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Research Article

# EFFECT OF GENDER, PARTICIPANT TYPE, AND SUBJECT TYPE ON STUDENT AND TEACHER PERCEPTIONS OF TEACHER ORAL COMMUNICATION BEHAVIOUR IN THE MATHEMATICS CLASSROOM

**Assuah, C. K[1]., Asiedu-Addo, S.K[1] and Arthur, Y.D[2]**

[1]Faculty of Science Education, Department of Mathematics Education, University of Education, Winneba
[2]College of Technology Education, Department of Interdisciplinary Studies, University of Education, Kumasi

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## ABSTRACT

Teacher and student communication behaviour in the mathematics classrooms can significantly affect students' mathematics thinking and understanding.This study assessed the effect of gender (male/female), participant type (teacher/student), and subject type (algebra/geometry) on perceptions of teacher communication behaviour in the mathematics classroom. The design for the study was a sequential explanatory design, comprising 550 (250 male and 200 female) students in the algebra lessons, 500 (250 male and 250 female) students in the geometry lessons, 11 (5 male and 6 female) teachers in the algebra lessons, and 11 (6 male and 5 female) teachers in the geometry lessons, who were randomly selected from a school district in the central region of Ghana. The quantitative data consisted mainly of teachers' and students' responses to the teacher and student versions of the Teacher Communication Behaviour Questionnaire (TCBQ). The qualitative data consisting of teachers' and students' responses to the open-ended questions, helped to explain the effect in the quantitative data. The results indicated that of all the dependent variables: Totaltcbq, Encouragement And Praise, Understanding And Friendly, Controlling, And Challenging, only participant type had an effect on Encouragement And Praise, with students having a greater effect than teachers.A major implication of this study is that teachers must realise that encouraging and praising their students should form a major part of their professional practice in order to improve students' mathematics understanding.



## INTRODUCTION

Effective communication in mathematics teaching has been hailed by many researchers, educators, policymakers and other stakeholders as one of the major determinants for improving student mathematics knowledge and understanding. For such communication to manifest itself in the mathematics classroom, teachers must ensure that students communicate among themselves thoroughly with understanding, for this understanding gaining expression in their adaptive reasoning capabilities. *Adaptive reasoning*, therefore, is the capacity for students to think logically, reflect, explain, and justify their actions on specific tasks (National Research Council [NRC], 2001). It refers to the capacity for students to think logically about the relationships among concepts and situations (NRC, 2001). In order for students to develop adaptive reasoning, teachers must support them with opportunities to practice communication in the mathematics classroom. Through this communication, they reflect, refine, discuss, and amend their ideas.

**Corresponding author:* **Assuah, C. K**
University of Education, Winneba, Ghana

When students are challenged to think and reason about mathematics and communicate their results to others orally or in writing, they learn to do that so clearly and convincingly. Listening to others' explanations gives students opportunities to develop their own understanding (NCTM, 2000).

The need for oral communication to improve the instructional delivery of mathematics in schools cannot either be overemphasized or understated. In fact, the National Council of Teachers of Mathematics (NCTM) (2000), clearly states that, instructional programmes in basic and high schools should enable all students organize and consolidate their mathematical thinking by communicating their mathematical thinking coherently and clearly to peers, teachers, and others; analyzing and evaluating the mathematical thinking and strategies of others; and, using the language of mathematics to express mathematical ideas with precision. In recent years, many studies have identified communication as a key process in building students' mathematics understanding (Macgregor & Price, 1999; Manouchehri& Enderson, 1999; Warfiel, 2003). Undoubtedly, there are significant associations among knowledge construction, student learning, and communication (Langer, 2001; Rubin, 2002). Wakefield (2000) admits that even though mathematics is like a language, few studies have approached communication about mathematics from a linguistic point of view. The focus, according to Christie and Unsworth (2000), should be on how people use language to accomplish a social goal through selections from the sets of choices that are available to the language system. Using the vocabulary of mathematics to enhance the teaching and learning of mathematics is very important (Huang, Normandia, & Greer, 2005). However, encouraging students to speak mathematically can be challenging because students are often unfamiliar with collaborative learning. They are inexperienced in communicating with one another, and they may find it difficult to verbalize and justify their ideas (Cooke & Buchholz, 2005).

