Title	Spontaneous behaviors of young children in quantitative activity : gender differences
Sub Title	
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Publisher	慶應義塾大学大学院社会学研究科
Publication year	1999
Jtitle	慶応義塾大学大学院社会学研究科紀要 : 社会学心理学教育学 (Studies in sociology, psychology and education). No.50 (1999.) ,p.27- 34
JaLC DOI	
Abstract	
Notes	論文
Genre	Departmental Bulletin Paper
URL	https://koara.lib.keio.ac.jp/xoonips/modules/xoonips/detail.php?koara_id=AN00069957X-00000050-0027

SPONTANEOUS BEHAVIORS OF YOUNG CHILDREN IN QUANTITATIVE ACTIVITY: GENDER DIFFERENCES

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In this study, the possible gender differences in spontaneous behaviors of young children in quantitative activity were examined. Eight children (4 males and 4 females) participated in the clinical interview in which the child's engagement in the quantitative activities (e.g., counting pennies) was encouraged by the interviewer. Spontaneous behaviors of the children, occurred during the interviews, were videotaped and coded into one of the following 5 categories; anticipating, expressing opinions, asking questions, rejection, and getting carried away. The participants were 4 to 5 year-olds. The males tended to show more spontaneous behaviors than the females mostly by expressing opinions and asking questions.

It has been reported that females take advanced mathematics courses less frequently than males in high school, and choose majors not requiring mathematical knowledge in college (Armstrong, 1985). The consequence has been that, having less mathematical qualifications, females have more limited career paths than males (Karp & Shakeshaft, 1997), because mathematical qualifications are often used as prerequisites to further training and apprenticeships (Sells, 1978).

The failure of females to pursue upper level mathematics has been observed despite the recent tendency of a decrease in the gender difference in mathematics achievement (Frost, Hyde & Fennema, 1994). Male and female students' motivations in mathematics, developed through differentiated classroom experiences, may be one of the possible causes of the observed gender difference in mathematics course taking (Armstrong & Price, 1982). In this study, in order to deepen our understanding of teacher-student interaction in the mathematics classroom, the possible pre-existing behaviors of males and females when they started elementary school were compared.

Rationale for the Study

From the beginning of this century, numbers of studies have been conducted in order to specify the possible variables causing observed gender differences in mathematics performance and participation in post-compulsory mathematics courses (see Leder, 1992, for a review). Although it has been reported that the gender difference in mathematics performance is decreasing (Frost, Hyde & Fennema, 1994), sometimes even to nil as measured by classroom grades (Freidman, 1989), still a lower percentage of females than males take advanced mathematics courses (Karp & Shakeshaft, 1997). Although there seems to be no simple explanation, studies have identified varieties of possible causes for this observed gender difference in advanced mathematics course-taking (Leder 1992).

Considering the influence from the educational environment where children actually learn formal mathematics, classroom experiences of males and females through their interaction with mathematics teachers may be the most influential variable of the observed gender difference in post-compulsory mathematics course-taking (Koehler 1990). Experiences of male and female students through interaction with their teacher in mathematics classroom may have been influencing the development of students' beliefs about their mathematics ability and potential for future success in mathematics (Leder, Forgasz & Solar, 1996). Studies have suggested that females have poorer motivation in mathematics. For example, Fennema and Sherman (1977, 1978), in their study of 6th-through 12th-graders, found that females constantly showed lower levels of confidence in their ability to do

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mathematics than did their male classmates. Leder, Forgasz & Solar (1996) have reviewed the representative studies from 13 different non-English speaking and non-western countries, in addition to the studies from English speaking countries. They reported that females tend to attribute mathematical failure to the lack of ability instead of the lack of effort, and have less functional beliefs about themselves as learners of mathematics than males do. Stereotyping mathematics as a male domain was found more by males than by females among 6th-, 8th-, 10th-, and 12th-graders in the study of Tartre and Fennema (1995). These beliefs of males and females about mathematics and mathematical skills are found to develop in response to the environmental and social demands (Carraher, Carraher, & Schiliemann, 1985). In other words, observed gender differences in beliefs might be developed as a result of the differentiated environmental demands, such as those of teachers in mathematics classroom, and possibly students' interaction with them.

