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Exploring Primary Pupils' Desirable Activities in Mathematics Lessons

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Abstract

An instrument developed mainly from responses of primary school pupils to an open-ended question was employed to find out types of activities that primary school pupils wished to have in mathematics lessons. One hundred and nine primary four and five pupils rated the activities individually according to their preference. There were four interpretative factor structures. The first factor (F1) comprised items related to unconventional learning activities in and outside classrooms such as recess, outdoor activities, games, and quiz. The second factor (F2) consisted of items related to conventional classroom (mathematics) activities such as mental sum, problem sum, doing worksheet, correcting mistake and examination. The third factor (F3) comprised items related to activities that challenge pupils' independent and expressive competencies such as acting or showing and telling, role play, reading, spelling words correctly and doing project. The fourth factor (F4) consisted of there items namely verbal presentation, competition and group work, and was related to a person's interpersonal competence. Using cluster analysis, the pupils were re-grouped according to these factors. Within a class there were pupils who demonstrated a high desirability for all activities. There were also pupils who showed less desirability for all activities. Implications of the findings for teachers were elicited.

Introduction

The importance of pupils' views in learning mathematics: Mathematics is likely to be perceived as a "serious" and "difficult" subject, and is "exclusively for a certain group of pupils". To make mathematics learning a manageable endeavour for every pupil, teachers should attempt to explore pupils' perceptions of mathematics as well as their favourable experiences and difficulties in learning mathematics. Pupils' views and opinions on mathematics learning are sources of information about their likes and dislikes, their learning experiences, as well as their perceptions of learning processes, styles, and conditions for mathematics.

Teachers who consider children's preferences and wishes are likely to nurture a positive mathematics learning environment. A pleasant learning environment can act as an incentive for continuous learning, knowledge exploration, and creative performances (Tan, 1998). When teachers integrate pupils' preferences and wishes effectively into mathematics lessons, pupils are likely to commit themselves to mathematics learning. Consequently, pupils are likely to claim the ownership of the learning activities and are likely to be motivated.

Four reasons for recognizing upper primary pupils' wishes in mathematics lessons: Recognising the significance of pupils' views and opinions, this paper intends to uncover activities that primary school pupils wish to have in mathematics lessons. It is believed that pupils' desirable activities are not pre-determined by their achievement levels. Variations in desirable activities can be observed within a class, among pupils of the same achievement level and among pupils of the mixed achievement levels as well as across classes. There are several reasons why desirable activities for mathematics should be addressed, especially for upper primary school years.

1) Complexity of the content area: The first reason is related to the increase of the complexity in the content areas from lower primary school years to upper primary school years. In lower primary school years (primary one to primary three), pupils learn five major areas: Numbers, fractions, statistics, geometry, and the application of simple measurement (length and weight). In the upper primary school years (primary four to primary six), the number of content areas increases to ten, adding decimals, areas and volumes, ratio and proportion, percentages, and average (speed and rate) to the list. The complexity of mathematics learning is not only attributed to the increase of the number of content areas but also attributed to the increase of the degree of difficulty in each content area.

2) Change in learning culture: The second reason concerns the learning culture in the upper primary school years featured by two streaming exercises at the end of primary four (school-based) and at the end of primary six (national). Consequently, the learning culture in the upper primary school years is likely to be examination oriented. Mathematics teachers often complete the syllabi several months before the streaming examinations. They usually help prepare the children for the examinations by conducting remedial classes and/or by giving them extra exercises. The change of learning culture can also be interpreted from the change of seating arrangement across school years. Lower primary pupils (primary one and primary two) are seated in clusters. The tables and chairs are arranged in a U-shaped leaving a common space for interactions between the teacher and the pupils and among pupils. In the communal mat (the space between the U-shape and the whiteboard), pupils are physically closed to the teacher and their classmates. Pupils read story from an enlarged book, share experiences and ideas. From primary three onwards, pupils are seated in rows. Interactions among pupils confine to those sitting near to each other.

3) New educational initiatives: The third reason addresses the recent educational initiatives which aims at preparing an informational and technological learning environment (Teo, 1997), implanting the sense of community (Lee, 1997) and cultivating creative thinking and independent life-long learning (Goh, 1997). Classroom learning should focus on striking a balance between high academic achievement and innovative discovery. Effectiveness of classroom learning can be improved by increasing pupil involvement. To instill a sense of belonging, teachers are encouraged to adopt a pupils-teacher interactive approach to teaching and learning. The interactive approach encourages pupil participation in all stages of lesson delivery. Computer-based learning is introduced to increase variations of learning activities.

