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Conceptual Metaphor for Teaching and Learning of Prime and Composite Numbers at Primary Grades

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Abstract: Metaphor is a conceptual mapping from one domain to another. It helps student to understand abstract and unfamiliar mathematical content knowledge through their everyday experiences, familiar and concrete objects. The subject of prime and composite number is a very important part of school mathematics curriculum at basic level. Different teachers use several metaphors to assist students' learning and encourage them to understand abstract ideas and concepts of numbers. The main objective of this paper is to provide a glimpse of teaching abstract mathematical content of prime and composite numbers through different conceptual metaphor based on constructivist approaches for teaching and learning. Action research was adopted with three level of interventions, followed and corrected depending on observations and reflections. Different interventions regarding the student experiences and everyday activities were used to communicate the concepts of prime and composite numbers. The color metaphor was applied as the first intervention. Then the area metaphor was applied as the second intervention and finally the teacher used colorful rainbow factore metaphor to analyze the change and improvement in classroom practice of teachers. The pre-class and post class interview with teachers and students were taken. From the classroom observation and interview, it was found that conceptual metaphors used by the teachers in the classroom contributed for the improvement of students' understanding of the concepts.

Keywords: Action research, Composite numbers, Conceptual metaphor, Prime numbers, ZPD

Introduction

Student and teacher consider mathematics as one of the difficult subjects in school. One of the reason of taking mathematics as a difficult subject is not taking account of the out-of-school mathematical knowledge into formal mathematics curriculum. The abstract concepts can be made more meaningful by connecting learners' real-life situations. The different physical apparatus and metaphors mediated to learn abstract mathematical concepts. In this vein, Bonotto (2007) viewed that the extensive use of cultural artefacts makes school mathematics more meaningful. The cultural artefacts and concrete materials introduced into mathematics classroom help in the process of knowledge construction. It is learnt that learners' experiences and knowledge regarding mathematics can help to understand school mathematics. The mathematical ideas and knowledge occurred in out-of-school environment can enable teacher to communicate abstract concepts of school mathematics to students. The out-of-school knowledge of the students can help to understand the mathematical ideas and concepts in learning formal mathematics in cultural friendly environments. The tools for allowing us to connect students everyday practices and experience to formal mathematics is the metaphors.

Metaphors provide as a powerful tool to understand one domain of knowledge in terms of another. The conceptual metaphors help to deal with relatively unfamiliar and more abstract domains of experience in a familiar and tangible way. Metaphor simply means the representation of abstract entities through very simple, familiar and meaningful objects. It can be taken as a mapping that the abstract ideas map into concrete, strong and meaningful images that were developed in different social and cultural context for a different purpose. Thus, metaphors help to understand abstract ideas by mapping them into strong, meaningful images that were originally developed in a different context. English (1997) sees metaphors as tools for creating formal concepts out of image schemas, and of restructuring these concepts in complex ways. Lakoff and Nunez (2000) also argue that the conceptual metaphor's "primary function is to allow us to reason about relatively abstract

domains using the inferential structure of relatively concrete domains," (p. 42) with structures of image schemas preserved by this mapping. Thus, metaphor can be considered as a mechanism for connecting two types of knowledge of which the new knowledge is comprehended through already existed familiar concepts.

The conceptual metaphors are tools with which connects students out-of-school environmental activities to understand school mathematics. The out of school mathematical ideas, knowledge, process and practices can be connected to teach and learn school mathematics. The mathematical ideas and knowledge that are practising in the out-of-school environment of children everyday activities can facilitates to understand school mathematics (Pradhan, 2018). The use of conceptual metaphors as a pedagogical tool could help to mathematical knowledge transformation and distribution in classroom teaching. Thus, the conceptual metaphor connects different target concepts through their relationships in the common source domain. Orey and Rosa (2006) argue that it is important to acknowledge contributions of diverse cultural groups who invent mathematical object to understand and solve problem in varied contexts. So, it is urgent to link academic mathematics and student experiences that become central ingredients in the teaching and learning of mathematics.

