STUDENTS DISCOURSE IN A SCIENCE CLASS ROOM; MAKES BETTER LEARNING: A DIFFERENT APPROACH

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Abstract
        Being a class room teacher in rural areas for more than two decade's author has observed that rural area learners are suffering from multi faced learning barriers.
        Conceptual understanding and reasoning capacity is very poor and they are performing poorly in their school based examinations.
        Aim of this paper is to present a suitable, cost effective and result oriented method that can help to impart better science education to the rural learners who are otherwise underprivileged.

Keywords: Rural learners, Effective Science Education, Learning Barriers', Concept and reasoning

Learning Barrier an important factor
        Basic problem of present day science education is non availability of students in university science curriculum. There is a huge shortfall in the skilled workforce pertaining to the STEM related field. A report (Lewin & Naidoo, 1998) suggests that "Less than 0.5% of South African students achieve university entrance qualifications in science and mathematics". In 2006 less than 29% of all admitted students to higher education were in SET (science, engineering, & technology) field (Scott, yeld, & Hendry, 2007). During 2005 it was 19% (Scott, yeld, & Hendry, 2007). The improvement from 19% in 2005 to 29% in 2006 is still un-impressive. An overall participation rate in the higher education system (Scott, yeld, & Hendry, 2007) is only 16%. This means that out of all youths of age group 20-24 present in the country only 16% of them are entering to the higher education system. Again only 12% of these participating populations are the black South Africans. Author would like to rephrase this "Black South Africans" as rural or native "South Africans" because by virtue of the earlier non democratic regime these native South Africans were concentrated in the rural hubs. This implies that out of every hundred youths of age group 20-24 in

the country only two Rural South African youths are going for higher education. The same report also indicates the shortage of high-level skills. Present democratic government is rightly stressing the need to aim of developing high level of knowledge and skills for all learners (National Curriculum Statement; Policy Document 2006, published by the Department of Education). A report (SAT MONITOR, 2010) published by the Solidarity Research Institute shows out of a total of 12881 medical doctors only 3691 are black South Africans. It is less than 35% of the total registered medical doctors. The same SAT Monitor report-2010 shows the presence of 5203 (16.7%) black Chartered Accountant in a total of 31160 Chartered Accountants. A five year cohort study 2000-2004 (Scott, yeld, & Hendry, 2007) shows that 45% of all enrolled students left the university without completing their courses. Only 38% could complete their courses in scheduled five years time. Majority of the population, who could complete their courses in stipulated time, are from the community who do not belong to the previously disadvantaged black community. On the other hand majority of the present youth community are from the previously disadvantaged community. Dropout rate (Scott, yeld, & Hendry, 2007)for all technical institutes (include all technikons) is a whopping 66%. Completion rate by the black students is less than 30% for all courses under the said cohort study. Even school final result (Grade 12 school leaving examination) is also alarming. A result analysis statement released (sent to schools-2011) by the Department of Education, Khulangwane Circuit (A rural area circuit in the district), Ehlangeni District, Mpumalanga province shows that the average pass rate in Physical Sciences is a mere 50% for the period 2008-2010. We need to agree that these "Rural South Africans" form a major portion of countries population. There is a need to empower this major part of the population to enable them to take part in the countries development effectively. The reasons for this failure by the learners in general are the learning barriers prevalent on the learners. Learners are not acquainted with the basics of science and mathematics.

Rural learners in current set up are burdened with multiple barriers. Few of these are cited for my reader's.

Performances of a group of 289 learners from three different schools were assessed by this author. Grade ten students were asked to write the number "two thousand thirty four" in numerical. This question was the part of a mathematical test set by the school district authority in 2012 June examination. One hundred and thirty seven learners failed to write the same correctly. This is almost 47% of the population. Students are supposed to acquire this particular numerical skill at their grade 6 or 7.

Learners do not have basic mathematical skill that is required to study and learn science and related subjects.

Regarding writing skill; copy of a grade eight learners' from a class of 2013 is presented in fig. 1.

Fig. 1

Many a learners do not have the skill of writing and expressing in the language that is used as the language of instruction in the class room.

