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Patterns of Class Talk Supportive to Prompt Reasoning among Students

Zafar Iqbal [*] Nasir Mahmood [†]

Abstract: *The study was based on classroom interaction to identify patterns of class talk supportive to prompt reasoning ability of students. Two intact classes pertaining 25 students each of grade VII were involved in the study. The data were based on classroom observation. One unit of science text book was taught by the teacher in nine sessions, each comprised of 40 minutes and was audio recorded. A content free worksheet based on the concepts included in the unit was developed to assess reasoning ability of the students. The worksheet was applied as pretest, post test procedure. Paired sample t-test was used to analyze the data. There was significant difference in pre-test post test achievement scores against 7 reasoning based items. The observation data (audio recorded) were transcribed and analyzed through Framework of class talk to see the supportive patterns of talk. Two main patterns; multifocal thematic teacher student and multifocal contextual teacher student were identified as supportive to trigger reasoning ability among students. The evidence was supportive enough to highlight the implication of interactive nature of class talk leading towards students' reasoning ability of science concepts.*

Keywords: Quality, education, trust school, case study.

Introduction

The classroom interaction provides a platform to students for sharing of ideas and construction of knowledge (Mercer, Wegerif, & Dawes, 1999; Setianingsih, 2018). This provision enables students to develop shared reasoning with proper guidance and support to the students, otherwise, even they are engaged in activities but they will lack any clear understanding. As learning is a social phenomenon, therefore, students should be provided more vocal role and mutual support (Rojas-Drummond & Mercer, 2003) which can result in the form of increase in exchanging ideas and enhancing their reasoning ability (Rocksén, 2015). This will shift role of students as thinkers enabling them to establish relationship among teachers and students with a move of classroom interaction as a powerful tool to sustain class culture and value student reasoning (O'Connor & Michaels, 2019).

Reasoning is a dialogic activity embedded in social practice in the class and its quality is based on quality of dialogue (Wegerif, 1996). The degree of criticism, explanation, justification, clarification and elaboration of an idea discussed in the interactive classroom contributes to the reasoning ability of the students. The way of classroom interaction and approaches used in the classroom demonstrate joint, explicit and collaborative

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reasoning (Mercer et al., 1999). Scott, Mortimer, and Aguiar's communicative approach examines different levels of dialogic discourse ranging from simple articulation to sharing. They contrast this dialogic approach with an authoritative approach that is mostly teacher driven and offers only a unifocal perspective. But dialogic discourse was usually followed by authoritative discourse and that authoritative discourse was often followed by a segment of dialogic discourse. Van Lier (2001) disagreed with 'Communicative Approach' and claimed that "although researchers frequently claim that the co-construction of knowledge is an important aspect of shared learning, only a few of them make a distinction between categories of talk that reflect different degrees and different types of talk or co-construction" (p. 59). The levels of co-construction at which these ideas define the degree of class talk. It is consistent with Piaget's ideas on cooperation, (Mercer, 2002; Mortimer & Scott, 2003) have characterized quality talk which displays reasoning. It is very important to categorize the relationship between the type of class talk and the quality of knowledge constructed by that talk. As Kitchener (2014) pointed out, 'not just a belief of any type (counts as knowledge), but rather one that (is) warranted' reasonable, justified, backed by adequate evidence, and so on' (p. 46).

Social interaction is necessary for development of reasoning ability of the students (Kimmerle, Moskaliuk, Oeberst, & Cress, 2015). Mercer, Dawes and Wegerif class talk as a tool for development of reasoning ability of students in science and mathematics. The concept of conceptualization by Piaget was criticized by Mercer (2002) and transmission model was rejected by the social model of talk. Researchers have consensus that knowledge is socially mediated except direct transmission (Wilson & Spink, 2005; Mercer et al., 1999). Dialogic orientation is beneficial for development and social interaction is essential for reasoning. Neo-Vygotskian accounts of individual cognitive development focus on induction into specific social practices. The combination of these two views would lead to the conclusion that learning to reason is essentially induction into a social practice. Research reports three conditions for socially emergence of talk; each participant must contribute in the talk, co-operation among participants rather than competition, and shared understanding (Mercer et al., 1999). Specific language used during the class talk also contributes toward students reasoning ability in the classroom.

The students' productive engagement and collaborative effort in the classroom caused emergence of some certain type of talk (Rojas-Drummond & Mercer, 2003) which engage students critically but constructively with each others' ideas. Most often, statements and suggestions are sought and offered for joint consideration. These may be challenged, but and counter-challenged but challenges are justified and alternative hypothesis are offered (Mercer et al., 1999). In exploratory talk, knowledge is made publically accountable and reasoning is visible in the talk. The literature on discursive practices in the classroom characterizes talk as a resource for learning, there is considerable support for our position that the development of knowledge is a co-constructed activity of all classroom members, constituted in and through talk (Mercer & Littleton, 2007; Rogoff, 1990; van Boxtel & Roelofs, 2001). Furthermore, we contend that some forms of talk are better than others for facilitating such understanding; in particular, types of talk that lead to creating opportunities for perspective taking are best suited for achieving mutual understanding. As Edwards and Westgate (2005) stated, classroom research is needed in order to understand

more clearly how language is used and organized in various modes of teaching. Mercer took the idea as reported talk promotes reasoning, 'in which partners exchange creativity constructively' (Rocksén, 2015).

