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# STUDENTS' MATH SELF-CONCEPT AND CORRELATES: SOME PRELIMINARY 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 is 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 One of this study is Instrumentation: validating the scales used in the measurement of treatment effect. Phase Two is Intervention: the teachers' / tutors' interactions with students, the enhancement of students' capabilities and confidence. These teachers / tutors will attend workshops conducted before the intervention in Phrase Two. The Pre-test results will help identify students with high or low Math Self-concept. And the Post-test will help measure the effect of invention on these students' Math Self-concept. Factors contributed to the significant changes will also be explored.

H.W. Marsh's Self-Description Questionnaire (SDQ-II, 1990) and B. Fraser's "What is happening in this Class?" questionnaire were validated together with the Motivational Orientation scale and Intellectual Achievement Responsibility (IAR) questionnaire in Phase One. More than 700 Secondary Two students from four neighbourhood schools took part in the survey. Some preliminary findings in Phase One of this study will be presented in this paper. Gender and course differences in Math Self-concept and other variables will also be discussed.

## Background

This is a cross-discipline quasi-experimental study involving colleagues of the Psychological Studies and Math & Math Education Academic Groups of NIE. Its main objective is 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.

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 is the first of its kind to study the relationship of Math self-concept and social climate.

The Principal Investigator of this study is Lui Hah Wah Elena, and the Collaborators are 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 One. 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 One 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 and 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 is 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.

**Findings**

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 General 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 |

Gender Difference

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 favour of male students, Cooperation ($F=3.56$, $p=.001$) and Student Cohesiveness ($F=9.03$, $p=.003$), in favour of female students (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 favor of male students, were also found in Lui's 1987 study and other studies in recent years. A local 3-year 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, as compared to their male counterparts (Liu, 2003).

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

| SDQ II scales | Mean Scores M ( N=322) | Mean Scores F ( N=360) | F |
|---|---|---|---|
| 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 M (N=321) | Mean Scores F (N=356) | F |
|---|---|---|---|
| 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 Exp > NA > 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 |

**Implications**

The objective of Phase I of this study has been achieved. All the four instruments were validated in the survey conducted in four neighbourhood schools involving some 700 Secondary Two students. The research team is confident to use these instruments in the pre-test and post-test of Phase II – Intervention.

The significant and positive relationship between the SDQII (self-concept) and WIHIC (social climate) 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) indicate 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 may suggest 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 may suggest that teachers should also look into the impact of parent relations in student's self-concept and academic achievement. In addition, they may 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.Kuar 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 help the research team in designing the appropriate training package and intervention programme in Phase II of this study. The emphases will be positive interaction and cooperative learning in the remedial classes for Mathematics.

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