## LITERATURE REVIEW

In this study, we anchored our theoretical framework on socioconstructivism. It is defined as an approach to learning where individual knowledge depends on its social construction (Doise & Mugny, 1984; Piaget, 1977). First, the social world of students include the people who directly affect them, including teachers, friends and administrators in all forms of activities. Accordingly, learning designs should enhance local collaboration and dialogue that could also engage other actors to participate in meaningful ways. Second, is the idea that the potential for cognitive development is limited to a "zone of proximal development" (ZPD). This zone is the area of exploration for which students are cognitively prepared, but requires help and social interaction to fully develop (Briner, 1999). A teacher or more experience peer is able to provide learners/students with "scaffolding" to support learners'/students' evolving understanding of knowledge domains or developmentof complex skills. Collaborative learning, discourse, modelling and scaffolding are strategies that can support the intellectual knowledge and skills of learners/students and facilitating intentional learning. The implications of Vygotsky's theory are that learners/students should be provided with socially rich environments in which to explore knowledge domains with their fellow students, teachers and other experts.

For improved mathematics teaching and learning in schools, teachers must abandon long-held beliefs and practices which retard progress and stifle innovation (Wood & McNeal, 2003). This requires students to learn by participating in communicative activities within classroom discourse communities (Wood & McNeal, 2003). Such communities provide shared responsibilities between teachers and students, both identifying and accomplishing respective roles in the mathematics discipline (Boaler, 2003). To achieve this objective, teachers should act as facilitators by building confidence among students to become successful problem solvers (Goos, 2004). For effective reform in mathematics teaching and learning, teachers and researchers must view discourse communities as potential communicative agents, which could disseminate relevant information (Wood & McNeal, 2003). The theme to reinforce, therefore, is the importance of communicative patterns of mathematical argumentation, to challenge and debate, and to stimulate deep student engagement in mathematical practices (Boaler, 2003; Brown & Renshaw, 2004; Rojas-Drummond & Mercer, 2003; Wood & McNeal, 2003).When argumentative cultures are established in the classroom, communication becomes a challenging task because such practices may bear little resemblance to teachers' experiences (Hufferd-Ackles, Fuson, & Sherin, 2004; Nathan & Knuth, 2003). Hunter (2005), Wood and McNeal (2003), identify differences in norms between the contexts of strategy reporting communities and inquiry in argument-oriented communities. Hunter (2005) asserts that established norms for strategy reporting communities serve as a foundation for developing inquiry and argument-oriented communities (i.e., group of individuals who support or oppose a given viewpoint). These exchanges enable students to shift from the inquiry community model to an argumentative community in which discursive interaction supports exploratory and collective argumentation (Brown & Renshaw, 2003; Mercer, 2000). These findings are consistent with Mercer's (2000) debate that learning communities reshape their discourse patterns in response to communicative demands. The enactment of a mathematical discourse culture based on inquiry and debate increases student autonomy and deepens the collective responsibility of students to engage in mathematical practices (Brown & Renshaw, 2003). This study was guided by the following fundamental research question: How do interviews with teachers and students help to explain any quantitative effect of the following variables: participant type (teacher/student), subject type (geometry/algebra), and gender (male/female) on student and teacher perceptions of teacher oral communication behaviour in the mathematics classroom?

## METHOD

### *Design*

A sequential explanatory design was adopted for the study, because qualitative interviews were used to explain any quantitative effect of the following variables: participant type (teacher/student), subject type (geometry/algebra), and gender (male/female) on student and teacher perceptions of teacher oral communication behaviour in the mathematics classroom.

### *Participants*

Participants for this study were senior high school mathematics teachers and students during algebra and geometry lessons in mathematics classrooms in the central region of Ghana. The participants consisting of 550 (250 male and 200 female) students in the algebra lessons, 500 (250 male and 250 female)students in the geometry lessons, 11( 5 male and 6 female) teachers in the algebra lessons, and 11(6 male and 5 female)teachers in the geometry lessons, were randomly selected from six senior high schools. The average ages of the students and teachers were 15 years and 32 years respectively.

