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The Discourse Levels Indicators Used by Mathematics Teachers to Promote Students' Understanding and Thinking for the High School in Jordan

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Abstract. Discourse is the mathematical communication that occurs in the classroom. The purpose of this qualitative study is to investigate classroom discourse levels indicators used by mathematics teachers to promote students' understanding and thinking for the upper stage in Jordan to meet the requirements of the communication standard of the National Council of Mathematics [1]. The research question for the present study is as follows: What are the classroom discourse levels indicators used by mathematics teacher to promote students' understanding and thinking for the upper basic stage in Jordan?

To answer the study question, a group of (10) teachers from public, and UNRWA schools have been observed and interviewed with the aim of identifying, describing, and analyzing their teaching procedures to find out the indicators that they used to promotes students' mathematical understanding and thinking. Every class session was transcribed, with an emphasis classroom discourse. The transcripts were analyzed using the Teachers Discourse Level Indicators (DLITR) that has been constructed by the researcher using theoretical background related to mathematical classroom discourse, and viewed by the researcher's colleagues.

To determine the extent to which teachers direct their classroom discourse towards understanding and thinking, we matched the results of teachers' comments from the interviews with the analysis of the classroom transcripts with items from the Discourse Level Indicators (DLITR).

The study adopted descriptive design using frequency and percentage to indicate the results of the study. Specifically, the results suggest that the teacher successfully provide opportunities for the student to get to the level of facts and procedure. On the other hand fewer opportunities to the students to understand communicate and justify respectively. In addition the least chance was for generalization; this means traditional models of instruction still dominate mathematics education especially at the high school level. Also results of teachers' interview reflect their unawareness of their classroom discourse; this can be attributed from comparing between interviews and observations results. This research recommends that high school mathematics teachers adopt more recent reform-based classroom discourse, also to get more training course for improve classroom discourse norms.

Keywords: Discourse, Discourse Level Indicators, High School.

1. Introduction

Many standards documents have set up new goals for the 21st century require mathematics education emphasize conceptual understanding, strategic competence, adaptive reasoning, productive communication, and procedural fluency, and to provide students' opportunities to engage in mathematical inquiry and meaning making through discourse [1], [2], [3]. According to Stein (2007), reform-based mathematics is focused on the idea that mathematics should be taught in a way that encourages students to use "mathematical discourse to make conjectures, talk, question, and agree or disagree about problems in order to discover important mathematical concepts" [4].

Traditionally, mathematics has been viewed as a body of facts and procedures, and the successful mathematics student was one who mastered them. Mathematics educators struggle to develop materials that foster "powerful mathematical ideas" including learning to reason statistically, to think algebraically, to visualize, to solve problems, and to pose problems [5].The current shifts in curricular and instructional contexts place special emphasis on students' active engagement, on solving non-routine problems, on applying mathematics to new situations and on communication regarding mathematical problems. According

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to Stodolsky and Grossman most high school mathematics teachers see mathematics as a rigid and fixed body of knowledge, and think that their responsibility is to transmit this knowledge to their students (1995, as cited in [6]. This agrees with the results of many recent studies in Jordan that trying to find the causes of difficulties in learning mathematics, and they find out that teachers tend to use traditional methods of teaching mathematics , which is based on transfer information and mathematical laws to the students over rote memorization; that made many students suffer from understanding basic mathematical concepts, weakness in their ability to solve math problems and low level of communication skills ([7], [8], [9]). The purpose of this study is to investigate classroom discourse levels used by mathematics teachers to promote students understanding and thinking as to meet the requirements and standards of the National Council of Mathematics [1].

1.1. Classroom Discourse

Discourse is the mathematical communication that occurs in a classroom. Effective discourse happens when students articulate their own ideas and seriously consider their peers' mathematical perspectives as a way to construct mathematical thinking and understandings. The common core math standards for mathematical practice encourage students to "engage in the actual use of mathematics, not just in the acquisition of knowledge about the discipline" [10]. Research tells us that through mathematical discourse, teachers must foster student engagement and participation while focusing on the deep conceptual understanding; this means that students need to develop the ability to formulate problems, to explore, conjecture, and reason logically, to evaluate whether something makes sense [11].