4) Creating a new learning environment: The fourth reason is related to creating a motivating, pleasant and non-threatening learning environment for mathematics lessons. Improving learning conditions is one of the major educational concerns. Extensive studies have been conducted on pupils' learning styles (Lim, 1995; Riding & Cheema, 1991), learning activities such as games (Kaye, 1995; Koran & McLaughlin, 1990) and play (Trawick-Smith, 1989), classroom environment (Cheah, 1997; Shade, Kelly & Oberg, 1997), and factors that motivate learning (Deci & Ryan, 1992; Paris & Turner, 1994; Gracia & Pintrich, 1996). Pupils' experience, socio-cultural diversity and views should be considered for any educational reform (Nieto, 1994). Nevertheless, there are limited resources on innovative classroom learning elicited from the pupils' perspective.

A study is conducted to investigate pupils' desirable activities in mathematics lessons. Subjects of the study were primary school pupils of a school where high achievers are grouped in a class a year prior to the streaming exercise in primary four. There were two major aims of this study. First, the study intends to find out types of activities that Singaporean pupils wished to have in mathematics lessons. Second, the study aims at uncovering variations in desirable activities demonstrated by high achievers and low achievers in the same class and across classes. Three research questions are formulated:

1) What kinds of learning activities do primary school pupils wish to have in mathematics lessons?

2) Do primary pupils' desirable activities for mathematics vary according to the achievement level?
3) Are primary pupils' desirable activities for mathematics different across classes?

Method

One hundred and nine children participated in a survey aiming at uncovering their desirable activities for mathematics lessons.

The instrument

An instrument comprised twenty-nine items of which some appeared frequently in a pilot study carried out between August and September 1997. In responding to an open-ended question, the pupils (age 8-12 years) described (in 20 minutes) activities that they wished for mathematics. Frequently appeared items in the study were games, quiz, group work, acting or showing and telling, constructing something or hands on experience, telling or listening to story, solving puzzles, competition, riddles, learning computer skills, asking question, project work, video show, spelling words correctly, doing worksheet, writing, reading, and correcting mistakes, taking a rest, discussion, role play, and telling or listening to jokes. IQ question is a general term referring to questions that challenge thinking beyond the classroom learning. Together with the IQ question, learning outside the classroom and verbal presentation occurred frequently in a survey designed to extract 140 student teachers' (18-24 years old) perception of creative activities for Singapore pupils. Teacher's demonstration, test, problem sum and mental sum are usual classroom activities in mathematics lessons, and hence they were also included.

Sample

The subjects comprised 109 children, 57.3% female and 40% male (2.7% did not report their gender). The average age of the subjects was 9.8 years with a standard deviation of 0.6 year. They were three principal groups of pupils. The first group consisted of 37 high achievers of primary five (high 5), the best class according to the streaming results in primary four. The second group comprised 39 high achievers of primary four (high 4), one of the best classes according to school achievement results. The third group consisted of 33 low achievers of primary four (low 4). According to the pupils' report, Mandarin was the most frequently used language at home (62.7%), followed by English (60.9%), Chinese dialects (27.3%), Malay (14.5%), Tamil (3.6%) and other languages (6.4%).

Procedure

The instrument was administered to the pupils during mathematics lessons at different time intervals in January 1998. The average duration for completing the instrument was 15 minutes. Before the subjects responded, the researcher read the instructions. The subjects then rated the degree of desirability for the activities that they wished to have in mathematics lessons. To avoid subjective interpretation of the 5-Likert scale, descriptors of the scale were defined. The number 5 meant a wish for an activity in every lesson, 4 referred to almost every lesson, 3 twice a week, 2 once a week, and 1 once a month. If an activity was not of the subject's interest, no answer should be given. The instrument was in English.

Data Analysis

The Cronbach's alpha reliability of the instrument was high, 0.92. Factor analysis was employed to reduce pupils' responses to manageable portions. It provided a general overview on various types of desirable activities that primary pupils wished to have for mathematics lessons (research question 1). The Kaiser-Meyer-Olkin measure of sampling adequacy of the instrument was high, 0.83. The Barlett Test of Sphericity was large (1467.65) and the associated significant level was low (0). The factors were extracted from the principal component analysis using the oblique rotation with Kaiser normalization. The researcher performed cluster analysis on the interpretative factors to re-group pupils according to their desirable activities, but not the achievement level (research question 2). The multivariate analysis of variance and the independent-T-test were employed to uncover group differences (research question 3).