This study is based on social constructivism paradigm to identify conceptual understanding of the students through reasoning based items and then exploration of classroom interaction to identify supportive patterns of class talk which prompt to increase reasoning ability of the students. Literature in the above paragraphs highlights that some specific patterns can be helpful in developing students shared understanding and reasoning ability. It is significant to explore such patterns from classroom interaction, particularly, in the context of Pakistani schools where little such research is available. However, this study aims to identify supportive patterns of class talk prompt reasoning ability among students.

Research Methodology

Mixed method approach was applied to conduct this research. The philosophical underpinning of the research was socially constructed in nature. It depicts to explore through integration of both modes of reasoning; deductive and inductive. The combination of both quantitative and qualitative approaches would provide better understanding of the problem in hand instead of single approach (Creswell, 2015). Reasoning ability of students depends upon the nature of questions having wide range and scope like who, what, why and how sort of questions consequently developing argumentative and interactive classroom interaction. Such situation can be studied through mix method research approach under a single study (Frels & Onwuegbuzie, 2013).

The Mix method approach offers explicit means for proceedings in a research design (Denzin & Lincoln, 2011). In side this approach Convergent parallel mixed method was employed as a research design in which the researcher congregates and merges both types of data in order to provide a complete analysis of the research problem. In this design, the investigator typically collects both forms of data at roughly the same time and then combines the information in the interpretation of the overall results (Creswell, 2014). For quantitative data collection a worksheet based on concepts of a unit from 7th grade science text book was prepared and pre-test and post-test procedure was used to collect data. After pre-test prescribed unit was taught to the classes in nine sessions and all classroom interactions were captured through audio recording. After teaching of complete unit post test was conducted to see the students understanding of science concepts.

Sample of the Study

The study was based on classroom observations during teaching of a science unit to grade VII students. The assumption of the study was to identify such schools where classroom interaction was open and flexible for students to participate and share their point of view. For this purpose many schools were visited to see their classroom practices so that the schools compatible to the scope of the study can be selected. The couple of schools asso-

ciated to the scope of our study were identified and their administration was informed about the scope of the study. After detailed discussions and deliberations a school was agreed to participate in the study on our terms and conditions. It was mutually decided with school administration that school schedule would not be disturbed. The classroom observation was made as per schedule already planned by the school administration. No alteration of any sort like schedule, content, class time and duration was made. The school administration agreed and signed informed consent to participate in the study. In this way, we have selected a school, a teacher and her class to be part of our sample in the study.

Nature of School and Teacher

The school system agreed to participate in the study had international chain with good repute situated in Lahore city. It was an English medium private school (female branch) from grade I to XII. It was associated with Cambridge University at O and A levels. The children of educated parents with moderate level of socio-economic background were mainly admitted in this school system. The school was well known for focusing on concept making, providing students' opportunity to share ideas and improving their reasoning and argumentative ability. Two intact classes of grade VII, section D and E were involved in the study with the consent of the school administration and concerned teacher. There were almost 25 students in each class, ranging 11-13 years of age and female in gender. This was another reason to involve this school as number of students in a class was supportive to conduct interactive sessions during teaching.

A teacher practised more interactive approach in classroom teaching was involved to observe her during teaching. The selection of school system, the teacher, and medium of instruction was based on more compatibility of these all with the nature of our study. The selection of teacher for this study was a compromise between consent of teacher to participate, permission of school, and teachers' inclination towards interactive and participative teaching. However, the selection of school and a teacher can be called purposive in nature to have directly relevant information to answer the research questions (Patton, 2014). The teacher was qualified having master degree in science teaching (M. Sc. Ed with distinction) and 15 years experience of teaching in the relevant subject at more than one popular school systems. She has experience of teaching to O' levels and A' levels which is generally perceived more demanding and further to transmission of knowledge approach of teaching.

Selection of a Class and Subject

The examination of some classes was conducted by the schools themselves and for terminal grades (V, VII, IX & X) exams were conducted by external examining bodies. The class VII was selected for observation due to low exam pressure being internal exams for this grade. Exams of 5th, 8th and 10th grade students were conducted by the external bodies and classroom practices were consequently derived by the exam pattern conducted by the examining bodies. Such exams mainly focus on factual recalling of information so

that majority of the schools do not emphasise on developing understanding of the students but merely focus on transmission of information rather than reasoning. This factual state restricted the choice of a selection of a class for researchers.

The subject of science was selected to observe during teaching owing to more conceptual and seeming to be relatively difficult to understand for the students. The subject of science is also considered significant in nature and plays a vital role in fulfilling needs and demands of our daily life. Majority of the students feel this subject boring and showed little interest in science. Keeping in view both the perspectives, researcher had decided to conduct study on the subject of Science.