1.2. Defining Discourse

The discourse of a classroom - the ways of representing, thinking, talking, agreeing and disagreeing – is central to what students learn about mathematics as a domain of human inquiry with characteristic ways of knowing. The discourse is shaped by the tasks in which students engage and the nature of the learning environment. But there's more to it than that if we're going to get to the level of discourse that encourages students to "think like mathematicians." [12].The quality and type of discourse are crucial to helping students think conceptually about mathematics ([13], [14], [15].

2. Previous Research

One area of mathematics education research that has gained attention recently is the examination of mathematics classroom discourse. Some researchers have investigated the complex dynamics between teachers and students in classrooms by focusing on argumentation, levels of talk, aspects of mathematical discussions, and so on ([16], [17], [18]). Others have interviewed students about issues related to classroom discourse and have set this alongside an analysis of students' participation patterns words ([19], [20]). Others have applied linguistic tools to written mathematics texts, including textbooks and student work, to discuss issues related to authority and assessment [21].

Achieving meaningful classroom discourse is a complex matter. Studies show that U.S. teachers tend to use a transmission style of classroom communication, stating information rather than developing ideas with their students, and offering little opportunity for students to justify, explore, or make meaning for themselves ([1], [22]).

However, recent evidence suggests that meaningful discourse may occur when the teacher focuses attention on the "development of the students' mathematics rather than on the communication of the teacher's mathematics" [23].Indeed, experienced teachers exercise professional judgment related to when and how to shift roles, when to "step in" as a participant and when to "step out" to become a commentator of rules, norms, and concepts [7].

Although each of these different ways of examining classroom discourse offers important information about the experiences of mathematics to students and teachers, there is still a looming concern that studies of mathematics classroom discourse need to attend further to the mathematics being construed in the discourse, especially in Arab Word in common and in Jordan in specific, therefore this paper will investigate the levels of teacher's role in classroom discourse to promote students thinking and understanding. We take seriously

this concern and, in this article, show how mathematics is construed in classroom discourse by using an analytic method.

3. Study Questions

This study aimed to investigate and achieve depth understanding for mathematical discourse used by teachers' to promote students' understanding and thinking for the high school students in Jordan during for the first semester for the academic year (2013-2014). In specific the study tried to answer this question:

What are the discourses levels indicators used by mathematics teachers to promote students' understanding and thinking?

4. Methodology

4.1. The Study Instrument (DLITR):

The study used Teachers Discourse Level Indicators (DLITR)) which has been constructed by the researcher and viewed by the researcher's colleagues. Stein identifies three level indicators as components of high-quality mathematical discourse as follows: Thinking skills to construct Procedures/Facts (P/F skills), Thinking skills to construct Understanding (U skills) , Thinking skills to construct Generalization (G skills) [4]. The researcher reconstructs these level indicators to become five levels, depending on the literature related to mathematics educational standards. The five levels are: Thinking skills to construct Procedures/Facts (P/F skills), Thinking skills to construct Understanding(U skills) Thinking skills to construct Communication (Com Skills), Thinking skills to construct Justification (J Skills) , Thinking skills to construct Generalization (G skills) The instrument used was rated: 3 always, 2 more often, 1 not often, 0 rarely. The instrument (DLITR) has been used by the researcher and the coresearcher team to analyze the data collected from interviews and observations.

4.2. Procedures for the Study

To answer the question of the study ,the researcher follows these steps:

The researcher intentionally selected (10) Sites; Government and UNRWA schools in Amman. Participated in this study were (10) high school female teachers from these schools. A team of (5) students who were enrolled in math teaching course on Math Department in the University of Jordan, participated in the study as co-researcher. The team is 3rd and 4th year mathematics student. This course was taught by the researcher and this is one of the students project for this course. The team with the researcher agreed on the way to record, code and analyze the data collected. Each member of the team selected randomly (2) teachers to interviewed and observed during math classes. After each observation or interview the observer will coded, analyzed and reported the data using (DLITR). Another researcher will repeat the same procedures to calculate agreement ratio between the two researchers who analyzed the same data. The average of the agreement ration was 91% which is acceptable for such research. Each teacher have been observed (4) times and interviewed twice.

4.3. Data Resources

- The data was collected contextually, in the natural setting in the light of the researcher’s observations (OD), which focused on highlighting the strategies from the points of view of the participants. In this regard, the study adopted the (DLITR).
- Also the data was collected through teachers' interviews(ID).Teachers’ interviews aimed at identifying their opinions regarding discourse for improving the students’ thinking and understanding in mathematics including those recommended by NCTM.
- The process of collecting data continued about three months during the 1st semester of the academic year (2013-2014).

