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Linguistic Choices of Interlocutors in the Classroom and Understanding of Science

ABSTRACT

The study was based on classroom interaction to identify linguistic choices among participants to understand concepts of science. Two classes of 7th grade students of a private sector school were observed during classroom teaching of a unit taught in nine sessions. The study employed mix method approach with convergent parallel mix method design. Quantitative data was based on students' conceptual understanding measured through pre-test post-test procedure using a worksheet based on concepts of the unit observed during teaching. The qualitative data was based on classroom audio recordings during teaching of this unit completed in nine sessions, each session was equal to 40 minutes. Paired sample t-test was used to analyze quantitative data while NVivo software was used to analyze text data based on audio recordings. Some significant words, questions words, styles and phrases were identified in the text of classroom interaction followed by productive discussion which enhanced students understanding of science. The findings also highlighted the importance of linguistic choices made during classroom interactions played role in students' participation and their learning opportunity.

Keywords: Classroom Interaction, Linguistic Choices, Students' Understanding, Science Concepts, School Systems, Scaffolding.

Introduction

One of the aims of education is to induct students in the classroom interaction for sharing ideas and construction of knowledge (Mercer, Wegerif & Daves, 1999). It develops precise interactional structures which

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enable students to construct individual and joint reasoning in the classroom (Rojas-Drummond & Mercer, 2003). Students showed great enthusiasm when involved in the classroom activities if properly guided of the process but commonly observed they lack any clear, shared understandings of the purposes of many of the activities they are engaged (Mercer, Wegerif & Daves, 1999). Teacher can encourage students to get involved more in the classroom activities and create opportunity to increase their understanding (Mercer, 1996; Wilson & Spind, 2005). Research supports this notion by indicating three elements of effective teachers; teacher ask question not to test knowledge but to assess the initial level of understanding of the students, not focus on the product (content of the subject) but on process, meaning and purpose through interaction to provide opportunity to the students to explicit their own thought as learning is social, students should provide more vocal role and mutual support (Rojas-Drummond & Mercer, 2003). Socially constructed and connected exchange of ideas in the classroom among interlocutors increase students understanding (factual and reasoning ability) (Atwood et. al., 201; Alvermann, Hynd & Qian, 1995). This will shift role of students as thinkers enabling 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, 2017).

Reasoning is a dialogic activity (Atwood et al., 2010) and its quality is based on quality of dialogue (Wegerif, 1996) which is embedded in a social practice (Wegerif, Mercer &Daves, 1999). The amount of criticism, explanation, justification, clarification and elaboration of an idea discussed in the interactive classroom contributes to the reasoning ability of the students (Wegerif, 1996). In the Spoken Language and New Technology (SLANT) project the outcome specifically typify the way of using language effectively resulted joint, explicit and collaborative reasoning (Mercer, Wegerif & Daves, 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 single perspective. But dialogic discourse was usually followed by authoritative discourse and that authoritative discourse was often followed by a segment of dialogic discourse (2006). Van Boxtel and Roelofs (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 level of co-construction at which these ideas are developed defines the degree of linguistic choices. Consistent with Piaget's ideas on cooperation, Mercer (2000), Mortimer and Scott (2003),

and van Boxtel and Roelofs (2001) have characterized quality talk which displays reasoning. Quality talk is basically linguistic choices made by the interlocutors as a social mode of thinking in the classroom culture and public reasoning (O'Connor & Michaels, 2017).

Mercer, Dawes and Wegerif use language as a tool for development of reasoning ability of students in science and mathematics (2004). Building on the work of Vygotsky's sociocultural theory of intellectual development, language have three critical integrated functions; as a cognitive tool, as a cultural tool and as a pedagogical tools encompassing process of knowledge, sharing among people and providing intellectual guidance (1962). There is an experimental research to evaluate a teaching programme for scaffolding children's effective use of language as a tool for reasoning (Mercer, Wegerif & Daves, 1999). It showed use of language for joint reasoning and highlighted some indicative words; if, because, would and could; some interrogative sentences; what do you think, why do you think that? Do you agree? and phrases; I think etc (Mercer, Dawes & Wegerif, 2004). This study is pre-post group experimental research design based on class discourse. There is a gap to research on exploratory mode of classroom interaction to find conceptual attainment of students against concepts of their science text book content and then explore language used during teaching of those concepts to identify language choices. Literature highlights some precisely used words and phrases for specific outcome which need to be verified particularly in the context of Pakistani schools where no such research is available. However, aim of this study is to uncover, how explicit outcome of any particular interaction might be linked to the linguistic choices of the classroom participants.