Methods of the Study

The classroom observation was made to capture interaction and explore supportive patterns of class talk contributing to students' understanding of science concepts. A unit from science text book of grade VII was selected to observe during teaching. The unit, 'Transmission of Heat' was taught in nine sessions which were audio recorded. The reasoning ability of students was measured through pre-test and post test procedure. The detail regarding purpose, construction and characteristics of methods used for data collection is given below.

1. Classroom observation to capture interaction among participants
2. A worksheet based on concepts of unit taught during the study
3. Framework for analysis of class talk (FACT)

Classroom Observation

The class teacher and researchers got a meeting and planned that which unit was coming on the schedule and decided to observe the next chapter Transmission of Heat which she is going to teach in coming weeks. The teaching of this unit was based on nine sessions expanded on three weeks. It was decided that class talk would be recorded by the teacher herself to avoid any inconsistency during observation. There was no chance of biasness in observation because there was no external observer and the focus was class talk which was audio recorded. The researcher handed over a voice recorder to the teacher and explicated its procedure. She was given a practice to record her voice couple of times in front of researchers and in this way she improved her skill of using the device. The procedure to observe the classroom interaction was to get the device on when teacher entered in the classroom and started to teach and got it off when the class was over. In this way we had nine audio files of classroom observations comprised on complete recording of this unit.

Transcription of Data

The audio files were transcribed by the professionals having experience of transcription. The accuracy of transcribed data was legitimated by following three steps; transcription

of data files, matching of transcription with original data files, typing of transcribed files after matching and proof reading by the concerned teacher.

In first step data were transcribed by the experts. Firstly, it was transcribed manually and then typed in the computer and matched with the hand written files. In second step, the files in soft form were matched with the original source mean audio files to see and address any discrepancy in the data files. At third step, the print of final transcribed files was taken and handed over to the concerned teacher for verification of data. In this way data files were finalized for data analysis.

Conceptual Worksheet

A content free worksheet was prepared based on concepts included in the unit to measure conceptual understanding of the students through pre-test and post-test procedure. The limitation of the school administration regarding external intervention was considered and decided to develop tests personally to assess students understanding. Keeping in view the concept and students' understanding of those concepts, reasoning based items were included in the work sheets. The items were constructed on separate constructs to get the real idea behind these common concepts of daily life. It was also decided that pre-test and post-test would be the same as we were interested to gauge difference of gain owing to classroom interaction by comparing means of achievement scores on both application of work sheets. The pre test and post test were conducted in the prescribed period specified for the science subject. Therefore, the limitation of time factor was considered during the test development. There were 10 questions in the worksheet. It was ensured that the students were able to finish the test in 40 minutes. Detailed summary of students involved like number of sessions and number of students appeared in the test is given in table 1.

Table 1
Summary of Pre-tests & Post-tests, Number of Lessons and Audio Recordings

Sr.no	Name of unit	Class	No. of students appeared in the Pre-test		Number of lessons/ Timing per lesson	Audio recordings		No. of students appeared in the Post-test	
						Hour	Min.		
1	Transmission of Heat	D	23	46	9/(40 minutes each)	6	0	22	45
		E	23					23	

Description of Worksheet

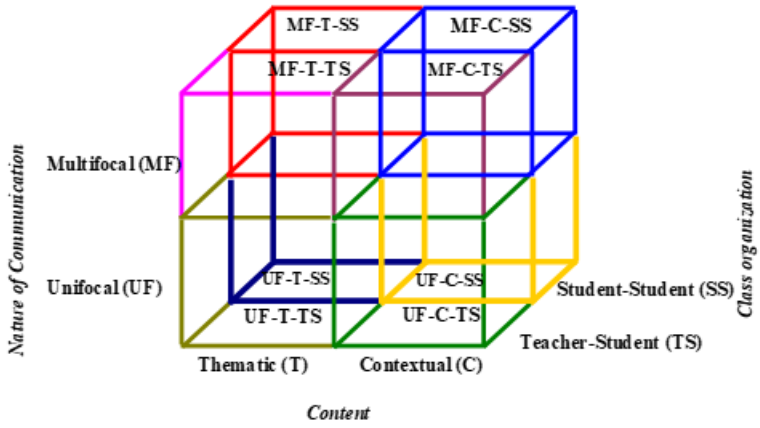
The unit taught during classroom interaction was the first unit of second term from physics section of science text book. The worksheet was based on ten items to measure reasoning ability of the students against the concepts of the unit. First of all, a list of learning outcomes of the unit was prepared and subject experts (9) were given content of the unit along with learning outcome for consultation. The researcher sorted the unit concept wise and prepared a worksheet against all concepts. It was developed with rigorous effort and then placed before the forum of experts for discussion. They discussed the items one by one keeping in view the concepts involved in the unit, learning outcomes, content matter

included in the unit, and items appropriateness to measure these learning outcomes. The worksheet got finalized in the light of above mentioned points followed by consultation of language experts. Description of worksheet is given in table 2.