Research Questıons

The purpose of this study was to explore the contribution of conceptual metaphors in the process of teaching and learning of prime and composite numbers at the basic level of education. To achieve this objective, I have set up the following research questions:

- How conceptual metaphors help for the teaching and learning of mathematical concepts at the basic level of education?
- What effects do conceptual metaphors on teaching and learning of prime and composite numbers at primary grades?

Understanding Conceptual Metaphor

Lakoff and Nunez (2000) define metaphor as a conceptual mapping from one domain to the other. Regarding the metaphorical thought, Lakoff and Nunez (2000, p.5) explain: "…human beings conceptualize abstract concepts in concrete terms, using ideas and modes of reasoning grounded in the sensory-motor system. The mechanism by which the abstract is comprehended in terms of the concrete is called conceptual metaphor". Thus, the conceptual metaphors play a major role for the understanding of abstract mathematical ideas. In this regards, Lakoff and Nunez (2000) created three types of conceptual metaphors and they are known as grounding metaphors, linking metaphors and extraneous metaphors. The grounding metaphors allow us to ground our understanding of mathematical ideas in based on everyday experience. For instance, the abstract mathematical idea of addition as putting things into piles/ bag or adding things to a collection, subtraction as taking things away from a collection, sets as containers, members of a set as objects in a container. Linking metaphors allow us to link one branch of mathematics to other branches of mathematics. For example, the metaphor "Numbers is a point on a Line" links arithmetic to geometry. Thus the linking metaphors allows to conceptualize the ideas of arithmetic in terms of geometry.

Lakoff and Nunez (2000) discussed another type of metaphor called extraneous metaphors. According to them "…extraneous metaphor or metaphors that have nothing whatever to do with either the grounding of mathematics or the structure of mathematics itself. Unfortunately, the term metaphor when applied to mathematics has mostly referred to such extraneous metaphors" (p. 53). The staircase is an example of extraneous metaphor of the "step function" because when graphed the step function can look similar to a staircase. Likewise, "Function is a machine" is a metaphor. The source domain of this metaphor is "machine" and the target domain is the mathematical concept of "functions". The image of staircase has nothing whatever to do with either the inherent content of the grounding of the mathematics, although the visual is a helpful reminder of how this function would look when graphed (Lakoff & Nunez, 2000). Extraneous metaphors can be eliminated without any substantive change in the conceptual structure of mathematics, whereas eliminating grounding or linking metaphors would make much of the conceptual content of mathematics disappear.

Lakoff and Nunez (2000) claim that "Metaphors are an essential part of mathematical thought, not just auxiliary mechanisms used for visualization or ease of understanding" (p.6). Barton (2005) uses boats as a metaphor for mathematics. He claims that different boats can be used for different purposes, the fishing boat can go to rocky places where the ferry cannot navigate and the ferry can travel under conditions too hard for the fishing boat. "It

is the same world, but it is a different understanding. Neither is the truth" (p. 100). The metaphors have two important role. First one is to contribute for the development of mathematical content knowledge. The defining theme of the interaction perspective (Ortony, 1993) is that metaphors play a constitutive role in creating new knowing. Metaphors are not just connecting old ideas in new ways, but changing both source and target ideas. Sometime as time passed the source domain may detach from the target domain. For instance, 'kite' was concrete device to conceptualize the geometrical quadrilateral but it has now become the name of this quadrilateral. This poses the question of what happens when a metaphor becomes a mathematical concept (Parzysz, Pesci, & Bergsten, 2005). Secondly, it is a tool for the understanding of one thing in terms of another. Thus, metaphor contribute as the pedagogical knowledge for the understanding of abstract concepts of mathematics. Consider the metaphors that "Numbers are points on line". The conceptions of numbers are not geometrical. The number line is one of the fundamental concepts in different branches of mathematics. Fyhn (2007) viewed that patterns in snow are examples of linking metaphors. Fyhn further maintained that "Some Sami mittens have the pattern grouse footprints on their edges. These repeating patterns show a connection between embodied experiences and ornamentation. Ski trails as well as animal footprints perform patterns in the snow, patterns with different symmetry properties" (p. 246).