It is significant to establish a relationship between linguistic choices made in the classroom and quality of knowledge constructed. As Kitchener (2004) 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). Research highlighted certain type of discussion can contribute to the development of conceptual understanding in science (Howe et. Al, 2000) using language as a reasoning tool and guidance by elder members (Mercer, Dawes & Wegreif, 2004). This concept is relevant to term scaffolding (Wood et al. 1976), guided participation (Rogoff, 1990) and dialogic teaching (Alexander, 2003). Language as a tool evokes thinking through critical questions, sharing information and negotiating decisions collectively which can influence the development of individual reasoning. There is need to make children skillful for using language appropriately as a tool of thinking together. For this purpose, higher order questions are required to stimulate students' critical thinking and reasoning (Gillies, 2014) lacking in our classrooms (Todade, Elsner & Haines, 2013).

Method and Procedure

This research employed *mixed method approach* of inquiry involving and integrating both quantitative and qualitative data and using distinct designs that may involve philosophical assumptions and theoretical frameworks. The core assumption of this form of inquiry is the combination of qualitative and quantitative approaches provides a more complete understanding of a research problem than either approach alone (Creswell, 2014; 2015). Mixed methods research can address a wide range of questions like who, what, where, why, and how within a single study (Frels & Onwuegbuzie, 2013).

Research Design

Mix method approach provides specific direction for procedures in a research design (Denzin & Lincoln, 2011). Within this approach *Convergent parallel mixed methods* is employed as a research design in which the researcher converges or merges quantitative and qualitative data in order to provide a comprehensive analysis of the research problem. In this design, the investigator typically collects both forms of data at roughly the same time and then integrates 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 & 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 completion of teaching the whole unit post test was conducted again.

Participants of the Study

The study was based on classroom observations during teaching of science subject to elementary grade students (VI-VIII). It was decided to visit different school systems which were enough supportive to students participation in the classroom interaction. The purpose and procedure of the study was shared with administration of couple of such schools. After discussions a school was agreed to participate in the study. We mutually decided with school administration that school routine matters would not disturbed by the researchers. The classes will be observed as per schedule given by the school administration. No alteration of any type in schedule, content, class time and duration would be entertained. The school administration signed informed consent to participate in the study.

Selection of a school and class

The school system agreed to participate in the study has international chain with good repute situated in Lahore city. It was an English medium private school (female branch) from grade I to XII. It is affiliated with Cambridge University at O and A levels. The children of educated parents with moderate level of socio-economic background were mainly got admission in this school system. The school was well known for focusing on concept making, providing students' opportunity to share ideas and improving their confidence. 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, age range 11-13 years and female in gender. This was another reason for involving this school as number of students in a class were reasonable to conduct interactive sessions during teaching (Atwood, et. al. 2010).

Grade VII class was selected for observation due to low exam pressure being internal exams for this grade. Exams of 5^{th}, 8^{th} and 10^{th} grade levels were conducted by the external bodies and classroom practices were consequently derived by 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 knowledge rather than reasoning. This factual state restricted the choice of selection of class for researchers.

Selection of a teacher and subject

A teacher practised more interactive approach during classroom teaching was involved in the study to observe her during teaching. We got consent of the teacher to participate in the study for a period of three weeks. 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 as to have relevant information to answer the research questions (Patton, 2015).

The teacher was a qualified science teacher 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. 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 significant in nature and played a vital role in fulfilling needs and demands of our daily life. Keeping in view the both perspectives, researcher had decided to conduct study on the subject of Science.

Methods

The classroom observation was a key purpose to capture interaction to explore linguistic choices contributes in students understanding of science concepts. A forthcoming unit from science text book, 'Transmission of Heat' was selected to observe during teaching. The unit was taught in nine sessions which were audio recorded. The degree of conceptual gain was gauged through pre-test before teaching of unit and then post-test after completion of the unit. 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 this study

Classroom observation

Researcher came to know on meeting with science teacher that next unit is, 'Transmission of Heat'. Teacher discussed plan of teaching this unit in nine lessons in three weeks time. Researcher handed over a device to the teacher and explained its usage. She was asked to record her own voice couple of times in front of researchers and improve her skill of using the device. Teacher got the device on when entered in the classroom and got it off when class was over. In this way we have nine files of classroom interaction as teacher has completed the unit in nine sessions.