How do teachers influence male and female students to develop differentiated beliefs about mathematics? Studies suggest that teachers tend to give more positive and more negative attention to male students than they do to females in mathematics class (e.g., Sadker, Sadker, & Klein, 1991). For example, teachers admonish males more often (Leder, 1990a), praise males more frequently for correct answers (Brophy & Good, 1974), monitor males' work more often than that of females (Leder, 1990b; Brophy & Good, 1974), and accept more cognitive questions from males (Leder, 1990b; Leinhardt, Seewald, and Engel, 1979). On the other hand, teachers tend to use disparaging remarks to female students for either not doing their work or getting something wrong in class (Taole, Zonneveld & Taole, 1995). In the study of Sadker, Sadker, & Klein (1991), it was found that teachers were more likely to encourage males than females to rethink incorrect responses and to arrive at correct answers. At the same time, teachers tended to give shorter or yes/no responses to females.

Teachers also tend to give different evaluative feedback to male and female students regarding their performance or behavior. Eccles and Blumenfeld (1985) have found, in their observations of 1st- and 5th-grade classrooms in both middle- and working-class school districts, that a majority of teacher feedback was negative regardless of the students' gender. However, Feedback given to males was primarily with regard to procedural violations, whereas feedback given to females was on their academic performance. Eccles and Blumenfeld argued that negative feedback for academic performance influences female students to have lower confidence in their mathematics ability as well as their ability to perform well on future tasks.

These findings suggest that, as Koehler (1990) insisted, "females and males do receive differential treatment in the classroom. Regardless of the grade level, length of observation, or observation scheme that was used, differences were found consistently" (p. 134). What makes teachers treat male and female students differently?

One possibility may be behaviors of males and females themselves. As Hart (1989) stated, "the number and type of interactions that two persons have cannot be attributed to either person alone: Both are involved in an interaction, and both play a part in determining whether or not the interaction happens and in what way it happens" (p. 257). There may be certain behaviors of males and females, which also influence teachers to treat males and females differently.

Eccles and Blumenfeld (1985) concluded their six-year study of 50 elementary and junior high school classrooms with the following statement:

> We like many others, have found small but fairly consistent evidence that boys and girls have different experiences in their classrooms. However, these differences seem as much a consequence of pre-existing differences in the students' behaviors as of teacher bias (p. 112).

They insisted that not only teachers' differentiated attitudes toward male and female students, but also students' sex-differentiated goals and attitudes, when they first enter school, influence the teacher-student interaction in mathematics classroom.

Then, what are the pre-existing differences in

students' behaviors? Findings of previous studies suggest that one of the differences may be spontaneous behaviors of male students, which seem to be more frequent than that of females in mathematics classroom. Taole, Zonneveld & Taole (1995) observed that males indicate their willingness to answer questions more frequently than females in mathematics class. They also found that "more boys had their class work marked by the teacher, in some cases even shoving their books in front of the teacher as he or she tried to mark a girl's book" (p.268). Another finding also suggests that boys tend to dominate in the classroom in their interactions with teachers and classmates (Brophy, 1986). In contrast, females tend to be concerned more with pleasing teachers, and be dependent on teachers for feedback (Harter, 1975).

In this present study, in order to identify the possible "pre-existing" behaviors of male and female children when they enter elementary school, behaviors of pre-school aged male and female children were examined. It was hypothesized that, as observed in elementary school, the young male children would behave more spontaneously than the young female children in the quantitative activity.

Method

A total of eight American children (4 males and 4 females), whose ages ranged between 4 and 5, served as participants in this study. They were chosen according to the residential circumstances of the author. The children were randomly selected from a daycare center located in a metropolitan area of New York. The daycare center was located in a low-income housing project, and the children from a low socioeconomic background took part in the study. The number of the participants was rather small, but was considered appropriate for the purpose of this present study which was to identify the general tendency of male's and female's behaviors.

Each child was given the clinical interview by either a faculty member or a trained graduate student in psychology. The child's involvement in the quantitative activity was encouraged during the interview. The interviews were conducted in a quiet computer room in the daycare center of which the children attended, and were videotaped in order to have more precise records of verbal and non-verbal behaviors of the children. The contents of the interviews included; a sorting task, counting, addition and subtraction with and without concrete objects, conservation, and numerical transformation. Also, papers, pencils and coins were available to the children when needed. The duration of the interviews varied from about 15 minutes to 40 minutes.