Results

Types of activities that primary pupils wished to have in mathematics lessons (research question 1): There were four interpretative factors contributing to a total of 52.1% variance. The first factor (F1) comprised items related to unconventional learning activities in and outside classrooms such as recess, outdoor activities, games, and quiz. The second factor (F2) consisted of items related to conventional classroom (mathematics) activities such as mental sum, problem sum, doing worksheet, correcting mistake and examination. The third factor (F3) comprised items related to activities that challenge pupils' independent and expressive competencies such as acting or showing and telling, role play, reading, spelling words correctly and doing project. The fourth factor (F4) consisted of three items namely verbal presentation, competition and group work, and was related to a person's interpersonal competence. Table 1 displays mean, standard deviation, and factor loading of the items.

Table 1: Descriptive Statistics and Factor Loadings of Primary Pupils' Desirable Activities in Mathematics Lessons

	Factor loading	High 5	Mean(SD) High 4	Low 4
F1		**3.09(0.89)**	**2.98(1.18)**	**1.37(1.05)**
Recess	0.77	3.24(1.57)	3.10(1.85)	1.32(1.90)
Outdoor activities	0.76	3.27(1.57)	3.03(1.74)	0.68(1.45)
Riddles	0.66	3.05(1.56)	2.72(1.75)	1.15(1.60)
Discussion	0.61	2.57(1.64)	1.74(1.90)	0.41(1.13)
Games	0.57	3.70(1.43)	3.90(1.47)	2.50(2.15)
Quiz	0.55	2.59(1.54)	2.92(1.74)	1.09(1.52)
Video show	0.54	2.84(1.66)	2.51(2.02)	1.85(2.15)
Teacher demonstration	0.49	2.46(1.69)	1.64(1.77)	0.35(1.10)
IQ questions	0.40	2.24(1.46)	2.72(1.92)	0.65(1.25)
Construct something	0.38	1.65(1.49)	2.08(1.83)	0.88(1.67)
Computer lessons	0.37	3.24(1.71)	3.44(1.92)	2.82(2.35)
F2		**2.14(1.12)**	**1.84(1.04)**	**1.01(0.98)**
Mental sum	- 0.89	1.70(1.29)	1.59(1.23)	1.50(1.69)
Problem sum	- 0.78	1.81(1.43)	1.87(1.56)	1.03(1.47)
Doing worksheet	- 0.62	2.68(1.73)	1.97(1.83)	0.68(1.39)
Asking question	- 0.61	3.03(1.67)	1.97(2.03)	1.15(1.73)
Correcting mistakes	- 0.53	1.92(1.62)	1.18(1.30)	0.24(0.65)
Writing	- 0.48	1.97(1.71)	1.72(1.81)	1.09(1.60)
Test or examination	- 0.46	1.08(1.09)	1.74(1.67)	0.91(1.54)
Solving puzzles	- 0.44	2.95(1.35)	2.69(1.69)	1.56(1.89)
F3		**1.63(0.88)**	**2.15(1.22)**	**1.09(1.07)**
Acting or showing and telling	0.85	1.30(1.58)	1.95(1.85)	1.32(1.85)
Role play	0.72	1.46(1.74)	2.23(1.88)	1.09(1.68)
Project work	0.57	1.24(1.23)	2.18(1.70)	1.06(1.65)
Spelling words correctly	0.53	0.46(0.93)	1.10(1.45)	1.09(1.78)
Listening or telling jokes	0.52	2.83(1.72)	2.79(2.09)	1.09(1.71)
Reading	0.45	2.46(1.89)	2.92(1.83)	1.03(1.75)
Story telling or listening	0.44	1.65(1.75)	1.90(1.67)	0.94(1.54)

Table 1 (... cont'd)

	Factor loading	Mean(SD) High 5	High 4	Low 4
F4		**2.50(1.13)**	**2.32(1.31)**	**0.81(0.94)**
Verbal presentation	-0.62	1.84(1.62)	1.49(1.67)	0.18(0.52)
Competition	-0.52	2.76(1.57)	2.77(1.61)	0.71(1.34)
Group work	-0.44	2.92(1.53)	2.71(1.79)	1.56(1.88)

N (high 5) = 37, age = 10.53, n(high 4) = 39, age = 9.52, and n(low 4) = 37, age = 9.48.
Mean for factor was mean of (sum of items of each factor/number of items of each factor).