Transcription of data

Data was transcribed and ensured appropriateness 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 as given in figure 1.

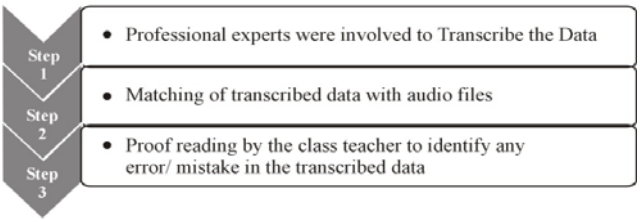


Figure 1: Steps taken for transcription of classroom interaction

A Conceptual Worksheet

A conceptual worksheet (content free) was prepared and applied as pre-test and post-test procedure to measure the conceptual understanding (gain) of the students across the concepts included in selected unit. 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 of understanding two types of items were included in the work sheets; factual and reasoning. The factual questions have short answer or even one word answer in some cases but some time followed by sub-questions based on reasoning to get the actual understanding of the student about the concept involved in the item. But most of the reasoning items were constructed on separate constructs to get the embedded 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 measure difference of understanding owing to classroom interaction by comparing means of achievement scores against these work sheets. The tests were conducted in the prescribed period allocated for the science subject. Therefore, the limitation of time factor was considered during the test development. There were 9 main questions followed by 12 sub questions. It was ensured that the students were able to finish the test in a 40 minutes time. Detailed summary of test is given in table 1.

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

Sr.#	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*	*00*	22 45
		E	23				23

Description of Worksheet

This unit was the first unit of second term from physics section of science text book. The worksheet was based on twenty one items (7 factual & 14 reasoning) to measure factual knowledge as well as 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 was get finalized in the light of above mentioned points followed by consultation of language expert. Description of worksheet is given in table 2.

Procedure and Analysis

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 audio recorded. After completion of unit same worksheet was again applied to capture students understanding after instruction of the unit. The teacher was same and after transaction of both classes shared with the teacher to select one. In this way nine files were get finalized for analysis. Pared sample t-test was used to measure mean difference in achievement scores ((Dimiter & Philip, 2003)). NVivo software was used to analyze text data (Jones, 2007). The transcribed data went through iterative process of extensive reading.

Ethical Consideration

All participants of the study were treated with respect (Creswell, 2008). Informed consent was sought from school administration, teacher and students. The school administration concerns like no involvement in the class, no alteration in time, schedule and content were considered. It was assured that data will be only used for research purpose. The purpose, scope, and time duration of the research was shared with the teacher.

Results

Quantitative data obtained in the form of Pre-test and Post-test was analyzed through paired sample t-test and presented below separately on factual and reasoning based items.

Factual Items

Table 3 showed comparison between pre-test and post-test achievement scores on factual items. There was a no significant difference in pre-test and post test achievement scores on factual items. But it is pertinent to mention that the achievement scores at post test are higher than the scores at pre-test on 7 pairs (87%) while the result for one item at sr. 4 remains the same in pre-test = 2 and post-test = 2, mean difference is 0 and t-value and significance could not be calculated and however excluded from the table.

Table 3: Comparison of Pre-test and Post-test achievement scores of Students on factual items

S	Pairs	Mean X1	Mean X2	Df.	t-value	Sig.
1	Pre-test Q1i - Post test Q1i	1.60	1.69	44	-.573	.570
2	Pre-test Q2i - Post test Q2i	1.87	1.91	44	.573	.570
3	Pre-test Q4ii-1- Post test Q4ii-1	1.18	1.28	44	.416	.413
5	Pre-test Q4iii1.i- Post test Q4iii1.i	.71	.89	44	-1.159	.253
6	Pre-test Q4iii2.i- Post test Q4iii2.i	.76	.80	44	-.256	.800
7	Pre-test Q4iii3.i- Post test Q4iii3.i	.84	.98	44	-.724	.473

N = 45, **p < 0.01

Figure 2 showed comparison of pre-test and post-test scores across students

on factual items. The zigzag lines showed real data while linear lines showed the trend of the scores. It is visible that the post test scores are slightly higher than the pre-test scores from sr. 1-45 but gradually decreased. If we see real score then (47%) students get more scores in post-test as compared to their pre-test, 13 students (29 %) have no difference in achievement scores either test was taken before or after instruction, while 11 students (24%) have reverse results and their achievement scores are decreased after instruction of the unit.