Lack of proper skills also develops other related learning barriers. Even though attitude cannot be considered as a learning skill but, a negative attitude towards learning can also be considered as an effective learning barrier. Negative attitude towards learning is always observed in the rural schools (fig. 2 & fig. 3).
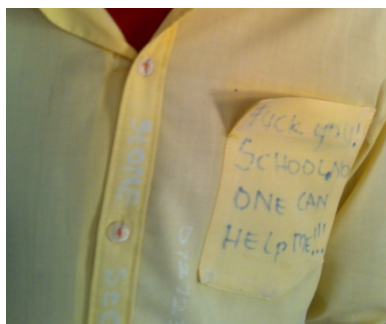

Fig. 2   Fig. 3

Use of abusive words towards teachers and school is rampant in rural schools. Sleeping in the classroom, disrespecting the word of teacher is very often found in the class. Hooliganism, destroying school properties is common in rural schools. These all together attribute towards a negative attitude and hence a great barrier towards proper learning. Along with these; rural schools are also running short of resources and facilities to impart training to the disadvantaged learners. Author himself being a student from deep rural set up has experienced them all in his personal life. Poverty and lack of knowledge walks hand in hand. To eliminate poverty youths are needed to be induced with proper teaching-learning activities. Developing

interest among the learners is one very important part of a teachers' activity for imparting better education and this can only happen when teaching is learner centered and actively is learners oriented.

As a teacher from a rural set up I am presenting my attempt in alleviating the future of these rural learners.

Learning barriers that are most prevalent in our rural schools are summarized for our sincere attention.

1. Overcrowded classrooms
2. Misinformed or less informed learners
3. Lack of reasoning ability amongst the learners
4. Poor information processing ability of the learners
5. Poor reading and writing skill in the learners
6. Lack of facilities and fund to the schools and educators

Effective learning; A review

Learning is greatly influenced by the previous knowledge of the learner(Asubel, 1968). This knowledge may come from information written in books, experiences from life situation or a statement from others. It is important for a teacher to identify these previous knowledge / pre-concepts and manipulate it effectively in favor of proper conceptual learning. In many occasions it is observed that, the concept held by the learners about the topic is different than it is supposed to be. It is suggested that(Edgar, 1990), it should be the duty of the teacher to find out the logic of the students' misunderstandings. Research has shown that a learner's prior knowledge (preconceptions) often confounds an educator's best efforts to deliver ideas accurately (Roschelle, 1995). Knowing learner's prior knowledge helps the teacher, to find out what is to be negatively reinforced and which is to be positively reinforced for developing proper conceptual understanding and creating an effective learning environment. A teacher must understand the fact that teaching is a continuous process of de-learning and re-learning. There is a state of dynamic equilibrium in which the wrong concepts are removed and a new and correct concept is established. A teacher cannot be an effective teacher without knowing the students pre-conceptions. These pre-conceptions of a student may be a misconceptions or alternate conception which could be a major hindrance in future learning and proper conceptual development. Hence it is always important to de-learn the misconceptions and re-learn the proper conceptions. Teacher can make teaching effective, only when s/he has a clear view of the learners' previous knowledge. Few well researched and effective options on how to determine pre-concepts are discussed and compared with the back ground of rural schools.

Strategies for learning
Concept Maps:

Scholars have shown that, Concept Mapping is useful in determining students' mental state of conceptual understanding and developing a proper conceptual understanding. Process of using concept mapping may be considered as an effective teaching method (Chowdhury, 1993); (Novak & Heinze-Fry, 1990); (Novak & Gowin, Learning How to Learn, 1984)to impart better conceptual development and hence a better learning. A good number of articles are published on the advantages of Concept Mapping in (CMC – Vol. 1, 2004) the proceedings of First International Conference on Concept Mapping (Editors: Canas, Novak, & Gonzalez, 2004). Unfortunately,several high school teachers interviewed by this author during the period of 1991 - 2005 in India always avoided the idea of using concept mapping in their classes. Also as a working classroom teacher in schools this author has never seen any high school teacher to use Concept Mapping in the classrooms. Use of concept mapping in UK secondary schools are also not wide spread (Kinchin, 2001). According to this author main factors that are responsible for non popularity of concept mapping amongst the school teachers are:

1.   Classroom Size:

Most important barrier in using Concept Mapping is the class-room size. Classes of fifty plus students demand a lot of extra time from the part of a teacher who wants to involve the students in making concept maps. Rural teachers are so over loaded with classes that they rarely have any time to spare during school hours. After collecting the maps, drawn by the students; teacher needs to study and analyze the work of each individual students. Simply making of few maps by the students really does not help them to improve their conceptual level. Author (Chowdhury, 1993)has observed that post map discussion makes a long lasting impact on students' learning but, hindrance is the time for conducting post implementation study and analysis of concept maps produced by the individual learners. Most part of the time of a teacher is spent in the class-room, which makes it difficult for a teacher to study and analyze the concept maps created by the individual students.