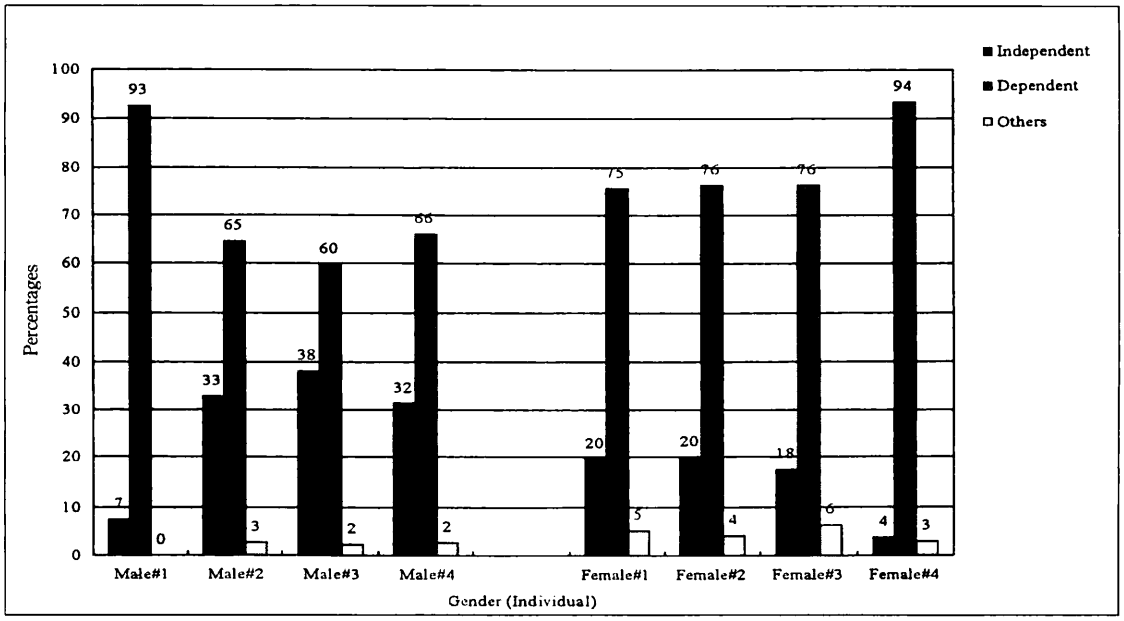
Coding has been done based on videotapes of the interviews by the author. Videotapes of two children, one male and one female, were coded independently by a graduate student of social science. There was 96% agreement on the coding of the children's behaviors. Every act the child made, following the interviewer's question was coded and counted as one response. The coding system developed for this study consists of three categories, which were (1) Independent, (2) Dependent, and (3) Other. The first category "Independent" means that the child behaves independently of the interviewer. This category consists of five sub-categories. The first is "Anticipating", which refers to the child speaking or behaving based on his/her prediction of what he/she will be asked next. For example, the child, who has been tested for the cardinality by covering the coins, may cover the coins voluntarily next time before the interviewer asks him/her to do so. The second is "Expressing Opinion", which refers to the child expressing his/her opinion that may be demonstrated by suggesting or creating a new problem. For example, the child may suggest a new problem of 3+5, when he/she is told to solve 2 +5 from the interviewer. The third is "Asking Question", in which the child asks the interviewer a question. The fourth, "Rejection", occurs when the child rejects solving the problem posed by the interviewer. Finally, the fifth is "Getting Carried Away", which occurs when the child starts to solve the problem asked by the interviewer, then gets lost. For example, when the child is asked to make a line with pennies, he/she may first start making a line, but becomes engrossed in what he/she is doing. Then, as he/she continues, the result for example, may be a square with three sides instead of a straight line.

The second category, "Dependent", is the child's response that is dependent on the interviewer. Every child's response, which is directly related to the interviewer's question, is considered dependent. For example, nodding as a response to the interviewer, or stating an opinion as a response to the question asked by the interviewer is categorized as dependent.

The third category, "Other", refers to the child's response that can not be categorized either as independent, or as dependent. There are two sub-categories. The first is "Misbehavior" in which the child speaks disrespectfully to the interviewer, or behaves distractedly. For example, the child's act of cursing the interviewer is considered misbehavior. The second sub-category, "Other", consists of a speech or a behavior of which motivations are unclear. The possible motivations may be factors such as, fatigue, getting bored, feeling that questions are too difficult. For example, the child may look out the door, or bury his/her face in his or her arms.