4.4. Subjectivity and Objectivity of the Collecting Data

To guarantee objectivity, the researcher followed the following methods: objective narration of events, long-time field observation and the triangular data collection method. Collection of data relied on interviews

and field observation at different locations and times. The study incorporates samples of the participants' comments, which had been reviewed and signed by each participant. Such methods of collection, describing and analyzing the data have been commended by many researches in the field. The collection and processing of the data passed through the following four stages: planning, developing intimate relations with the participant, collection of raw data, and finally summarizing, coding, and analyzing the collected data.

4.5. Data Analysis

Researcher used inductive analysis to arrive at the results of the data collected. The study adopted the descriptive design using percentage and averages for each level of the discourse indicators from all sites.

5. Results

In this section, we will present the results of the analysis for the research question.

Table. 1: Results of Discourse Levels Indicators for Teachers Role (DLITR) for all Sites

Discourse Levels for Teacher's Role	Interview (ID)		Observation(OD)	
Thinking skills to construct Facts\ Procedures (F\P skills)	2.63	66%	2.64	66%
Thinking skills to construct Understanding (U skills)	2.8	70%	1.44	36%
Thinking skills to construct Communication (Com skills)	2.1	53%	0.8	20%
Thinking skills to construct Justification (J skills)	2.4	60%	0.6	15%
Thinking skills to construct Generalization (G skills)	1.6	40%	0.2	5%
Average	2.31	58%	1.136	28%

As shown in the table (1) the result indicates that the 1st level indicator which represents Facts and Procedures skills is relatively high comparing to other levels. The percentage is (66%) for (OD) and (ID) . While the 2nd level indicator which represents understanding skills percentage is (70%),(36%) for (ID) and (OD) respectively. For the 3nd level indicator which represents communication skills the percentage is (53%) for (ID) while the percentage for (OD) is (20%). For the 4th level indicator which represents Justification skills the percentage is (60%) for (ID) while the percentage for (OD) is (15%). For the 5th level indicator which represents Generalization skills the percentage is (40%),(5%) for (ID) and (OD) respectively. The study revealed the significant difference between the data collected from (ID) and (OD) for the last four levels indicators of the discourse; this reflects the teachers' unawareness about their teaching.

6. Discussion

The research findings that emerge from the observations showed that the teachers could successfully apply the first level of discourse indicators skills failed in the use of others; which asserted the professional application of the procedural and facts skills, and lacked understanding, justification, communication and generalization skills by the teachers in all locations. This results supports by many researchers that teachers tend to use a transmission style of classroom communication, stating information rather than developing ideas with their students, and offering little opportunity for students to justify, explore, or make meaning for themselves in order to arrive to the conceptual understanding ([1], [7], [22]). This also reflects what many theoretical background and related research conclude that most high school mathematics teachers see mathematics as a rigid and fixed body of knowledge, and think that their responsibility is to transfer information and mathematical laws to the students over rote memorization, and concentrate only on the procedures; that made many students suffer from understanding basic mathematical concepts, weakness in their ability to solve math problems and low level of communication skills ([1], [6], [7], [8], [9]). The research findings emerge from interviews' reflects that the teachers are not experienced nor aware about their teaching to the extent to exercise professional judgment related to when and how to shift roles, when to "step in" as a participant and when to "step out" to become a commentator of rules, norms, and concepts to arrive to the meaningful discourse that will develop students' mathematical understanding and thinking ([1], [9], [23]).

7. Recommendations

Based on the study results it urges those responsible for teacher training to stress the importance of mathematical discourse that improve reasoning and proving in training programs and to emphasize the need to employ it in-class. The study also urges mathematics teachers, to be more aware and to change their role from being a carrier of information to being a supervisor and facilitator of the process of education, and to be more aware and give more attention to their teaching skills. The research presented here provides beginning of structures from which to build an effective classroom discourse. Also similar studies cover different stages are recommended.

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9. References

[1] National Council of Teachers of Mathematics (NCTM), (2008).Principles and Standards for School Mathematics, Retrieved 15/8/2008 from http:// standards. nctm. org/document/ index. htm.