2.   Teacher training:

Another important factor is expertise of teachers. Quite a number of teachers are not competent to analyze and explain the concept maps drawn by the learners effectively.

Student Interviews

Other method of finding pre-concept is the study of students' response by interviewing the students. Interview techniques(Hackling & Garnet, 1985);(Osoborne & Gilbert, 1980); used by these authors are again

individual centric and a large sample size is a time consuming process and pose a strong barrier for the large rural classes. A regular high school teacher is not adequately equipped to use interview method on a daily basis.

Tests

Other methods are multiple choice tests (Treagust, 1988); (Linke & Venz, 1979)and diagnostic test (Banerjee, 1993); Combination of diagnostic and multiple choice tests (Chowdhury P. (., 1993). These methods are very often used by different teachers in their classes, mainly to determine the post effect of teaching-learning process. But they are rarely used to determine pre-knowledge. Teachers use these tools as a part of their formal test materials. In order to use these tools effectively for pre-concept determination, teachers need standardized test materials for every topic to be taught. Rural area teachers mostly suffer from the lack of standard test materials. Oversized classes with overloaded work effectively stop the teachers to prepare a standard test material. In many a cases schools even avoid to help the educators to collect standardized test materials from reputed sources because it comes with a cost. It becomes an economic burden on the part of a teacher to collect standardized test materials. On the other hand better from the worst is always expected from the teachers.

A possible solution

Now we need to understand that no single pedagogic tool is adoptable in a rural classroom situation in its togetherness. But we need a viable solution of our teaching learning problem. Learning is a process of interaction between More Knowledge Others and Zone of Proximal Development (Vygotsky, 1978). A teacher is the only MKO available to the rural learners. Learning is a mediated relation between individuals and knowledge (Bussi, Corny, & Mariani, 2012). Teaching and learning of sciences always involve semiotics and semantics. Author hereby suggests a semantic mediation for learners' involvement and hence creating a positive learning attitude. As a high school teacher we need to be innovative and imaginative. It is a very important question: "why some students succeed in science, while so many others find it impossibly difficult and frustrating(Lemke, 1990)?" This is a real time challenge for rural teachers. There are enough indication of (Ong & Ruthven, 2010) ineffectiveness of note giving and copying. Unfortunately most of our rural classrooms are still engaged in the process of note writing and answer copying (fig. 4). Students are busy copying answers from a previous question paper as answers are written on the chalk board by the teacher.

Fig. 4

Learning is a process consisting of both constructivist and information processing (Stott & Hobden, 2010). It is established that talking in a class enhances learning(Borde, 2007). Language is a system of resources for making meanings and our language gives us semantic (Lemke, 1990). Author strongly believes that language is the main accelerator of information processing. Aksela, while working with microcomputer-based laboratory inquiry; strongly suggested(Aksela, 2011) that peer interaction (students' talking) provide necessary positive and supportive environments for higher-order thinking, encouraging students' thought and discourse in chemistry.

On the other hand several researchers also have doubted that the talk; which takes place when children are asked to work together. Talks may be uncooperative, off-task, inequitable and ultimately unproductive ((Galton, Hargreaves, & Pell, 2009); (Wegerif & Scrimshaw, 1997)). The same also has been observed by this author. There are also some students those who definitely follow the instructions. It is (Alder & Bapoo, 2002)argued that "learners have to be initiated into specific way of talking".

Author argues that talking in a specific way does help to improve learners working memories. Also it develops learners thinking and hence reasoning ability. All together students discourse may develop better concept and enhance performance level. This is also supported by Aksela(Aksela, 2011).

Author also suggests use of students' talk may effectively overcome the deficiency of resources. Interactions in between a lesson with the students and posing very short questions based on the important concepts taught can effectively help a teacher to determine the state of cognitive development of the learners. This method, if used with deliberate effort and planning can effectively determine the level of conceptual understanding of the learners at any stage of learning process. These also effectively involve students in scientific talking and improve their reasoning ability. Size of working memory(Stott & Hobden, 2010) is the limiting factor in learning and thinking. The process of making students to talk can effectively help students to overcome the barrier of low working memory. This goes in

congruence of Mercers' (Mercer, Dawes, Wegerif, & Sams, 2003) (Mercer & Wegerif, 1999) argument of talking as an important tool for social thinking. Thinking can effectively improve the working memory. Conversations allow learners and the teacher to consider, question and add to each other's thinking ((Borde, 2007). Over all it makes learning an interactive and student centric process. Mercer (Mercer, Dawes, Wegerif, & Sams, 2003) (Mercer & Wegerif, 1999) quotes Vygotsky; suggesting that language plays a very important role in learning.
They are:

   i)   As a cognitive tool which, children come to use to process knowledge.

   ii)   As a socio cultural tool that, children use for sharing their knowledge.

   iii)   As a pedagogic tool which, teacher use to provide intellectual guidance.