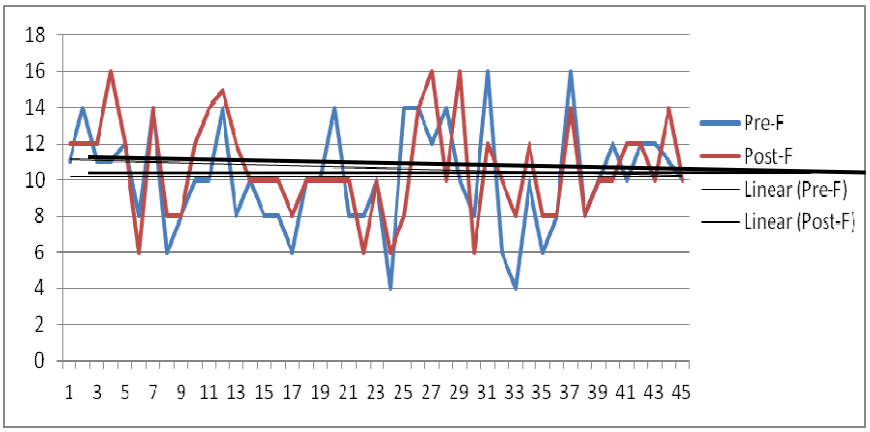


Figure 2: Comparison of pre-test and post-test achievement scores on factual items

Reasoning items

Table 4 showed the comparison of 14 reasoning based items to assess conceptual understanding of the students in pre-test and post test. There was a significant difference on 8 out of 14 pairs (57%) in pre-test and post test achievement scores while the scores on 6 pairs (43%) have no significant mean difference in the achievement scores before and after instruction. The achievement scores of post test are higher than the achievement scores in relative pre-test, where significant differences were not found.

Table 4: *Comparison of Pre-test and Post-test scores of Students on reasoning items*

Pairs			Mean X1	Mean X2	df	t-value	Sig.
Q1_ii_pre_R	-	Q1_ii_post_R	1.38	1.69	44	-1.735	.090
Q2_ii_pre_R	-	Q2_ii_post_R	1.56	1.91	44	-2.701	.010*
Q3_i_pre_R	-	Q3_i_post_R	1.40	1.64	44	-1.857	.070
Q4_ii_2_pre_R	-	Q4_ii_2_post_R	1.87	1.96	44	-1.000	.323
Q4_iii_1_ii_pre_R	-	Q4_iii_1_ii_post_R	.67	.89	44	-1.530	.133
Q4_iii_2_ii_pre_R	-	Q4_iii_2_ii_post_R	.71	.80	44	-.496	.623
Q4_iii_3_ii_pre_R	-	Q4_iii_3_ii_post_R	.76	.98	44	-1.301	.200
Q5_pre_R	-	Q5_post_R	.33	1.47	44	-8.055	.000***
Q6_i_Pre_R	-	Q6_i_Post_R	1.27	1.71	44	-4.304	.000***
Q6_ii_Pre_R	-	Q6_ii_Post_R	1.53	1.82	44	-2.666	.011*
Q7_Pre_R	-	Q7_Post_R	1.20	1.91	44	-6.563	.000***
Q8_Pre_R	-	Q8_Post_R	.89	1.67	44	-5.955	.000***
Q9_i_Pre_R	-	Q9_i_Post_R	1.18	1.64	44	-.724	.007**
Q9_ii_Pre_R	-	Q9_ii_Post_R	.91	1.73	44	-5.891	.000***

N = 45, ***p < 0.001, **p < 0.01, *p < 0.05

The comparison of pre-test and post-test achievement scores on reasoning items is shown through figure 3. The zigzag lines showed real score of individual student in pre-test and post-test while linear lines are showing trend of scores. Forty four students (98%) got more scores in post-test as compare to relative pre-test, only one student (2%) has no difference in her both achievement scores. Overall in reasoning based items students obtained more scores in post-test as compared to their relative pre-test. We can see trend lines of pre-test and post test achievement scores on reasoning based items against student range (1-45). Line graph clearly shows that the achievement scores of all students on post test are higher than their relative pre-test. The mean difference in individual students' achievement scores (almost 5 marks) is evident from the trend lines indicating pre-test and post test scores.