[2] Ministry of education in Jordan ,(2005). The General Framework for Mathematics Curriculum for primary and secondary in Jordan, Amman, Jordan.

[3] Ryve, A. (2011). Discourse research in mathematics education: A critical evaluation. Journal for Research in Mathematics Education, 42, 167–198.

[4] Stein, Catherine (2007). : Let's Talk – Promoting Mathematical Discourse in the Classroom. Mathematics Teacher. November 2007, Volume 101, Issue 4:285-289.

[5] English, L.D.:(2002). 'Priority themes and issues in international research in mathematics education', in L.D. English, M.-G. Bartolini Bussi, G. Jones, R.A. Lesh and D. Tirosh (eds.), Handbook of International Research in Mathematics Education, Lawrence Erlbaum, Mahwah, NJ, pp. 3–15.

[6] Staples, M. (2007). Supporting whole-class collaborative inquiry in a secondary mathematics classroom. Cognition and Instruction, 25 (2), 161-217.

[7] Balas Ryad; Barhem, Areej(2010). The effect of using multiple mathematical representations for the eighth grade students to gain the Basic mathematical concepts and their ability to solve word problems, Dirasat, educational science, University of Jordan. Vol.37 (1): 1-13.

[8] Alali, Omar (2001).The acquisition of tenth grade students the skills of estimation, mathematical communication, patterns and mathematical relationship. Unpublished MA Thesis, Yarmouk University, Irbid, Jordan.

[9] Sabbagh,S.A.(2007). Mathematical Communication Strategies Used by Talented Students in the Upper Basic Stage in Jordan.Dirasan,Educational Science, University of Jordan .Vol:34,No.7:302-318.

[10] Schwols, A., & Dempsey, K. (2012a). Common Core standards for high school mathematics: A quick-start guide. Alexandria, VA: ASCD.

[11] Bruce, C. D. (2007). *Student interaction in the math classroom: Stealing ideas or building understanding*. Retrieved from http://www.edu.gov.on.ca/eng/literacynumeracy/inspire/research/Bruce.pdf

[12] Schwols, A., & Dempsey, K. (2012b). Making connections: Mathematical practices, assessment, and instruction. Presentation at the North Dakota Curriculum Initiative, Bismarck, ND.

[13] Morgan, C. (2006). What does social semiotics have to offer mathematics education research? Educational Studies in Mathematics, 61, 219–245. doi:10.1007/s10649-006-5477-x

[14] Nathan,M.J., & Knuth, E.J.(2003). A study of whole classroom mathematics discourse and teacher change. Cognition and Instruction, 2:175-207.

[15] Van Oers,B.(2002).Educational forms of initiation in mathematical culture. Educational Studies in Mathematics,46:59-85.

[16] Brodie, K. (2007). Teaching with conversations: Beginnings and endings. For the Learning of Mathematics, 27(1), 17-23.

[17] Truxaw, M. P. & DeFranco, T. C. (2007). Lessons from Mr. Larson. An inductive model of teaching for orchestrating discourse. Mathematics Teacher, 101 (4), 268-272.

[18] Hufferd-Ackles,K.C.Fuson, K.,& Sherin, M.G.(2004). Describing levels and components of a math-talk learning Community. Journal for Research in Mathematics Education, 35:81-116.

[19] Jansen, A. (2006). Seventh graders' motivations for participating in two discussion-oriented math-
ematics classrooms. The Elementary School Journal, 106, 409-428. doi:10.1086/505438.

[20] Wagner, D. (2007). Students' critical awareness of voice and agency in mathematics classroom discourse. Mathematical Thinking and Learning, 9, 31–50. doi:10.1080/10986060709336604

[21] Herbel-Eisenmann,(2007).From intended curriculum to written curriculum. Examining the "Voice"book of mathematics text book.Journal for Research in Mathematics Education, 38:344-369.

[22] Al-Khateeb, Mohammad and Abadneh, Abdalla (2011). Thinking and Attitudes towards Mathematics with Seventh Graders in Jordan .Darasat for Educational Studies. Volume No. 38 (1): 189-204.

[23] Lobato, J., Clarke, D., & Ellis, A. B. (2005). Initiating and eliciting in teaching: A reformation of telling. Journal for Research in Mathematics Education, 36, 101–136