Framework for Analysis of Class Talk (FACT)

Different frame works are used to analyze classroom interaction, initially; Flanders work on classroom interaction and many researchers followed and worked on different aspects of classroom interactions (Amidon & Hunter, 1966; Flanders, 1970; Sinclair & Coulthard, 1975). The FACT had significantly differentiated features as compared to available different frameworks to analyze classroom talk. It dealt with the whole classroom interaction and has facility to categorize the whole class talk in three main dimensions: nature of communication (unifocal or multifocal), content contextualization (thematic or contextual) and class organization (teacher student or student-student). The classroom interactions were formed including one sub category from each dimension to make the teaching approach. In this way eight different teacher approaches were formed; four were interactive and four were non-interactive. Detail description of the FACT is given below.

Figure 1
Framework for analysis of class talk (FACT)



Teaching Approaches: Categories of Talk in FACT

1. Unifocal- Thematic –Teacher & Student (non-interactive)
2. Unifocal - Thematic –Student & Student (non-interactive)
3. Unifocal - Contextual – Teacher & Student (non-interactive)
4. Unifocal - Contextual – Student & Student (non-interactive)
5. Multifocal- Thematic – Teacher & Student (interactive)
6. Multifocal - Thematic – Student & Student (interactive)
7. Multifocal – Contextual – Teacher & Student (interactive)

8. Multifocal – Contextual – Student & Student (interactive)

Procedure and Analysis

The conceptual worksheet was applied as pre-test before instruction. The above mentioned unit was taught by the teacher in nine sessions in three week time and all sessions were audio recorded. After teaching of complete unit same worksheet was again applied to capture students understanding after instruction of the unit. The teacher was same and after instruction to both classes data files were shared with the teacher to select one file as both files were same to analyze the classroom interaction. In this way nine files were get finalized for analysis. Pared sample t-test was used to measure mean difference in achievement scores. NVivo software was used to analyze classroom interaction (Jones, 2007). The transcribed data went through iterative process of extensive reading and got coded in the NVivo software to see the supportive patterns of talk.

Table 2
Description of Unit, Transmission of Heat

Sr.	Concept	Students' will be able to	Item No.	Type of question
1	Application of poor conductor	Understand the application of poor conductors in our daily life	Q 1. ii	Reasoning
2	Application of good conductor	Understand the daily use of good conductors	Q 2. Ii	Reasoning
3	Conduction	understand the meaning of conduction	Q 3. i	Reasoning
4	Poor conductor	Comprehend the concept of poor heat transferring of the elements	Q4. III, iii	Reasoning
5	Convection current in gases	Understand the formation of convection current in gases	Q 5	Reasoning
6	Convection current in liquids	Understand the formation of convection current in liquids	Q 6. i	Reasoning
7	Application of convection	Understand the application of convection in our daily life	Q 6. ii	Reasoning
8	Bad absorber of heat	Understand the type of elements having poor absorption of heat	Q 7	Reasoning
9	Bad absorber of heat	Elesments with poor absorption of heat	Q 8	Reasoning
10	Bad radiators of heat	Understand the type of elements who are bad radiators of heat	Q 9. ii	Reasoning

Result

Paired samples t-test was used to compare means of pre-test and post test achievement scores of the students. Table 3 shows the comparison of 10 pairs based on reasoning items to assess the conceptual understanding of the students in pre-test and post test. There is a significant difference on 7 out of 10 pairs (70%) in pre-test and post test achievement scores while the scores on 3 pairs (30%) have no significant difference but post test scores are reasonably high as compared to pre-test scores. The results show that students understanding after classroom interaction extensively increased emerging need to probe classroom discussion to know the embedded features of classroom interaction especially patterns of talk which supported to increase students reasoning ability (Mercer, 2008).

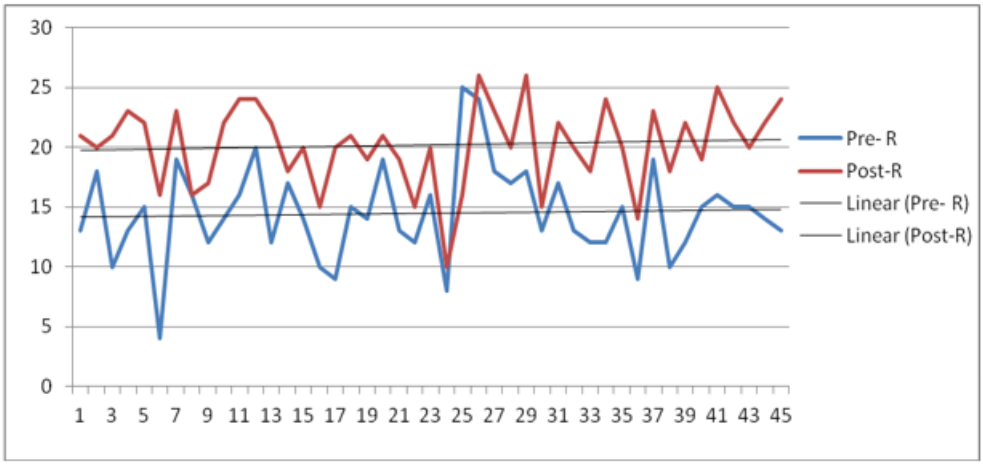
Table 3
Paired sample t-test results of students on their achievement scores