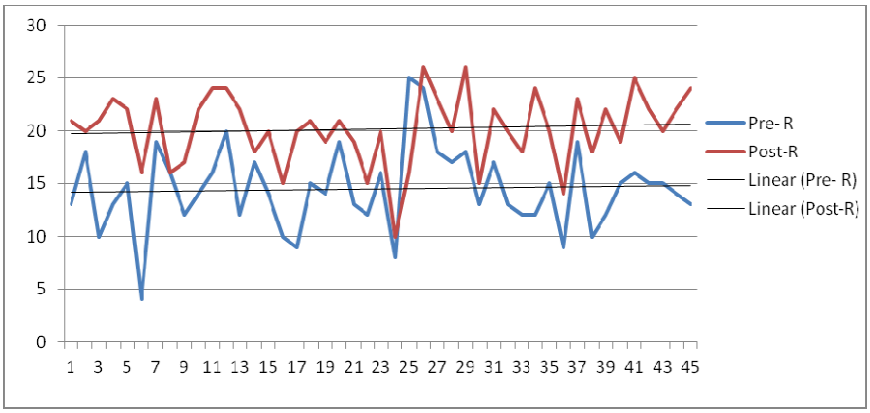


Figure 3: Comparison of pre-test and post-test achievement scores on factual items

Qualitative Results

Table 5 showed detail of classroom teaching based on 9 sessions in which session 2-3 were audio recorded in the same file and transcribed altogether also. Sessions were interactive in nature but teacher turn taking is at large as compare to students. Lesson wise turn taking detail, number of pages of transcribed data, total number of rows and words in each lesson are given in table 5. Initial sessions were long comparatively while last two sessions were extra brief and short.

Table 5: Comparison of Pre-test and Post-test achievement scores of Students on factual items

Sr.	Sessions	Teachers Turns	Students Turns	Pages	Rows	Words
1	Lesson 1	43	33	8	178	1952
2	Lesson 2-3	62	44	15	399	3576
3	Lesson 4	59	43	13	291	3383
4	Lesson 5	20	14	9	184	2411
5	Lesson 6	75	44	16	369	4457
6	Lesson 7	23	24	5	117	1186
7	Lesson 8	13	10	2	42	359
8	Lesson 9	7	4	3	49	535

The aim of research to identify linguistic choices contribute in students understanding during classroom interaction were taken into account through concepts in which there was significant difference in pre-test and post-test scores (table 3 & 4). Significant difference in pre and post tests was

found mainly in concepts asked through reasoning based items. Text was identified from classroom interaction related to concepts having significant difference in sessions 2-3, 4, 6, 7, 8 and 9 from transcribed data. The relevant excerpts from these sessions were selected for analysis to see nature of language used.

The selected text was analyzed word by word using iterative process to find linguistic choices of participants caused discussion and contribute towards students' understanding. After multiple readings of transcribed text some words most commonly used within this text followed by an extended discussion were identified. The evidence from the literature and frequency of occurrences of these words followed by extended discussion of the participants were also considered. These are some words, question words and some certain styles of language used. It includes, "if, because, but", "why, what" and "little information followed by a question, knowledge of facts with solid reasons and contextual examples". There is presented an example from the text with little explanation about these linguistic choices. The text is extracted from the transcription of lesson (2-3), lines 31-74 in which a concept was discussed having significant difference at pre-test and post-test achievement scores.

Example from the Text

Concept 1: Application of good conductor from lesson 2-3, lines reference (31-74)

Teacher: Different objects or different materials conduct heat differently, Ok, you see that there are some objects become hot very quickly and some take time to become hot.

Student: Like steel

Teacher: Ok, steal is a metal, **if** you put a **table of iron or table of wood** in sunlight then after 2 hours **if** you touch both these tables, **will there be any difference in temperature.**

Student: Yes.

Teacher: **What?**

What will be that?

Student: Iron table will be more hot.

Teacher: Ok.

Student: Iron is hot than wood.

Teacher: **Why** iron is more hot than wood?

Teacher: So it means metal is good conductor so steel table or iron table becomes much more hotter than the wooden table.