Variations within a class and across classes (research question 2): The subjects were re-grouped into two clusters according to the interpretative factors. The first cluster (C1) comprised 38 (34.5%) children and the second cluster (C2) consisted of 72 (65.5%) children. C1 is defined as desirable activities at a high level, whereas C2 is defined as desirable activities at a low level. Figure 1 illustrates the distribution of children in various classes according to the clusters. Distributions of high achievers in primary five (high 5) and primary 4 (high 4) were relatively equal across clusters: Cluster 1 (48.6% high 5, 43.6% high 4) and cluster 2 (51.4% high 5, 56.4% high 4). The majority of the low achieving pupils (low 4) were distributed in cluster 2 (91.2%).

Primary pupils' desirable activities across classes (research question 3): The results of a 2 (gender) x 6 (class) x 2 (English, no English) multivariate analyses of variance showed that there was main class effect. Means of all factors for class high 5 and class high 4 were significantly higher than those for class low 4 (between the p=0 and p= 0.02 levels, 2 samples independent T test). Class high 5 scored the highest mean except for factor 3 in which class high 4 scored significantly higher than class high 5 (at the p= 0.03 level, 2 samples independent T test). There was no significant gender difference across factors. Table 2 displayed alpha reliabilities, percentages of variance, eigenvalues, clusters, means, and correlations of factors.

Figure 1: Distributions of Pupils According to their Desirable Activities for Mathematics

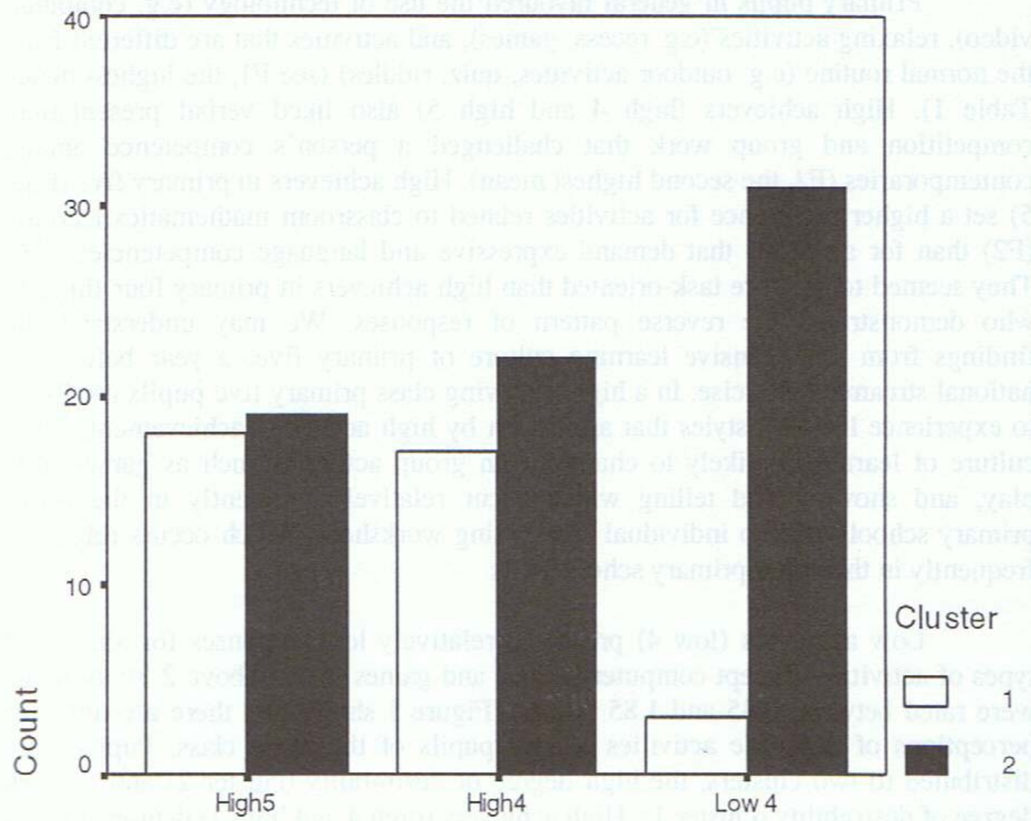

Table 2: Descriptive Statistics and Factor Correlation Matrix

F	% Var.	Alpha	Mean (SD)	Pmean (SD)	Cluster 1	Cluster 2	F1	F2	F3	F4
1	31.0	0.85	25.18 (12.97)	2.52 (1.30)	3.58	1.96	1	-	-	-
2	8.8	0.85	13.50 (9.11)	1.92 (1.36)	2.60	1.21	-0.25	1	-	-
3	7.3	0.77	11.54 (8.00)	1.69 (1.14)	2.54	1.18	0.34	-0.30	1	-
4	5.0	0.69	5.75 (4.07)	1.65 (1.14)	3.18	1.25	-0.23	0.21	-0.08	1