Results

The proportion of behaviors in each category and sub-category was calculated in percentage for each child. The percentages of behaviors obtained by two gender groups were compared by means of the Mann-Whitney "*U*" rank sum test for each category and sub-category. The significance level of 5% or 10% may commonly be selected. However, for the purpose of this study which was to bring out the possible hypothesis for future study by identifying the general tendency of male's and female's behaviors in this small sample, I took the behavioral differences that were worth consideration to exist at a significance level of 20%. Such differences will be called reliable differences here in after. Figure 1 represents the percentages of each child's behaviors which fell into "Independent", "Dependent", or "Other" categories in the given interview. The reliable differences in proportion were found between the males' and the females' independent behaviors, $U = 3.00$, $p \leq .20$ (two-tailed), as well as dependent behaviors, $U = 3.00$, $p \leq .20$ (two-tailed), and other behaviors, $U = 0.00$, $p \leq .05$ (two-tailed). In the present study, the first category of independent behaviors will be of the focus of the analysis below, although reliable differences were found



Note. Each child's behaviors can be added to 100%

Fig. 1. Behavioral patterns of each child.

in the other two categories as well.

As shown in Table 1, the independent behaviors of both the males and the females mainly consist of behaviors which fell into "Expressing Opinion" and "Asking Question" categories. Both the males and the females showed low percentages in "Anticipating" and "Getting Carried Away" categories. And no "Rejection" was recognized for either gender. When the percentages of the behaviors in each subcategory of "Independent" were compared, a reliable difference in behavior between two gender groups was found only in "Asking Question" category, $U = 3.00$, $p \leq .20$ (two-tailed). However, although a reliable difference was not found, the males tended to show behaviors categorized in "Expressing Opinion" more frequently than the females, on average 18% and 11% of total behaviors during the interview respectively. No reliable difference was found when the behavioral proportions in each subcategory of total independent behaviors were compared between two gender groups.

To show how the males and the females behaved independently during the interview, the protocols of "Expressing Opinion" and "Asking Question" category were further analyzed.

Expressing Opinion

Two typical types of behaviors of the males and the females which fell into the "Expressing Opinion" category were identified. One type of behavior was that the child suggested or told numbers he/she wanted to work on to the interviewer.

Interviewer (I): Let's try another one, all right? Now we have ... we have ...
Child male #2(Cm2): Five! Five! [*Looks at the interviewer and smiles, his hand in front of his mouth.*]
I: No. We have, uh ...
Cm2: Nine! Nine! [*Again, looks at the interviewer and smiles, his hand in front of his mouth*]
I: [*Laughs*] No. We have eight-a lot, a lot of children are in this house. It's a big house. Eight children in this house, right?
Cm2: [*Holds up eight fingers, and leans his hands over towards the smaller house.*] And two in there.
I: Well, that would be nice, but we have three. [*Laughs*]
Cm2: Three. And it still makes, oh! [*Puts his hands in front of his face.*]
I: And they're all going outside. [*Says this at the same time as male #2 says his next statement.*]
Cm2: It still makes ... tell them folks ... [*Faces the camera as he makes a dramatic pause, then puts his hands out towards the camera.*] ... eleven!
I: Yeah! How did you know that? How did you know that?

Creating new number games/problems spontaneously was the other type of behavior in the

Table 1. Percentages of the children's independent behaviors in each sub-category.

Participants		Sub-Categories of Independent Behaviors					Total
		Anticipating	Expressing Opinion	Asking Questions	Rejection	Getting Carried Away	
Male	#1	0	2	5	0	0	7
	#2	2	20	11	0	1	33
	#3	1	24	12	0	1	38
	#4	0	24	7	0	0	32
Female	#1	0	15	3	0	2	20
	#2	0	13	7	0	0	20
	#3	0	11	7	0	0	18
	#4	0	4	0	0	0	4

Note. The total percentage of each child represents the proportion of the child's independent behaviors of total behaviors during the interview.

"Expressing Opinion" category. The following is the protocol, when the child was suggested to sort coins from the piles by the interviewer.

I: OK, how about all the dimes together? [*Points to a dime.*]
Cm3: [*Arranges all the dimes in a line. As he finished the task he spontaneously counts the coins that he arranged.*] It's four of these and six of these!
I: Yeah! [*Smiles.*] And can you see anything else?

Asking Question

The following protocols illustrated some patterns of the children's behaviors when their behaviors were categorized as "Asking Question". One type of behavior was that the child appeared to have a certain desire and asked the interviewer if his/her desire was possible to be heard.