Sr no.	Pairs	Mean x1	Mean x2	df	t-value	Sig.
1	Q1_ii_pre_R - Q1_ii_post_R	1.38	1.69	44	-1.735	0.090
2	Q2_ii_pre_R - Q2_ii_post_R	1.56	1.91	44	-2.701	0.010*
3	Q3_i_pre_R - Q3_i_post_R	1.40	1.64	44	-1.857	0.070
4	Q4_ii_2_pre_R - Q4_ii_2_post_R	1.87	1.96	44	-1	0.323
5	Q5_pre_R - Q5_post_R	0.33	1.47	44	-8.055	0.000***
6	Q6_i_Pre_R - Q6_i_Post_R	1.27	1.71	44	-4.304	0.000***
7	Q6_ii_Pre_R - Q6_ii_Post_R	1.53	1.82	44	-2.666	0.011*
8	Q7_Pre_R - Q7_Post_R	1.20	1.91	44	-6.563	0.000***
9	Q8_Pre_R - Q8_Post_R	0.89	1.67	44	-5.955	0.000***
10	Q9_ii_Pre_R - Q9_ii_Post_R	0.91	1.73	44	-5.891	0.000***

N= 45, ***p<0.001, *p<0.05

Figure 2 further clarifies the trend of pre-test and post test achievement scores on reasoning based items across students appeared in the tests. Line graph clearly shows that the achievement scores of all students on post test are higher than their relative pre-test scores. The mean difference in individual students' achievement scores (almost 5 marks) is evident from the linear lines indicating pre-test and post test scores. The post test mean achievement score is comparatively higher than the pre-test scores of the students.

Figure 2
Student wise comparison to see the trend of pre-test and post test achievement scores



Analysis of Class Talk

The quantitative results are very much encouraging that students reasoning ability is significantly increased after teaching of a unit. There is a need to explore classroom interaction and identify the patterns of talk which are supportive to develop students reasoning ability. The classroom interaction, when and where these concepts were discussed, were identified. The concepts were identified from table 2 in which significant difference in pre-test and post-test achievement scores was found. Following the information in those

concepts relevant topics were identified from the transcribed data of classroom interaction. The identified extracts from the relevant sessions of class talk were picked up and analyzed with the help of FACT by coding through NVivo software.

Table 4 provides concept wise detail of the text where significant difference was found. It includes question number of worksheet through which that concept was measured, type of question, number of lesson in which that concept was discussed, line reference indicating the placement of this text in a particular lesson, line based coding reference of different sub categories of talk in the extract, dimensions of FACT and placing coded data through symbol "Y" in the relevant category of talk, the patterns of talk existed in the text are mentioned, with their length of occurrence (based on lines of text regarding a particular approach of talk) and in the last column supportive patterns of talk are reported on behalf of frequency of occurrences/length of text coded against a particular pattern of talk. It is worth mentioning that the number mentioned in second last column against each approach of talk is based on numbers of lines of text relevant to that particular approach of talk.

The supportive patterns of talk are identified on two bases; frequency of occurrences of particular approach and length of text basis coded against a particular pattern of talk. The results based on length of text are comparatively more valid as compared to frequency of occurrences of an approach of talk in the text.

The first concept, 'application of good conductor' in which significant difference was found, assessed through question (2.ii) discussed in lesson 2-3 starting from 31-74 lines of transcribed data. This concept was discussed through two approaches of talk namely; unifocal- contextual- teacher & student and multifocal-contextual-teacher & student. Actually, the variation in talk is based on communication while other dimensions of talk are related to only single sub category of talk. The communication is almost multifocal because the length of text based ratio among sub categories is 42/2 form multifocal to unifocal showing interactive nature of talk. The frequency of occurrences is also indicating the same patterns among these categories 2/1 from multifocal to unifocal. Hence the most appropriate pattern of talk seen for understanding of this concept is multifocal-contextual-teacher and student.

The second concept, 'convection current in liquids' in which significant difference was found, measured through reasoning based question (6.i). The relevant text where this concept was discussed in the class identified in lesson 4, based on 51-130 lines of transcribed data. The text of these lines was analyzed thoroughly according to the codes already allocated. When it was sorted line wise, 16 different codes were allotted to the text. It was placed to the relevant categories of talk. More variation is seen against the talk categories during the discussion of this concept. Four talk approaches are found; unifocal- contextual- teacher & student, unifocal-thematic-teacher & student, multifocal-contextual- teacher & student and multifocal-Thematic-teacher & student. If we see length of text based categories of talk against different dimensions of FACT, the nature of communication is mostly unifocal as compare to multifocal with ratio (47/35). While most of the talk is thematic as compare to relative category of contextual 71/9 and class organization is only among teacher and students. The length of text based results shows that unifocal-thematic-teacher & student approach of talk is mostly used during the discus-

sion of this concept. The text coded frequency of occurrence shows results in favor of multifocal-thematic-teacher & student patterns of talk.