From the study of the various literature on metaphors, I have come to know that metaphors contribute in the process of teaching and learning of mathematics. It was observed that many of the researchers who studied metaphors argue that all of our thinking is fundamentally metaphorical: "the way we think, what we experience and what we do every day is very much a matter of metaphor" (Lakoff & Johnson, 1980, p. 3) even though metaphor may remain largely unnoticed. Metaphors are used not only for communication purposes but also can be considered as thinking devices intended for teaching and learning abstract mathematical ideas.

In this study, I took Lakoff and Nunez conceptual metaphors as the working definition of metaphors, which enable to support mathematics teaching and learning. In this vein, Bonotto (2007) viewed that the extensive use of cultural artefacts makes school mathematics more meaningful. For him, the cultural artefacts, introduced into mathematics classroom are concrete materials, which children typically meet in real life situations. Those concrete materials can be the suitable tools to transfer from one domain to another domain of knowledge. In this paper, I used physical apparatus like different colors, geoboard and other instructional materials that mediated the teaching and learning of the abstract concepts of prime and composite numbers.

Framework of the Study

Our learning is intimately associated with our connection with other human beings, our teachers, our peers, our family as well as casual acquaintances. The term Zone of Proximal Development (ZPD) is probably one of the most widely recognized and well-known ideas associated with Vygotsky's scientific production. The common conception of the ZPD presupposes an interaction on a task between a more competent person and a less competent person, such that the less competent person becomes independently proficient at what was initially a jointly accomplished task (Chaiklin, 2003). Vygotsky's notion of ZPD is a crucial precept which is central to all of social constructivist learning theory. The ZPD was described by Vygotsky (1978) as

> The Zone of Proximal Development is the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers (p. 86).

Appropriate and timely interventions in the course of learning within an individual's ZPD has become an essential strategy for teachers. Understanding mathematical ideas, concepts and knowledge is socio-cultural activities. With this regards, van Harmelen (2008) viewed that the social constructivism has a central precept that knowledge is created by learners as a result of social interaction. Thus, the social constructivist believes that the knowledge is social product and the learning is a social process (Pritchard and Woollard, 2010). The lessons

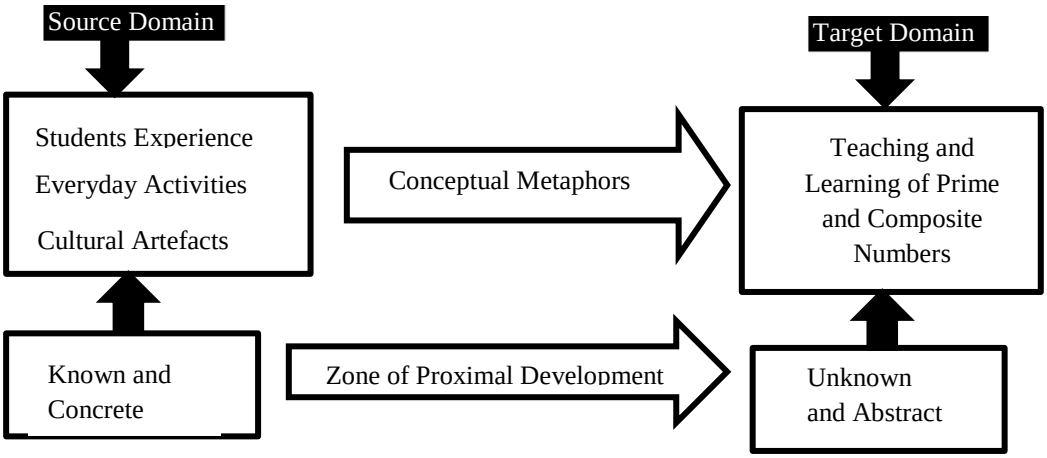

Figure 1. Theoretical framework of the study

were implemented in a student-centred approach to creating a learning environment in which students were encouraged to construct their knowledge through interactions with the cultural environment, community/ peers, the researcher and the regular classroom teacher. In this framework, cultural artefacts were used as a metaphor to communicate abstract ideas of prime and composite numbers.

