.88. $sd = .9$), $t(392) = 2.3$, $p < .05$
- 2) teacher support (pretest: 2.81, $sd = .80$; post-test: 2.93. $sd = .8$), $t(391) = 2.54$, $p < .05$
- 3) involvement (pretest: 2.76, $sd = .76$; post-test: 2.88. $sd = .74$), $t(392) = 2.96$, $p < .01$
- 4) investigation (pretest: 2.58, $sd = .81$; post-test: 2.74. $sd = .78$), $t(391) = 3.78$, $p < .001$

The t-test by schools showed a significant increase of Math Self-concept mean scores in Coral Secondary but decrease in Westwood Secondary. Further investigation found the That there were only 24 students went to the remedial class and involved in the intervention. The t-test of this specific sample indicated a significant increase of General Self-concept pre-test ($M = 3.66$, $sd = .65$) to post-test ($M = 4.08$, $sd = .7$), $t(21) = 2.89$, $p < .01$., but no other significant increases in Math self-concept and other variables. .

The findings also showed the gender effects in the Westwood remedial class:

Female students perceived higher teacher support ($M = 4.16$, $sd = .21$) than do male students ($M = 3.27$, $sd = .25$), $F(1,20) = 7.15$, $MSe = 1.16$, $p < .05$.

Female students perceived higher task orientation ($M = 3.96$, $sd = .17$) than do male students ($M = 3.23$, $sd = .21$), $F(1,20) = 7.46$, $MSe = .77$, $p < .05$.

Paired-sample t-test –Westwood School only (experimental)

There were significant differences in pre-test to post-test results for the following variables:

- 1) math self-concept (*pretest: 3.48, sd=1.26; post-test: 3.29, sd=1.3*), $t(228)=2.98, p<.01$
- 2) student cohesiveness (*pretest: 3.51, sd=.64; post-test: 3.64, sd=.62*), $t(228)=3.41, p<.01$
- 3) teacher support (*pretest: 2.97, sd=.77; post-test: 3.09, sd=.75*), $t(228)=2.74, p<.01$
- 4) investigation (*pretest: 2.59, sd=.71; post-test: 2.75, sd=.73*), $t(228)=3.22, p<.01$
- 5) equity (*pretest: 3.21, sd=.81; post-test: 3.39, sd=.74*), $t(217)=3.24, p<.01$

Paired-sample t-test –Coral School only (experimental)

There were significant increases from pre-test to post-test results for the following variables:

- 1) general self-concept (*pretest: 3.9, sd=.94; post-test: 3.96, sd=.72*), $t(235)=2.19, p<.05$
- 2) *math self-concept (pretest: 3.26, sd=1.21; post-test: 3.42, sd=1.1), $t(236)=2.65, p<.01$*
- 3) equity (*pretest: 3.36, sd=.87; post-test: 3.51, sd=.82*), $t(231)=2.86, p<.01$

Discussion

In general there were some significant findings in different phases and aspects of this research. However it seems lacking a significant contribution to the field of self-concept and social climate studies, because the findings were not showing any particular indicator or consistency.

In Phase I of this study, gender differences are found in both SDQ-II and WIHIC. Male students' Math SC mean score (3.75) is 0.41 higher than that of female students (3.34), $F=27.31, p=.000$. In WIHIC there are small yet significant gender differences in 3 scales: Investigation ($F=2.82, p=.009$), in favor of male students. However, in Cooperation ($F=3.56, p=.001$) and Student Cohesiveness ($F=9.03, p=.003$), female students' mean scores are higher than the male's.

In Phase II, the findings showed the gender effect in the Westwood remedial class: Female students perceived higher teacher support ($M=4.16$) than do male students ($M=3.27$), $p<.05$. Female students perceived higher task orientation ($M=3.96$) than do male students ($M=3.23$), $p<.05$. However, the sample was small, only 24 students. The Coral sample was the only one that had a significant increase of Math Self-concept after the intervention. (*pretest: 3.26, post-test: 3.42, $p<.01$*). Could it be due to the mixed-ability, same-gender grouping in the intervention?

Further investigation is required in the gender effects of social climate and self-concept enhancement. There were several limitations in this study: time constraint of the researchers and teachers was the main reason for not having sufficient observation and discussion in the research processes. The selection of schools and samples was limited and depended on the cooperation of the principals and teachers in-charge. And it was a happy co-event when some of the results were presented at the Action Research conference at Coral Secondary in Oct 2004. The researchers in this study would like

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