The next concept, 'application of convection' in which significant difference was found, measured through reasoning based question (6.ii) of the worksheet. The relevant text identified in lesson 4 based on 236-246 lines. The text was coded as per FACT dimensions of categories of talk. When text was sorted on line to line basis, 5 different categories were found at different levels of the text. After combining these sub categories of different dimensions approaches of talk were formed. The same approaches were gathered and their cumulative degree of occurrence in the text obtained. There were three approaches of talk; unifocal-contextual-teacher & student, multifocal-contextual-teacher & student and multifocal-Thematic-teacher & student used during this concept. If we see length of text based categories of talk against different dimensions of FACT, the nature of communication is equally distributed between unifocal and multifocal (6/6). While most of the talk is thematic as compare to relative category of contextual 9/3 and only mutual interaction among teacher and students is existed. The length of text based results showed that unifocal-thematic-teacher & student approach of talk is mostly used during the discussion of this concept. The text coded frequency based results equally favors to the unifocal-thematic-teacher & student and multifocal-thematic-teacher & student approaches of talk (3/3).

The next concept 'understanding meaning of convection' in which significant difference in pre-test and post-test was found, measured through question (5) of the worksheet. The relevant text discussed in lesson 6 comprising 154-220 lines. The identified text was coded according to the already assigned nodes. When line wise data were sorted against sub categories of talk, 16 approaches were found at different levels in the text. After combining sub-categories of different dimensions, approaches of talk were formed. The same approaches were gathered and found and their cumulative degree of occurrence was found in the text. Finally, four approaches of talk were identified; unifocal- contextual-teacher & student, unifocal- thematic- teacher & student, multifocal-contextual- teacher & student and multifocal- Thematic- teacher & student. The length of text based results showed nature of communication was intended towards unifocal 42/25, content is mostly thematic as compared to contextual (48/19) while class organization showed only interaction among teacher and students in both directions. The length of text based results showed unifocal- thematic- teacher & student talk approach. If we see text coded references of occurrences based results then unifocal- contextual- teacher & student and multifocal- contextual- teacher & student equally exist with the ratio (5/5).

The concept, 'type of elements having poor absorption of heat' was measured through question (7) of worksheet. The relevant text identified in lesson 7 based on 23-105 lines. The text in the mentioned lines was coded according to the already allocated nodes. When line wise data sorted 10 approaches were found at different levels of the text. The approaches of talk were based on subcategories of different dimensions. In an approach of talk one subcategory from each dimension was included. The same approaches were gathered and found their cumulative degree of occurrence in the text. There were two approaches of talk exist in the text; unifocal-thematic-teacher & student and multifocal-thematic- teacher & student. The length of text based results showed that the nature of

Table 4
Analysis to identify patterns of talk supportive to trigger reasoning ability of students of science concepts

Sr.no	Concept asked in the question	Q.no	Type of Question		Reference in the text	Line wise talk Categories within text	Dimensions of FACT						Patterns of Class Talk	Supportive Patterns of talk (Text L/F)
							NO Com		C Cont		C Org			
							U	M	C	T	TS	SS		
1	Application of good Conductor	2.ii	Reasoning	02-Mar	31-74	31-40		Y	Y		Y		MCTS (10)	UCTS= 1/2 MCTS= 2/42
						41-42	Y		Y		Y		UCTS (2)	
						43-74		Y	Y		Y		MCTS (32)	
2	Convection Current in liquids	6.i	Reasoning	4	51-130	51-54	Y			Y	Y		UTTS (5)	UCTS= 2/2 UTTS= 5/45
						55-56		Y		Y	Y		MTTS (2)	MCTS= 3/7
						57-57	Y		Y		Y		UCTS (1)	MTTS= 6/28
						58-58		Y		Y	Y		MTTS (1)	
						59-63		Y	Y		Y		MCTS (5)	
						64-64	Y		Y		Y		UCTS (1)	
						64-69		Y		Y	Y		MTTS (6)	
						69-69		Y	Y		Y		MCTS (1)	
						69-73	Y			Y	Y		UTTS (5)	
						73-73		Y	Y		Y		MCTS (1)	
						74-82		Y		Y	Y		MTTS (9)	
						83-91	Y			Y	Y		UTTS (9)	
						91-98		Y		Y	Y		MTTS (8)	
						98-102	Y			Y	Y		UTTS (5)	
						103-104		Y		Y	Y		MTTS (2)	
						105-130	Y			Y	Y		UTTS (26)	
3	Application of convection	6.ii	Reasoning	4	236-246	236-237		Y	Y		Y		MCTS (2)	UTTS= 2/6
						238-240		Y		Y	Y		MTTS (3)	MCTS= 2/3
						241-243	Y			Y	Y		UTTS (4)	MTTS= 1/3
						244-244		Y	Y		Y		MCTS (1)	
						245-246	Y			Y	Y		UTTS (2)	
4	Meaning of Convection	5	Reasoning	6	154-220	154-154	Y		Y		Y		UCTS (1)	UCTS= 5/8
						155-155		Y	Y		Y		MCTS (1)	UTTS= 2/34
						156-157		Y		Y	Y		MTTS (2)	MCTS=5/11
						158-160		Y	Y		Y		MCTS (3)	MTTS= 4/14
						161-162	Y		Y		Y		UCTS (2)	
						163-166		Y		Y	Y		MTTS (4)	
						167-168	Y		Y		Y		UCTS (2)	
						169-172		Y	Y		Y		MCTS (4)	
						173-174	Y		Y		Y		UCTS (2)	
						175-176		Y		Y	Y		MTTS (2)	
						177-182		Y		Y	Y		MTTS (6)	
						183-208	Y			Y	Y		UTTS (26)	
						209-210		Y	Y		Y		MCTS (2)	