### *Instruments*

Modified versions of the Teacher Communication Behaviour Questionnaires (TCBQ) developed by She and Fisher (2000), for both students and teachers were used for data collection. Each modified version of the TCBQ consisted of 32 Likert scale items with 8 items in each of the scales: challenging, encouragement and praise, understanding and friendly, and controlling. The non-verbal scale on each of the original questionnaires consisting of 8 items was excluded from the modified versions in order to focus on oral communication. The first part of the questionnaire sought biographic information on participants' age, gender, participant type, and subject type. The Likert scale items had responses: almost never, seldom, sometimes, often, and almost always. Cronbach's alpha coefficient for the teacher and student versions of the modified TCBQ for all the 32 items were 0.94 and 0.85 respectively, indicating that the internal consistency and reliability of the modified versions of the TCBQ were excellent. To address validity of the test instruments, they were sent to four lecturers with extensive knowledge and experience in effective pedagogical practices in the classroom. Their feedback helped to construct a final version of the survey and interview questions. Tables 1& 2 show descriptions of scales and sample questions for each scale of the TCBQ. To help explain differences that might be present in the quantitative responses, we further interviewed some of the teachers through the use of an interview guide. We then read carefully through the interview data for each teacher interviewed, and meticulously coded the data from teacher-to-teacher and student-to-student. Some codes later collapsed into others, and similar codes were categorized or sorted to identify themes. These identifiable themes were later merged into the following identifiable themes: *soliciting students' opinion, encouraging students to answer questions, encouraging students to discuss ideas with their peers, and praising students for asking good questions*. In the qualitative results in which a specific teacher or student is quoted, a pseudonym is used rather than the teacher's or student's actual name. The responses given are representative of the total number of teachers and students. The results of the quantitative data were presented first, followed by the results of the qualitative data.

**Table 1** Description of Scales and a Sample Question for Each Scale of the TCBQ-Student Version

| Scale Name | Description of Scale | Sample Question |
|---|---|---|
| Challenging | Extent to which the teacher uses high-order questions to challenge students in their learning | This teacher asks questions that require me to integrate information that I have learned in class. |
| Encouragement and Praise | Extent to which the teacher praises and encourages students | This teacher encourages me to discuss my ideas with other students. |
| Understanding and Friendly | Extent to which the teacher is understanding and friendly towards the students | If I have something to say, this teacher will listen. |
| Controlling | Extent to which the teacher controls and manages student behavior in the classroom | This teacher expects me to obey his/her instruction. |

**Table 2** Description of Scales and a Sample Question for Each Scale of the TCBQ-Teacher Version

| Scale Name | Description of Scale | Sample Question |
|---|---|---|
| Challenging | Extent to which the teacher uses high-order questions to challenge students in their learning. | I ask questions that require students to integrate information that they have learned. |
| Encouragement and Praise | Extent to which the teacher praises and encourages students | I encourage students to discuss their ideas with other students. |
| Understanding and Friendly | Extent to which the teacher is understanding and friendly towards the students | If students have something to say, I will listen. |
| Controlling | Extent to which the teacher controls and manages student behavior in the classroom | I expert students to obey my instructions. |

Statistical and Structural Model for a three-way ANOVA is indicated below:

$$Y = MODEL + ERROR$$
$$Y_{ijk} = \mu + \alpha_j + \beta_k + \gamma_l + (\alpha\beta)_{jk} + (\alpha\gamma)_{jl} + (\beta\gamma)_{kl} + (\alpha\beta\gamma)_{jkl} + \varepsilon_{ijkl}$$

*Mean Model Components*:
$\mu$: The overall mean of the scores

*Main Effect Model Components*:
$\alpha_j$: The effect of being in level j of Factor A
$\beta_k$: The effect of being in level k of Factor B
$\gamma_l$: The effect of being in level l of Factor C

*Two-way Interaction Model Components*:
$(\alpha\beta)_{jk}$: The effect of being in level j of Factor A and level k of Factor B
$(\alpha\gamma)_{jl}$: The effect of being in level j of Factor A and level l of Factor C
$(\beta\gamma)_{kl}$: The effect of being in level k of Factor B and level l of Factor C

*Three-way Interaction Model Components*:
$(\alpha\beta\gamma)_{jkl}$: The effect of being in level j of Factor A, level l of Factor B, and level l of Factor C

*Error Components*:
$\varepsilon_{ijkl}$: The unexplained part of the score

***Procedure***

Letters were initially sent to the headmasters/headmistresses of all the schools to seek their approval to allow their teachers and students to participate in the study. Prior to that, the students had been given forms to indicate their consent and willingness to participate in the study. During the algebra and geometry lessons, and within the last 25 minutes in July, 2017, the questionnaires were hand-delivered for them to indicate their responses. The time allotted for the responses was 20 minutes.The teacher version of the questionnaire were also given out to the teachers to give their responses as well. All the teacher and student responses were put in an envelope for analysis. To help explain the quantitative results, some teachers and students were later interviewed using an interview guide.