The figure 1 indicates that the meaningful mathematics teaching and learning provide the means for connecting two conceptual domains. This framework is based on the theory of conceptual metaphor that indicates the connection between source domain and the target domain for meaningful mathematics teaching and learning (Pradhan, 2018). The source domain is the students' experience, everyday activities, and different cultural artefacts regarding mathematical ideas, concepts and knowledge embedded in their out-of-school context. The connection of these concepts and ideas in the teaching and learning to enhance school mathematics is target domain (learning objectives) of the conceptual metaphor theory.

In this framework, different primary colors, mixing of two or more colors, area of rectangle, and factors of the numbers were the source domain which mediate teaching and learning of abstract concepts of prime and composite numbers (target domain). The contextualization of school mathematics that enables them to successfully accomplish the rewarding task of facilitating their students' learning. The understanding of learners' culture, their everyday activities and experiences not only enables teachers to gain a greater understanding of their students, but provides rich material to incorporate into classroom learning activities (Stringer, Christensen, & Baldwin, 2010). It also provides an opportunity to teachers learn to understand their students in a richly meaningful way, and in the process develop relationships that enable them to accomplish their work more effectively. The students participated in the construction of mathematical knowledge through activity. In this framework, students were encouraged to investigate different mathematical ideas based on their experience and everyday practices (Pradhan, 2018). The interactions with cultural activities and with peers are important aspects of this framework.

Methods and Procedures

The main objective of my study was to analyze the contributions of conceptual metaphors in the process of teaching and learning of school mathematics. The particular paradigm I adopted to conduct my research was interpretative which assumes a relativist ontology, a subjective epistemology and a naturalistic set of methodological procedures (Denzin and Lincoln, 2005). The term interpretative research refers to a set of approaches where the central research interest is the meaning that humans give to their experiences and social interactions. Interpretative research involves long-term participation in a field setting and careful recording and collecting of data. This is followed by reflection and writing using rich description, narrative descriptions and direct quotations (Erickson, 1986). The contribution of cultural metaphors in the process of teaching and learning of school mathematics was analyzed through the collaborative action research. The effective change in

the practices in teaching and learning of school mathematics and improving students understanding on the concepts were gather from the model of collaborative action research model (Somekh, 2006).

I developed detailed plan to conduct Teacher Facilitation Program (TFP) to acquaint about the knowledge of conceptual metaphors for the teaching and learning of school mathematics. Thus, my intention to conduct the TFP was to provide the answer of questions of the teachers' participants based on What are the conceptual metaphors? How cultural metaphors plays the important role to communicate abstract mathematical ideas? How the cultural metaphors incorporate to in the process of teaching and learning of school mathematics at the basic level of education? After conducting two day's teacher facilitation program, I provided the open-ended questions and blank sheet to write the perceptions and their reflections on TFP. Only 15 out of 22 participants provided me their written reflection about the TFP. About seven teacher participants were not interested to write their views and they did not provide me the written sheets. I collected the reflection notes of fifteen participants of two day's TFP and analyzed their written documents with the collaboration of my research supervisors. I took oral interview to the same fifteen teachers. The teachers who had keen on conceptual metaphors and practices on mathematics classroom was selected. The only six teachers were ready to participate and committed for the collaborative action research.

I provided the information sheet and explained orally about the purpose, nature and possible effect of the study to fifteen participants to gain access for collaborative action research. The nature of the data collection instrument and their rights and responsibilities as participants have been explained to them, individual consent was obtained from six participants included in the study. The researcher convinced them to safeguard the confidentiality of collected data and the privacy of each participant as well.