I: ... And, we're going to move on to another game of pretend, OK?
Cm2: [*Leans his head on his left hand, and nods.*]
I: OK. Now, we have ... I'm going to draw two houses, OK?
Cm2: Two houses? [*Sits up, smiles, and looks at the interviewer's paper as she draws.*]
I: Yeah. Let's see ... [*Starts drawing a house that's almost as high as the width of the paper.*]
Cm2: Can I make one? I know how to draw a house. [*Watches the interviewer intently.*]
I: Sure you can.
Cm2: Can I make the other one? [*Continues watching her.*]
I: Sure you can.

Another behavior was that the child appeared to be unsure about whether what he/she should do or what he/she had in mind were correct to solve the given problem, so that he/she tried to confirm this by asking a question to the interviewer. The following protocol is an example of this kind of behavior observed.

I: Let's Pretend you have three pennies in left hand [*pointing child's left hand*], and four pennies in this hand [*pointing child's right hand*]. How many do you have all together?
Cf2: [*Opens the right hand.*]
I: How many do you have all together?
Cf2: Count them?
I: Sure.
Cf2: like that? [*Touches pennies.*]

The other type of behavior in the "Asking Question" category was that the child asked the interviewer for permission to try the new problems that the child created.

Cm3: I see something else. And three of these. [*Takes out the three tokens from the pile. Looks at the interviewer*] Can I stack up these with these? [*Indicating the nickels.*]
I: Excuse me?
Cm3: Can I stack them up with these? [*Smiles at Interviewer*]
I: OK. [*Smiles back*]
Cm3: [*Moves the tokens into the same line as the nickels.*] So, that's six and that's six. [*He indicates the line of nickels/tokens and the line of dimes, not counting them as he enumerates. He looks up at Interviewer.*]
I: Oh, great!

Discussion

It was found in this study that the males and the females tended to behave differently in the quantitative activity even before they enter elementary school. As hypothesized, the young male children tended to behave more spontaneously and actively than the young female children in the quantitative activity. This behavioral tendency of the young male and female children was consistent with the reported findings that males behave spontaneously and actively more frequently than female students in elementary school (e.g., Hamilton, Blumenfeld, Akoh & Miura, 1991).

The findings of this study suggest that males may be seen as more active than females in mathematics classroom, because males express their opinions and ask questions more often than females. The present study showed that the pre-school aged males participated in this study tended to express their opinions more frequently than the females in the quantitative

activity. When the male and the female children expressed opinions it was done in such ways as suggesting or telling numbers he/she wanted to work on, and spontaneously creating new number games/problems. The young male children in this study also tended to ask questions more frequently than the young female children. Both the male and the female children tended to ask questions when they had certain desire to be heard, when the children were not sure about what to do, and when the children needed the permission to try new problems created by themselves. These spontaneous behaviors of the males more frequently shown than those of the females may be one of the reasons that males have "more interactions with the teachers", receive "more help and more teacher attention", and have "more informal contacts with teachers" (Koehler, 1990 p. 134). Compared to the behaviors of expressing opinions and asking questions, anticipating, getting carried away, and rejection were found to be less common behaviors for both genders.

When two children (Male#1, Female#4), who behaved spontaneously much less frequently than other children, were compared, pattern differences were found. The male tended to ask questions, when he behaved spontaneously and actively in the quantitative activity. In contrast, the female, who behaved spontaneously almost as often as the male, tended to express her opinions when she was actively involved in the quantitative activity. This may mean that in order to invite males and females who are less active and less spontaneous to the quantitative activity, encouraging males to ask questions and females to express opinions may possibly be effective.

These findings of this present study may provide teachers with some pieces of information about what kind of behaviors males and females bring into classroom on the first day of school. By keeping in mind the possible behavioral differences of male and female students, teachers may better be able to prevent male and female students from having differentiated classroom experiences. However, in order to fully understand the possible causes and to find solutions to this issue of gender differences in mathematics, it is necessary to know how male and female children become to behave differently from early on in their lives, pre-school age.

Hamilton, Blumenfeld, Akoh and Miura (1991) conducted a comparative study of 5th-graders in Japan and the USA. They have argued that the collectivistic and socially gender-differentiated culture of Japan has influenced mathematics classroom activities in Japan in the form of whole group structures, and that Japanese teachers tend to treat males and females more stereotypically than their counterparts in the USA. Additionally, Japanese male and female children tend to have more behavioral differences than American male and female children in the mathematics classroom.

In order to understand how gender differences in mathematics occur and to find the possible solution to this issue, it is necessary to consider the influence from the unique culture of each country for future research. Further study on spontaneous behaviors of young male and female children in quantitative activity in Japan and in its relation to the influence from Japanese culture, may provide deeper understandings on early gender differences in mathematics.

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