So, it means different material conduct heat differently, they both are at the same temperature in the environment **but** still the amount of heat absorbed by them is different. The absorbed amount of heat from the environment or from the sun is different, after equal time interval. **If** you are giving them the same time like 1 to 2 hours they will be having different temperature so it means the amount of heat

absorbed by both of them is different. **Clear?**
Teacher: Now, **why** they both are absorbing different amount of heat, **because?**
Student: Iron table is made of metal so it becomes hot quickly.
Teacher: So it means you can say that metal is a good conductor as compared to wood. Now, **why** metal is a good conductor, **because** the particles in metal are absorbing heat and transferring to the other **but** they also have some helping hands in them and those are free electrons so it means the metals are always good conductor **because** of free electrons. Particles transfer heat from one to the other end, plus there are some free electrons which are also transferring heat from one end to other end that's **why** we can say that metals are good conductors of heat **because** they have free electron in it. Metals are best conductor, good conductor, they are always at the top of the list of conductivity.
Student: **Please repeat this.**
Teacher: Metal are good conductor **because** they have free electron in them, so particles are transferring heat energy plus free electron are also transferring heat, energy
Student: **Why** do they have free electron?
Teacher: **Have** you studied atomic structure?
Student: Yes. **What** is atomic structure?
Student: Protons and neutrons in the nucleus are in the orbits.
Teacher: Electrons are in the orbital's ok now there are always some electrons which are free to move in other orbital in metals.
So all metals are good conductors **because** particles are transferring heat energy plus there are some free electrons which are transferring heat energy as well.

Analysis of the Text

In the first line teacher provides information about conduction of heat which depends upon nature of the material. She explains further by taking students in account that you know about variation in time taken by the different objects to become hot. Students acknowledge and respond in the form of an uttering name of an element (steel). In this way, she involved the students in the construct under discussion and gets the response of the student. It is evident from the text of the lesson that teacher discusses the concept with the help of daily life simple and contextual examples which are well known to the students. She has given a simple and easy example of two tables made up of different materials (iron and wood) by putting them in the sun for some time. Then she raised a question; there would be any difference in their temperature after some time? Her strategy to provide little contextual information followed by a question by using very simple and well known objects to everybody engaged the students in the discussion. Because when students able to respond the simple query, resultantly their confidence and motivation level increased and they deeply engaged in the lesson (Mercer, 2008). In the given example students' respond positively but in single word reply. She does not leave the

point on getting one word true response but continued and asked again, *what?* Followed by, *what will be that?* Actually she wants to seek answer in more descriptive form to know the actual background knowledge of the students about the concept. She confirmed not only their knowledge but tried to explore actual embedded understanding of the concept through seeking reasoning behind this difference. She elaborated the point by extending students' given information in which the word, *"if", "but"* clarified the concept in a better way. She concluded the point and confirmed from students' about it, *"clear"* before going ahead. On assuring that students are familiar with the concept she asked a question again, *why* they both are not absorbing equal heat, *"because"?* Actually she is asserting on the point to know the level of understanding of the students. On students' response teacher explains it in detail by using words, *"why" and "because"* frequently to make the concept clear to the students and they might understand it with justifiable reason. In line 65, students asked for repetition of the idea to the teacher showed interactive class with flexibility to interrupt the teacher during the session. She explains the concept of absorption of heat with the help of different material objects by using a new term, free electron, and students' raised question about it. At this, she did not repeat the idea but heading the class through question towards a relevant concept which is known to them. By developing connectivity between the relevant concepts already known to the students' and they recognized that concept and feel ease to comprehend the new term. Then she asked a question about that known concept which is relevant to this one. When student respond, she picked up relevant piece of information from their response and accomplished the unknown concept to the student by using precise linguistic choices (initiators).

It is evident from this example that teacher is just playing role of *a facilitator by moving direction* of the class towards relevant phenomena which is very simple in nature and *match with the daily life experience* of the students. They recognized the idea relevant to their context and easily moved towards the concept which is new and creating hurdles for them to understand. Teacher seemed to be just *scaffolding* the student on some certain points where they are needed. The approach adopted by the teacher was process oriented and encouraging students to move along through deep involvement to understand the concept under discussion (Felder & Brent, 2005).