      Language makes its highest contribution towards the cognitive development. Researchers ((Mercer, Dawes, Wegerif, & Sams, 2003); (Mercer & Wegerif, 1999); (Bruner, 1990); (Rogoff, 1990)) have also suggested that children's' talk help in promoting children's thinking. "Both the information processing model and social constructivist theory must be considered when examining learning in the 21st century"(Gabel, 1999).

      The method of involving guided discourse obeys the norm of the social constructivist theory very effectively while engaging students in a meaningful discourse. Most importantly, it provides complete freedom to the teacher in operational term. It is strongly suggested that the method (discourse in classroom), if used on a regular basis, it is going to improve the performance of the learners.

Method adopted and put forward by the author

      The above discussions suggest that language plays an important role in developing students' understanding and conceptual development. Hence it is of importance in the class. A classroom teacher needs to make use of language effectively to make the students to learn. Students discourse in a controlled environment is an important pedagogic tool to develop students understanding and hence improve their performance. Author designed and implemented a specific way of controlled classroom discourse where students are activated to discuss and answer the posed questions during the course of teaching-learning process.

      In order to use this method effectively in the classroom, a teacher needs to make certain planning and preparation. An overall step wise planning as used by the author is presented below.

1. Identify the main concepts that are required to understand the topic to be taught.

2. Set few short questions on the identified concepts.

3. Instruct the students to make a group of them as and where they are seated.

4. Take few minutes time before the start of a topic and pose the pre decided questions to the class. Instruct the students to answer after discussing in their respective group.

5. Write all the responses given by the students on the chalk board.

6. Encourage the students to identify (talk) the correct response with reasoning.

7. Analyze and give response to address the knowledge gap.

8. Make the process repetitive for progressing through topic to topic.

Immediate after the responses are collected from different students it become important for the teacher to provide immediate explanations. This stage is detrimental in the conceptual learning process. Teachers need to target the wrong responses and explain in detail why these responses are wrong. This process of de-learning ultimately facilitates re-learning of proper concept. Author argues that, it is important for a teacher to teach about the correct response but; it is more important for a teacher to teach about the wrong responses that should be avoided at all time of learning. Awareness about the wrong approach will make the learners more conscious and help in an effective learning.

The same is applicable while progressing with a topic. Teachers need to pre-identify the basic concepts and come prepared with required questions that they may ask during the progression of a topic.

Study of semantic mediation in a classroom
Context

Before we proceed further it will be proper to look into the students' environmental background that in particular pertaining to the learning barrier.

Sl. no.	Barriers of learning for the students'
1	Most of the learners have no motivation. They have no idea for why do they come to school.
2	Learners are taught in a language (English) that is different from their home language. They are resistive and shy to speak in the classroom. Some time they do talk when code switching takes place.
3	Back ground knowledge of the learners are far below of the required average.
4	There is no learning environment for most of the learners outside the school campus.
5	There is no technology available to make learning attractive or that can develop

	curiosity amongst the learners.
6	Science and technology concepts are seemingly alien and abstract to the learners.
7	High density of new and abstract concepts in the science and technology texts.
8	New and unknown environment in terms of semantics and semiotics used in science and technology classrooms.

Sample for the study

During the year 2011 author was assigned to teach grade ten Physical sciences. A group of 77 students from grade ten were taught by the author and as a class room teacher author was at liberty to use his own methodology of teaching. Students were taught throughout the year using this method. One point was consciously implemented by the author. During the whole process of teaching learning activities no old question papers were given to the learners along with the answers to practice. Not even before the final year ending examination. Their performances were judged on the basis of their performances in the tests administered by the district education authority and other required activities as assigned by the department.

Without personifying the students their attitude and activities were noted by the author and at the end of the term performances of the learners were recorded.