Note: N = 110, F = factor, Pmean = mean of (sum of items of each factor/number of items of each factor), distance between cluster 1 and cluster 2 = 3.19.

Discussion

Primary pupils in general favoured the use of technology (e.g. computer, video), relaxing activities (e.g. recess, games), and activities that are different from the normal routine (e.g. outdoor activities, quiz, riddles) (see F1, the highest mean, Table 1). High achievers (high 4 and high 5) also liked verbal presentation, competition and group work that challenged a person's competence among contemporaries (F2, the second highest mean). High achievers in primary five (high 5) set a higher preference for activities related to classroom mathematics learning (F2) than for activities that demand expressive and language competencies (F3). They seemed to be more task-oriented than high achievers in primary four (high 4) who demonstrated the reverse pattern of responses. We may understand the findings from the intensive learning culture of primary five, a year before the national streaming exercise. In a high achieving class primary five pupils are likely to experience learning styles that are driven by high academic achievement. Their culture of learning is likely to change from group activities such as games, role play, and showing and telling which occur relatively frequently in the lower primary school years to individual work using worksheets which occurs relatively frequently in the upper primary school years.

Low achievers (low 4) presented relatively low responses for almost all types of activities. Except computer lessons and games (mean above 2.5), all items were rated between 0.35 and 1.85 (mean). Figure 1 shows that there are different perceptions of desirable activities among pupils of the same class. Pupils were distributed to two clusters, the high degree of desirability (cluster 2) and the low degree of desirability (cluster 1). High achievers (high 4 and high 5) demonstrated a relatively similar pattern of desirability for learning activities. However, low achievers (low 4) demonstrated a unique response, 31 of them were grouped to cluster 2, and 3 to cluster 1. The majority showed a low degree of desirability for all the activities.

There are at least two reasons for low achievers' low respond patterns. Pupils in class low 4 may lack exposure to various types of activities in mathematics lessons. Another reason could be the nature of the instrument developed from responses of moderate and high achievers that may not be suitable for low achievers. Future exploratory study should invite low achievers to elicit their desirable activities through interviews and/or open-ended questions.

What are the implications of this study for mathematics educators? A mathematics teacher should establish the competence to evaluate the effectiveness of learning activities according to pupils' achievement levels. Teachers should develop strategies to increase low achievers' desirability by disclosing their wishes for mathematics learning activities as well as by developing intervention programs that can motivate them. It was evident that the degree of enthusiasm of individual pupils can be different among pupils of the same achievement level and across achievement levels (Figure 1). A mathematics teacher should possess the skills to identify various types of wishes within a class. Classroom learning culture should benefit highly enthusiastic, moderately enthusiastic, and lowly enthusiastic children. It seems that high achievers in this study were more enthusiastic to disclose their desirable activities than the low achievers. Unless there is a valid evidence, teachers should not hold an assumption that pupils of high achievement are more enthusiastic than their counterparts of low achievement. It is also not true to generalize that all pupils in the high achievement class are interested in all kinds of activities.

If we consider there is a relationship between students' desirable activities and their interest in participating in the learning activities, we may learn that not all pupils of the same class possess a unitary interest. The assumption that high achievers are highly motivated and low achievers less motivated may not be valid. In a class there are pupils who show interests in all kinds of activities and at the same time there are pupils who do not show strong interest in any activity. A pupil's degree of desirability toward a learning activity may vary according to the pupil's experience, the learning style, the learning subject, and the teacher's teaching style. The uniqueness of a person's learning needs is a complex phenomenon that demands further investigation.

A pleasant classroom attempts to integrate pupils' choices and learning autonomy. It is important to organise a variety of activities that may be effective and enjoyable for children with different needs. Pupils' views entail information that can help improve classroom learning. While the instrument considers only activities for mathematics lessons, it should be complemented by instruments which can be used to identify desirable activities for other academic subjects. It should also be used with instruments that detect self-concept, motivational problems and home environment of the learners.

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