Table 6 showed excerpts from classroom interaction synthesized on commonalities related to concepts which have significant difference in pre-test and post-test achievement scores of the students. These excerpts are some part quoted as precedence showing linguistic choices not complete interaction. These are some words, question words, some certain phrases and teaching styles. Two excerpts for each are given as example with indication of linguistic choices in bold. The excerpts are taken from the sessions like at the top in the table; excerpts from sessions 4 and 7 with line references 55-81 and 76-105 respectively. The excerpts are continuous interaction displayed during the discussion of these concepts. The words, *'if, but and because'* and question words like, *'why, what and which'* are contributing in generating discussions and consequently improving reasoning ability of the students. *Concrete contextual examples* from the *daily experience of students* like; *tables made of iron and wood* putting in the sun and *thermos flask* are very *common*. These are taken from lessons 2-3 and 9 with line references 31-43 and 21-33 respectively. A phrase is also identified, *'what do you think'* supportive to understanding of the students. There is a style; teacher just introduces a concept with incomplete information followed by a question which is very common and productive for students' understanding. This little information provides stimuli and initiative to get engaged in the activity in hand and developed understanding of the concept.

Cluster analysis of classroom interaction of nine sessions was run with minimum length of three and maximum occurring 50 words shown in Figure 4 in NVivo software. Text (words) presented through balls with different colors and sizes. Size of ball presenting a word, is basically frequency of occurrence of that word during classroom sessions and color shows context of occurrence. As words: you, convection and water (red); teacher, *because* and heat (cream); *how,* refrigerator and high (light green) are in same colors shown context of occurrence.

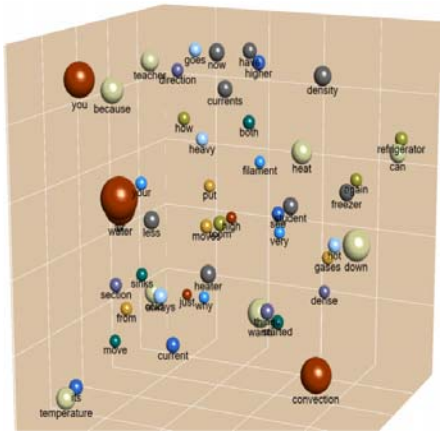
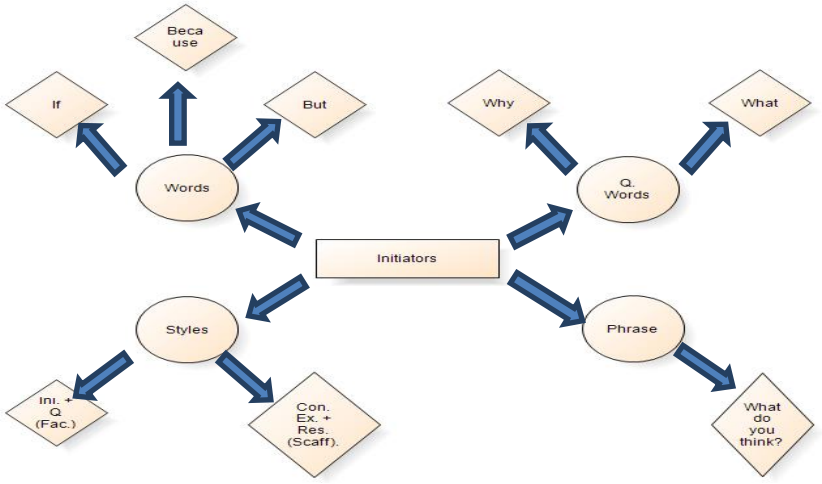


Figure 4: cluster analysis of classroom interaction of sessions 1-9

Finally, linguistic choices contributed to students understanding are some words, 'if, but and because' questions words, 'why and what' and some styles (initiation with little piece of information of daily life followed by a question and then playing role of a facilitator by the teacher), (concrete examples with reasoning and role of teacher to provide scaffolding where needed) and a phrase 'what do you think'. The linguistic choices are presented in model 1 to get them visible and easy to understand. The model is generated in the software NVivo 9 manually.

Model 1: Linguistic choices (initiators) increased understanding of science



Ini. + Q (Fac.) = Initiate with little but contextual information followed by a question and play role of facilitator Con. Ex.+ Res. (Scaff.) = Concrete examples with solid reasoning, teacher role just to scaffold where needed

Conclusion and Discussion

Science subject is very demanding and majority of the students faced difficulty to understand it in the traditional classrooms through knowledge transmission approaches. The study explicitly showed use of language made if precisely and carefully play a key role in developing understanding of science concepts in the classroom. Basically, meaning are making through words and if choice of words accurately made during classroom interaction then students involved and starts their thinking process (Thompson, 2006). The learning process is dynamic and demands active

involvement of students in the activity to share their point of view and develop shared understanding of concepts under discussion (Eison, 2010). The classrooms with little involvement or no involvement of students in the activities leave no room for students to think and can hardly construct any understanding for them (Park, 2005).