***Data analysis Procedure***

A single dependent variable (TOTALTCBQ) for all students was determined by finding the mean responses of each student on all 32 Likert scale items. The next dependent variables (CHALLENGING, ENCOURAGEMENT AND PRAISE, UNDERSTANDING AND FRIENDLY, and CONTROLLING) for all students were determined by finding the mean responses of each student on the eight Likert scale items under each scale. Table 2 shows the formulae used in calculating the dependent variables.

**Table 2** Formulae for Dependent Variables

| Dependent Variable | Formula |
|---|---|
| Totaltcbq | $= \frac{q1+q2+...+q32}{32}$ |
| Challenging | $= \frac{q1+q2+...+q8}{8}$ |
| Encouragement and praise | $= \frac{q9+q10+....+q16}{8}$ |
| Understanding and friendly | $= \frac{q17+q18+...+q24}{8}$ |

| | |
|---|---|
| Controlling | $= \frac{q25 + q26 + ... + q32}{8}$ |

*q1, q2, q3... q32*, are the 32 Likert scale items. The distribution of the 32 TOTALTCBQ scores was approximately normal with a mean of 3.70 and a standard deviation of 0.65 (Table 3). Skewness and Kurtosis values of -0.58 and 0.66 respectively show that the distribution of scores is approximately symmetrical and matches the Gaussian distribution. Similarly, the distributions of each of the subscales: Encouragement and Praise, Understatanding And Friendly, Controlling, Challenging was approximately normal. The test for homogeneity of variance was not significant, *Levene F* (1, 1064) = .67, *p* = .65> .05, for TOTALTCBQ, indicating that the assumption underlying the application of a three-way ANOVA was met. With alpha level of .05 set for the analyses, each of the subscales satisfied the homogeneity of variance test.

**Table 3** Approximate Normal Distribution of TOTALTCBQ Scores

| Sample Size | Mean | SD | Skewness | Std. Error of Skewness | Kurtosis | Std. Error of Kurtosis |
|---|---|---|---|---|---|---|
| 1072 | 3.700 | 0.645 | -0.582 | 0.120 | 0.659 | 0.239 |

## RESULTS

A three-factor (2×2×2) Analysis of Variance was conducted to evaluate the effect of the subject type, gender, and, participant type, on the perceptions of teacher oral communication behaviour. The three independent variables in this study were subject type (algebra and geometry), gender (male and female), and participant type (students and teachers). The dependent variables: TOTALTCBQ, ENCOURAGEMENT AND PRAISE, UNDERSTANDING AND FRIENDLY, CONTROLLING, and CHALLENGING were the scores on the teacher oral communication behaviour questionnaire, with higher scores indicating higher levels of teacher oral communication behaviour. Table 4 shows the three-way ANOVA summary table of students' responses for TOTALTCBQ by subject type, gender, and participant type.There was a non-significant main effect of subject type, gender, and participant type on student and teacher perceptions of teacher oral communication behaviour, $F$ (1, 1064) = .09, $p > .05$, partial $\eta^2 = .002$.

**Table 4** 3-Way ANOVA Summary Table of Total Responses for TOTALTCBQ by Subject type, Gender, and Participant type

| Source | *SS* | *df* | *MS* | *F* | $\eta^2$ | *p* |
|---|---|---|---|---|---|---|
| Subject (S) | .076 | 1 | .076 | .192 | .001 | .661 |
| Gender (G) | .007 | 1 | .007 | .018 | .001 | .893 |
| Participant (P) | .272 | 1 | .272 | .686 | .002 | .408 |
| S × G | .003 | 1 | .003 | .008 | .001 | .928 |
| S × P | .737 | 1 | .737 | 1.857 | .005 | .174 |
| G × P | .322 | 1 | .322 | .812 | .002 | .368 |
| S × G × P | .035 | 1 | .035 | .089 | .002 | .766 |
| Within | 161.576 | 1064 | .397 | | | |
| Total | 171.995 | 1071 | | | | |

*$p < .05$

Table 4 shows the three-way ANOVA summary of total responses forTOTALTCBQ by subject type, gender, and participant type. There was a non-significant main effect for subject type, gender, and participant type on student and teacher perceptions of teacher oral communication behaviour, $F$ (1, 1064) = .09, $p > .05$, partial $\eta^2 = .002$. Table 5 shows three-way ANOVA summary of total responses for CHALLENGING by respect to subject type, gender, and participant type.