Score of the learners

Term	Number of Students Scoring Below 30%	Number of Students Scoring Above 30%	Number of Students Scoring Above 40%	Number of Students Scoring Above 50%	Number of Students Scoring Above 60%
First Quarter	74	3	0	0	0
Second Quarter	-	-	-	-	-
Third Quarter	-	-	-	-	-
Fourth Quarter	24	29	4	13	7

Analysis of the said performance

Grade10 Physical Sciences No. of Students 77	Students Attitude	Participation	Performance	Comments
First Quarter	Students are resistive to speak and also resist taking part in the classroom discourse. They demand notes and question answers.	Only four students participate in the process of classroom discourse.	Only three pass and they are from the four who took part in discussion. They scored only a mere 30% marks.	95% of the students show very poor performance. Resentment is felt amongst the students about the non conventional method of teaching.
Second Quarter	Half of the students are still resistive to the activities. They feel that they are over loaded with work because teacher is not providing old question answers to learn.	Participation increases. Participation is passive rather than to be active.	Performance in the tasks given improves	
Third Quarter	Non participating students stop disturbing the class.	Students show interest in discussing answers more frequently to the posed questions. They sit together to discuss and find answers of given tasks. But some are still busy copying answers from their peers.	Students show more confidence to solve posed tasks. Performs better	
Fourth Quarter	Classroom is well controlled	Non participants fail to improve their performance	31% of students fail to pass. 26% of the students score 50% or more	Fail percentage decreases and also more than 25% of the students show above average performance.

Comments

An increase in the pass rate from 4% to 70% is an encouraging factor of this study. The process not only helped the learners in developing better understanding of science it also reflected in their performance. This process of learning made the learners self dependant rather than becoming a note and answer based parasite. About 8% of the students scored more than 60% in their final assessment. It means that the method could help the serious students to achieve a good understanding of the science concepts and hence improves their performance level.

Students were never given the old questions and answers to copy as prevailing in the current system. Neither any notes were provided to the class in the form of question and answer. This was consciously done to avoid a chance of the intervention result being masked by the existing methodology of teaching. This method of determining pre-concept of students and then involving them towards a meaningful discourse does not require any extra investment in terms of money and time. No extra stationary or equipments are needed. Even the lowest resourced school can adopt it. It is highly suitable for the under privileged schools. It makes a teacher more innovative and creative. Teachers need not to specialize on methodology or tools to use in this system. This method can be used effectively at any part of teaching learning process to identify the knowledge gap, if any. Most importantly; learners get a chance to be involved actively in the teaching-learning process. This method is highly student centered. This method could be very effective in a rural school system where teachers are suffering from resource crunch and over loaded class-rooms. It is effective in proper concept development and hence towards an effective learning. Author hereby suggests to the academics to try to implement the method in their classes to find the effectiveness of the claim made by this author.

Annexure
How the talks are prepared:
(An example)

Topic: "Atomic Model"

Instead of talking atom, students are asked to answer "What is a model?" Students make several types of noise. But, no one comes out with an answer. Suddenly one of the boy answers "the girls seen in pictures and posters are models". As a subject teacher this author asks, why these girls are shown in pictures / posters. Discussion proceeds and lesson progress through the year in a similar manner for different topics.

Models

Serial Number	Questions posed by the teacher	Expected Response from the students	Teachers' Activity	Teachers' Response
1.	Talk about a model. (An open ended statement to start a discussion) // What is a model? (A straight forward question)	Students may come out with the idea of Models walking in a model show, Models in a product advertisement, Models of a Housing Building etc.	As the students tell different names teacher needs to write the same over the writing board.	
2.	Why we need these models? What is the role of these models?	As felt by the students different responses may be expected	Different responses are noted	At this stage teacher needs to identify the need of MODELS to study the scientific properties and inform the students about the uses of models / theories in sciences.

Introduction of the "Atomic Model"

Activity

1.   "Take a piece of chalk and start breaking it". "Where you come up to a point where you may not hold it any more to write". Chalk is a compound made by Ca, C, and O_2. We may get a single of $CaCO_3$.

a)   How small is the single $CaCO_3$?

b)   Can we see a single $CaCO_3$?

2.   "Take a piece of Wood Charcoal". This is an element (inform the students) known as Carbon. Start breaking it as small as possible. Get to the level of getting fine powder from the charcoal.

a)   If we get a single C element, how does it look? (please note the answers given by the students)

b)   Do you think that the single C and the single $CaCO_3$ will be looking the same? (please note the answers given by the students)

3.   Now explain to the class that smallest part of an element and a compound are not the same thing.

4.   Ask the students to discuss in their group and write at least FOUR SENTENCES on atoms and molecules.

Develop your own questions and activities according the topic you are planning to teach.

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