This empirical study found some linguistic choices which stimuli students to get participate and involve in discussion deeply and developed conceptual understanding. There was a significant difference in 8/14 (57%) reasoning based items which supports use of language choice made by the interlocutors caused development of students understanding. On the other hand, in factual items there is no significant difference showed meaningful implications for classroom interaction to ponder and devise a strategy which best suits and can contribute in developing understanding of the students. The implications for teaching of information based concepts through flat language without involving students did not challenge the cognitive zone of students. Ultimately, they try to memorize information, which remains intact in the short term memory for a while and then fade away after some time. Science concepts are not to memorize only but to digest with proper involvement of students cognitively in the process which can be initiated through precise and proper language choices.

The research aim to identify certain initiators to establish discussion and get the students involved and consequently increased their understanding of the concepts was examined. The text was analyzed and some words, question words, phrases and styles were identified. These were, 'if, because and but', 'why, what', 'I think, what do you think, you agree' and 'authentic questions followed by continuous clarifications and playing role by the teacher of a facilitator, concrete and daily life experienced examples and scaffolding the students where they needed'. The teacher's style to establish connectivity among known and unknown concepts seem to be powerful strategy to get them understand of the new concepts (da-Luz, 2015).

The words identified as initiators put assertion on the concept by explicating the embedded genre behind the idea and provide background rationale of the concept. The word, 'if' conditioned the state of a narration on a particular level and distinguished it from the most relevant but different concepts which create ambiguities in the minds of the students and they felt difficulty to cope the idea in a real sense. The second word, 'because' clarifies the concept by disclosing proper cause behind the phenomena to be like that which justify the students un-equilibrium state of mind and resultantly they got understanding of the concept. The word, 'but' built up further clarifications about the understanding they attained from the interaction in the classroom.

The questioning words played key role in understanding of concepts

abstract in nature. Especially, when an idea is initiated by the teacher followed by a question, on having response from the students follow up clarifications are persuaded by the teacher mostly started with the word 'why'. Through this strategy the actual background knowledge of the fact and its application through reasoning is asked which strengthen the concepts in the minds of the students. The word, 'what' when we used for interrogatory purpose, also plays a role in understanding of the students by exploring the myth of the concept in the minds of the students. The assertive and precise language, interrogatory words are supportive to develop reasoning ability of the student very common in the classroom among interlocutors (Wu, Tseng & Greenan, 2003).

The phrases, 'I think', 'what do you think' and 'I agree' are also playing role in developing understanding of the students. The phrases have some embedded features which attract involvement of the students and encourage them to think about the concept under discussion. The students ponder over the idea and indulged in the discussion deeply to give their point of view about the concept. When teacher asked the students to give your opinion about a concept then definitely they had to be deeply involved and think about that to utter something relevant to the concept. On having opinion, teacher kept their point and asked further clarifications based on their response. These clarifications and responses built up good debate among the participants. Teacher played role of a facilitator and kept the sequence of interaction in line with to meet the objectives of session. She seemed to be scaffolding the students where they needed. The daily life socio-contextual examples given by the teacher facilitate them to understand the concepts even they were difficult and innovative in nature.

It is *recommended* that the use of these words, questions words, phrases and styles should be increased during classroom teaching especially science subject. These initiators trigger teachers and students for deep thinking of the construct in hand. The asserting words are very important and play key role in establishing discussion and developing students' reasoning ability. Without deep involvement in the discussion passive learners just hear information of the concepts which remains in the memory for a short term and faded after a while. Deep involvement of the students in the lesson only can establish discussion mandatory for their understanding. However, there is need to initiate training of science teachers for precise and clear usage of language choices in the classroom during teaching.

This study showed that constructive classroom interaction open avenues for students engagement contributive to deep understanding. The information through verbal communication and transmission mode is not demanding to involve students required for teaching of abstracts science concepts. The science concepts demand linkage from known to unknown

in a logical way. Therefore, classroom interaction among participants should be based on socio-contextual perspective integrating students experience and it would be more beneficial for development of students' understanding (Wegerif, Mercer & Dawes, 1999; Zander, 2003; Scott, 1998).

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