Table 4
Contd.

Sr.no	Concept asked in the question	Q.no	Type of Question	Reference in the text	Line wise talk Categories within text	Dimensions of FACT						Patterns of Class Talk	Supportive Patterns of talk (Text L/F)
						NO Com		C Cont		C Org			
						U	M	C	T	TS	SS		
					211-218	Y			Y	Y		UTTS (8)	
					219-219		Y	Y		Y		MCTS (1)	
					220-220	Y		Y		Y		UCTS (1)	
5	Bad absorbers of heat	7	Reasoning	7	23-105	23-27	Y			Y	Y	UTTS (5)	UTTS= 5/40
						28-30		Y		Y	Y	MTTS (3)	MTTS= 5/43
						31-46	Y			Y	Y	UTTS (17)	
						47-58		Y		Y	Y	MTTS (11)	
						59-66	Y			Y	Y	UTTS (8)	
						67-76		Y		Y	Y	MTTS (10)	
						77-79	Y			Y	Y	UTTS (3)	
						80-85		Y		Y	Y	MTTS (6)	
						86-92	Y			Y	Y	UTTS (7)	
						93-105		Y		Y	Y	MTTS (13)	
6	Good radiators of heat	9.i	Reasoning	8	Aug-35	08-Oct		Y	Y		Y	MCTS (3)	UCTS=1/5
						11-Dec	Y			Y	Y	UTTS (2)	UTTS=2/4
						13-16		Y		Y	Y	MTTS (4)	MCTS=2/9
						17-23	Y			Y	Y	UTTS (7)	MTTS= 1/4
						24-25	Y			Y	Y	UTTS (2)	
						26-30	Y		Y		Y	UCTS (5)	
						31-35		Y	Y		Y	MCTS (6)	
7	Bad radiators of heat	9.ii	Reasoning	9	Jul-49	07-Oct	Y		Y		Y	UCTS (4)	
						Nov-14		Y		Y	Y	MTTS (4)	
						15-20	Y			Y	Y	UTTS (6)	UCTS= 1 /4
						21-22		Y		Y	Y	MTTS (2)	UTTS= 2/10
						23-32		Y		Y	Y	MTTS (10)	MTTS= 3/29
						33-36	Y			Y	Y	UTTS (4)	
						37-49		Y		Y	Y	MTTS (13)	

NO Com=Nature of communication, C Cont= Content Contextualization, C Org= Class Organization; U= Unifocal, M= Multifocal, C= Contextual, T= Thematic, TS=Teacher- Student, SS= Student- Student; Text L/F= lent of text based on lines/frequency of occurrences; UCTS= Unifocal-Contextual-Teacher & student, UTTS= Unifocal-thematic-Teacher & student, MCTS=Multifocal-Contextual- Teacher & student, MTTS= Multifocal-Thematic-Teacher & student

communication was slightly intended towards multifocal as compared to unifocal (43/40). The variation across sub categories of talk lies only in the nature of communication. The line based text count results showed slightly in favor of multifocal-thematic-teacher & student. While the text coded frequency based results were equally distributed among unifocal-thematic-teacher & student and multifocal-thematic-teacher & student approaches of talk with the ratio of 5/5.

The concept, 'good radiators of heat' was measured through reasoning based question (9.i) of worksheet. The relevant text was identified in lesson 8 based on 8-35 lines. The text in the mentioned lines was separated according to the codes already allocated. When line wise data coded seven approaches of talk were found at different levels of the text. These approaches were based on subcategories of different dimensions of FACT. In an approach of talk one subcategory from each dimension is included. The same approaches were gathered and found their cumulative degree of occurrence in the text. There were four approaches of talk; unifocal-contextual-teacher & student, unifocal-thematic-teacher & student, multifocal-contextual- teacher & student and multifocal-thematic- teacher & student. The length of text based results showed nature of communication was intended towards multifocal as compared to unifocal 13/9, content was mostly contextual as compared to thematic (14/8) while class organization showed only interaction among teacher and students in both directions. The best approach of talk by length of text used was multifocal-contextual- teacher & student. If we see results based on frequency count of occurrence of a talk pattern, unifocal-contextual-teacher & student and multifocal-contextual- teacher & student were equal in the text with ratio 2/2.