**Table 5** 3-way ANOVA Summary Table for CHALLENGING of Total Responses by Subject type, Gender, and Participant Type

| Source | *SS* | *df* | *MS* | *F* | $\eta^2$ | *p* |
|---|---|---|---|---|---|---|
| Subject (S) | .000 | 1 | .000 | .001 | .001 | .976 |
| Gender (G) | .205 | 1 | .205 | .375 | .001 | .541 |
| Participant (P) | .632 | 1 | .632 | 1.154 | .003 | .283 |
| S × G | .076 | 1 | .076 | .139 | .001 | .709 |
| S × P | 1.275 | 1 | 1.275 | 2.330 | .006 | .128 |
| G × P | .320 | 1 | .320 | .320 | .001 | .445 |
| S × G × P | .181 | 1 | .181 | .331 | .001 | .566 |
| Within | 223.241 | 1064 | .547 | | | |
| Total | 231.684 | 1071 | | | | |

*$p < .05$

Table 5 shows the three-way ANOVA summary of total responses for CHALLENGING by subject type, gender, and participant type. There was a non-significant main effect of subject type, gender, and participant type on student and teacher perceptions of teacher oral communication behaviour, $F$ (1, 1064) = .33, $p > .05$, partial $\eta^2 = .001$,Table 6 shows the three-way ANOVA summary of total responses for ENCOURAGEMENT AND PRAISE by subject type, gender, and participant type.

**Table 6** *3-way ANOVA Summary Table for ENCOURAGEMENT AND PRAISE of Total Responses by Subject type, Gender, and Participant type*

| Source | *SS* | *df* | *MS* | *F* | $\eta^2$ | *p* |
|---|---|---|---|---|---|---|
| Subject (S) | .422 | 1 | .422 | .506 | .001 | .477 |
| Gender (G) | .046 | 1 | .046 | .055 | .002 | .814 |
| Participant (P) | 3.264 | 1 | 3.264 | 3.912 | .010 | .049* |
| S × G | .073 | 1 | .073 | .088 | .001 | .767 |
| S × P | 1.650 | 1 | 1.650 | 1.978 | .005 | .160 |
| G × P | .103 | 1 | .103 | .123 | .001 | .726 |
| S × G × P | .174 | 1 | .174 | .208 | .001 | .648 |
| Within | 339.604 | 1064 | .834 | | | |
| Total | 366.647 | 1071 | | | | |

*$p < .05$

Table 6 shows the three-way Anova summary of total responses for Encouragement And Praise by subject type, gender, and participant type. There was a significant main effect of participant type on the student and teacher perceptions of teacher oral communication behaviour, $F$ (1, 1064) = 3.91, $p < .05$, partial $\eta^2 = .010$ .The Games-Howel post-hoc test further indicated that student and teacher perceptions of teacher oral communication behaviour was significantly greater with students than with teachers ($p < .05$). Table 7 shows the three-way Anova summary of total responses Understanding and Friendly by subject type, gender, and participant type.

**Table 7** 3-way Anova Summary Table for Understanding and Friendly of Total Responses by Subject type, Gender, and Participant Type

| Source | *SS* | *df* | *MS* | *F* | $\eta^2$ | *p* |
|---|---|---|---|---|---|---|
| Subject (S) | .079 | 1 | .079 | .104 | .001 | .747 |
| Gender (G) | .633 | 1 | .633 | .835 | .002 | .361 |
| Participant (P) | .593 | 1 | .593 | .782 | .002 | .377 |
| S × G | .160 | 1 | .192 | .211 | .001 | .646 |
| S × P | .514 | 1 | .514 | .679 | .002 | .411 |

| | | | | | | |
|---|---|---|---|---|---|---|
| G × P | .192 | 1 | .160 | .254 | .001 | .615 |
| S × G × P | .009 | 1 | .009 | .012 | .003 | .912 |
| Within | 309.324 | 1064 | .758 | | | |
| Total | 326.902 | 1071 | | | | |

*$p$< .05

Table 7 shows the three-way ANOVA summary of total responses for UNDERSTANDING AND FRIENDLY by subject type, gender, and participant type. There was a non-significant main effect of subject type, gender, and participant type on student and teacher oral communication behaviour, $F$ (1, 1064) = .25, $p$ > .05, partial $\eta^2$ = .001. Table 8 shows the three-way ANOVA summary of total responses for Controlling by subject type, gender, and participant type.