The last concept, "bad radiators of heat" was measured through question (9.ii) in the worksheet. The relevant text identified in lesson 9 based on 7-49 lines. The text in the mentioned lines was identified according to the codes already allocated. When line wise data sorted seven approaches were found at different levels of the text. The approaches of talk were based on subcategories of different dimensions of FACT. In an approach of talk one sub category from each dimension is included. The same approaches were gathered to find their cumulative degree of occurrence in the text. There are three approaches of talk exist in the text; unifocal-contextual-teacher & student, unifocal-thematic-teacher & student and multifocal-thematic- teacher & student. The length of text based results against sub categories of different dimensions showed that nature of communication was intended towards multifocal as compared to unifocal 29/14, content was almost thematic as compared to contextual (39/4) while class organization showed only interaction among teacher and students in both directions. The best approach of talk by both ways; length of text used and the frequency of occurrence of a talk pattern was multifocal-contextual-teacher & student.

Discussion

The approaches used in our classrooms are normally traditional in nature which rarely matched with demanding nature of science subject. The factual knowledge is increased through any kind of interaction but conceptual clarity and knowing rooted cause and rea-

son behind that factual information is actual learning which lacks in our students. The students' active involvement in the classroom activity is vital for construction of knowledge. The space provided by the teachers to participate in the class discussion open opportunities for students to get involve and initiate their thinking process. On the other hand, passiveness of students in the classroom has little chance of students' involvement in the lesson under discussion and in such case this results in no conceptual clarity among students. The students reasoning ability is directly based on their classroom participation which start their thinking process and inculcates reasoning ability (Rocksén, 2015).

The emphasize on developing higher order thinking skills among students is repeatedly highlighted in different education policies but unfortunately it lacks and we have little evidence up to so far. The reason behind can be assumed assessment system which derives our classroom practices. The test based on items directly taken from the content of the relevant text even without changing words encourages students to verbalize the text and reproduce when such items appear in the exam. However, students are scantily capacitated to apply factual information in different contexts. The knowledge through product approach lacks connectivity among the daily life experiences of different events and occurrences. The classroom teaching and interaction is mostly based on covering of content matter in such a way that students might be in a position to get good grades in their assessment. In this study the worksheet used to assess students' achievement was based on reasoning items instead of factual knowledge which demands students' active involvement through invoking cognitive processes. The classroom discussion was challenging and students were get engaged in the process. The approaches emerged during discussion were supportive to develop reasoning ability of the students which is consistent with the study.

The patterns of class talk supportive to develop students reasoning ability were dependent on nature of content under discussion. The nature of communication is intended on both categories; unifocal and multifocal but mainly it is interactive in nature especially when the concept under discussion is related to application and related to students experiences. The novel concepts are mainly discussed by the teacher with little involvement of students as they have little exposure of such concepts. The content contextualization also consists of both categories; contextual and thematic. The talk focuses mainly on themes especially when they were talking new themes and students have no prior knowledge of those concepts. But generally, concepts were discussed by relating them with context and students' prior knowledge and their daily life experiences. The contextual relevance establishes linkage among concepts and student understands the concept accurately. The classroom organization was mainly in the hands of teachers but students also have opportunity to participate in the discussion. Patterns of talk were interactive in nature on the basis of length of occurrence basis but on frequency of occurrence basis results were intended towards non-interactive patterns of talk. Overall, multifocal thematic and teacher student pattern of talk was supportive for development of reasoning ability among students.

The interactive nature of classroom in which student involved and teacher take up her stance from the information shared by the students, encourage them to integrate their prior learning with new concept under discussion (Edwards-Groves, 2018). Such dis-

cussions were very open and sometime beyond the textbook to connect the idea with the daily life experiences of the students because the knowledge is contextualized and embedded in the system and society. But in our schools there is aloofness between classrooms and the daily life experiences. The development of reasoning ability among students is not based on a certain method of instruction but it is teacher dependent. The teachers academic communication skills based on content knowledge and its relatedness to life should be focused. The assessment should be used as a delivery tool intending teacher and students towards development of reasoning skills.

Generally, classroom environment is structured in our schools which create student teacher relationship more structured. There is need to change the trend of students' level of involvement in the classroom which may lead to give place and openness for students participation in the class discussion. This openness will provide encouragement to students to get involved and their thinking process would be initiated. There is need to change the classroom environment, furniture setting should be adjustable in different intended arrangements. There is a need to provide facilities physically required for interactive nature of classrooms. The space should be enough for free movement of the teachers to different groups of the students. Due to these modifications in the classroom organization better understanding of the students can be developed through group discussion. Language should be simple, precise and focused situated in the context and daily life experiences of the students. The delivery of content from the text book is not sufficient for coping reasoning ability without developing connectivity with the context which lies in the daily life experiences. Interactive, contextualized and participative classroom interaction is suggested for developing reasoning ability among students of science concepts.

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