**Table 8** 3-Way ANOVA Summary Table for Controlling of Total Responses by Subject type, Gender, and Participant type

| Source | SS | df | MS | F | $\eta^2$ | p |
|---|---|---|---|---|---|---|
| Subject (S) | .032 | 1 | .032 | .060 | .001 | .807 |
| Gender (G) | .040 | 1 | .040 | .075 | .001 | .784 |
| Participant (P) | .083 | 1 | .083 | .154 | .001 | .695 |
| S × G | .004 | 1 | .004 | .004 | .002 | .190 |
| S × P | .081 | 1 | .081 | .081 | .002 | .698 |
| G × P | .928 | 1 | .928 | .928 | .004 | .190 |
| S × G × P | .029 | 1 | .029 | .029 | .003 | .817 |
| Within | 219.739 | 1064 | .539 | | | |
| Total | 224.865 | 1071 | | | | |

*p< .05

Table 8 shows the three-way ANOVA summary of total responses for CONTROLLING by subject type, gender, and participant type. There was a non-significant main effect of subject type, gender, and participant type on student and teacher oral communication behaviour, $F$ (1, 1064) = .03, $p$ > .05, partial $\eta^2$ = .003.

***Soliciting students' opinion***

Most participants perceived that teachers solicited students' opinion in deciding on specific solution strategies during discussions. Individual opinion, to a large extent, helped to enrich the repertoire of discourse that occur in the mathematics classroom.

Interviewer: What perception do you hold about teachers regarding students' opinion?

Teacher 4: Teachers respect and solicit students' opinion in all classroom discussion.
Student 8: Teachers allow students to show alternative solutions to problems.

***Encouraging students to answer questions***

Most participants perceived that teachers encouraged their students to participate actively in the class discussions.By this approach, the participants viewed mathematics learning as a shared responsibility, where teachers and students alike, have responsible roles to play.

Interviewer: What steps do you follow to ensure that students always admire your teaching?

Teacher 8: Teachers encourage students to do their best, even when they go wrong.

***Encouraging students to discuss ideas with their peers***

Most participants perceived that teachers encouraged their students to discuss ideas with their peers. During such discussion periods, students learn from their peers and overtime build the necessary confidence to be able to communicate mathematically.

Interviewer: In what forms do teachers' and students' classroom interactions take?
Student 40: Sometimes teachers allow students to work individually, other times they
work in groups. In all these steps, teachers demonstrate a huge responsibility by encouraging students to follow procedures and strategies.
Teacher 50: The interaction between teachers and students is very cordial.

***Praising students for asking good questions***

Most participants perceived that teachers praised their students who ask good questions in class. In fact, teachers' attitude helps students to always give off their best.

Interviewer: What complements do teachers give students for asking good question?
Teacher 8: They praise them.
Student 50: They cheer them on.

## DISCUSSIONS

With Encouragement And Praise as a dependent variable, and gender, subject type, and participant type as independent variables, there was a significant main effect for participant type on how teachers encourage and praise students, with students having a greater effect than teachers. There was, however, no significant effect for subject type, gender, and participant type, and their interaction, on Totaltcbq, Challenging, Understanding And Friendly, And Controlling. This indicate that students' and teachers' perceptions about teachers' oral communication behavior in the mathematics classroom have generally been ranked very low on the subscales indicated above. This clearly shows that participants perceived teachers do not ask challenging questions, are not understanding and friendly, and do not control their students.

***Implications for teaching and learning***

Even though effective oral communication enhances students' conceptual understanding of geometry and algebra, students' understanding and performance in these subjects could greatly be enhanced if teachers become understanding and friendly and ask challenging questions in the classroom. That notwithstanding, other variables other than those discussed, could impact teacher communication behavior in the mathematics classroom. These variables are beyond the scope of this study.

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