Selectıon of Teaching Unit and Conceptual Metaphors

During the teacher training cum workshop programme, in our Collaborative Action Research (CAR) project, we had listed out some mathematical concepts that were comparatively difficult for the teachers to teach in the classroom. Among the teacher participant, Pooja and Deepa (pseudo name used) both asked about the way of teaching prime and composite number in an easier method rather than definition method they are using since long.

I put this issue in the group of CAR project. Then for the teaching of prime and composite number, we discussed about the method of teaching in the group of many teachers.Is definition method only permissible in the teaching of prime and composite number? If not true, what other ways there may exist in course of teaching this concept? And as result, we arrived at a conclusion that different metaphors can be used in the teaching to make it simpler and effective. And the metaphors could be "Sieve of Erathosness", Color Metaphor, Area Metaphor and so on. Then, Deepa mentioned that she would use the area metaphor and Pooja would use colour metaphor and "Sieve of Erathosness" in the future class of prime and composite numbers.

The mathematical ideas and practices in out-of-school culture and possible to connect school mathematics were explored. To assess the effectiveness of the conceptual metaphor, the mathematics lessons were developed to teach the concepts of prime and composite numbers at grade four. The cultural artefacts the geoboard, chart board materials regarding mathematical ideas are considered as the source domain for the teaching and learning abstract concepts of mathematics at the basic level of education. The lesson was developed and based on constructivist design. The students were encouraged to investigate the mathematical relations in activity based instruction design.

Metaphors for Teaching-Learning of Prime and Composite Numbers

There are different metaphors to communicate the ideas of prime and composite numbers. My teacher participants use three metaphors such as color metaphor, area metaphor and rainbow factor metaphor to conceptualize prime and composite numbers.

First Intervention: Color Metaphor

The traditional colour theory states that there are three types of primary colours. These are the colours of red, yellow and blue. The primary colour is that colour which cannot be created by any combination of other colours.

They are the colour equivalents of mathematical prime numbers. Like prime numbers, the basic three colours cannot be reduced to more fundamental colours. They form the building blocks of all other colours. Color is one of the common metaphor that can help to conceptualize the concepts of prime numbers and composite numbers. Then we together developed the lesson plan according to constructivist teaching framework. Deepa had prepared a chart board as shown in the figure. The figure represents a Venn-diagram showing the intersections of three primary color sets; Red, Yellow, and Blue. The chart was put in the flannel board and explained about the formation of different colors when the primary colors were mixed with each other. Then the whole class was divided into four small interactive groups each of eight members. Each group was provided with a color pad with three primary colors; Red (R), Blue (B) and Yellow (Y) and a blank painting sheet. They were asked for mixing the colors R+B, R+Y, B+Y and R+B+Y.

Image 1. Colors in Venn diagram

Image 2. Displaying the composite colors

After few minute for the task, she asked each group to share their result with the whole class. Then, Deepa asked the students if all of them got the same outcome as per discussed before. All the students had the reply of having the same outcome as per her teaching of the formation of those colors. Then she concluded that the color mixing can be compared with the prime and composite numbers. She further described the prime numbers as those primary colors which are not a mixture of any other colors, and the colors like orange, grey, green and violet formed as a mixture of more than a color were compared to the composite number. After this discussion, the teacher then encouraged to write the definition of prime and composite numbers.

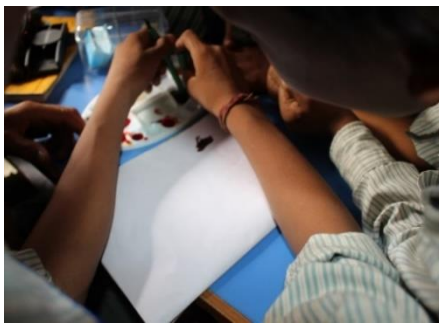

Image 3. Students participations in the learning process

After some time, the teacher gave an opportunity to each group leader to share their definition with the whole class. Encompassing all the concepts, prime number can be defined as a number which has just a factor, itself other than the factor 1. For further clarification, the prime number can be considered as a primary color, a unique item. For instance, if we take yellow color, then its mixing item, if considered as the factor, is just single color i.e. yellow is an independent item with a single factor concluding that yellow is a prime color. Likewise, composite number can be defined as a number which has two or more factors other than the factor 1. For further illustration, composite color can be directly connected with the secondary colors composed of two or more color items. For instance, if we take orange color, then its mixing items if considered as the factors are of 2 colors i.e. two factor concluding that orange is a composite color. At the end of the classroom, I asked the students near to me:

Researcher: Students, what did you find about today's class? Was it interesting?
Students: Yes. Today's class was the most interesting class till date.
Researcher: What made you feel that interesting about today's class?
Students: Madam, brought so many interesting items like colors and charts. This really made us feel fantastic about the class today.
Researcher: Did not she brought those items before in the class?

Students: Actually, not sir. Mam, always used to teach textbook directly and solve the problems from the exercise.
Researcher: Did she made you to solve some of those problems or not?
Students: Yes. She made us to do that.

Seeing that keen participation of the students in today's class, I could find that the teacher had never used this way of teaching approach till now. She always used chalk and talk methods during her teaching.

Researcher: Did you enjoy in learning the concepts?
Student: The class was the really enjoyable and interesting today. We learnt those bookish concepts with a simultaneous playing as if those were games. This class will be really memorable for us.
Researcher: That's good. Thank you for your compliments.

Studnets enjoyed to play with the colors. The color metaphor help to conceptualize the meaning of prime and composite numbers to most of the students. But some studnets not clearly understand the concepts and then she used another metaphor know as Area Metaphor.

Second Intervention: Area Metaphor

Area is one of the common metaphor that can help to conceptualize the concepts of Prime numbers and composite numbers. The area can be visualized as the small square unit in the geoboard. It is one of the common visual instructional material for the teaching and learning of mathematical concepts. It is equally important to teach prime and composite numbers. Then we together developed the lesson plan according to constructivist teaching framework. The whole class was divided into five small interact groups of members six. Each group was provided with a geoboard and rubber bands of different colours. Each groups were assigned with two numbers, one prime and other non-prime(Composite). For example; the numbers 5 and 6 are given to group A, the numbers 7 and 8 are given to another group B and so on. Each group has requested to form possible rectangular plot with the help of rubber bands in the geoboard. After few minutes to discuss within the group, she asked each group's reporter to share their answer with the whole class.

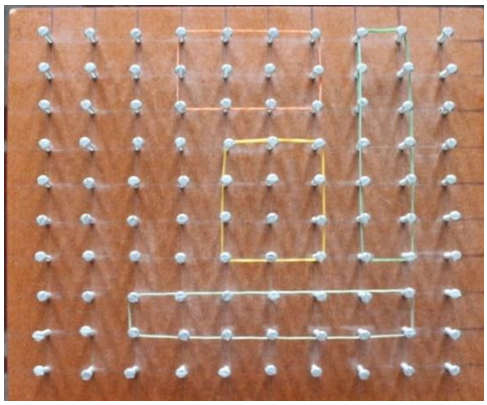

Image 4. Artefacts showing the rectangular area

Deepa: Are you finished with your task?
Reporter of each group replied yes madam.
Deepa: Good, my children. If so, please tell your answer to the class turn by turn.
Students: Okay madam.
Deepa: At first, who is the reporter of Group A?
Reporter of Group A: Yes, madam, me Rohan.
Deepa: Its okay. Please tell me your numbers in task.
Rohan: We have two numbers 5 and 6, madam.
Deepa: Then now tell me how many possible rectangles did you get for the number 5 and 6?
Rohan: Madam, for 5 we could make only 2 rectangular plots but for 6 we could make 4 rectangular plots.
Deepa: What were the sizes of rectangle you could prepare?
Rohan: We could prepare 1×5 and 5×1 in case of 5 and 1×6, 2×3, 3×2 and 6×1 in case of 6 Madam.
Deepa: Okay sit down! Can other group tell me if any other sizes of rectangular be made for 5 and 6?
Groups: Madam, Rohan is probably correct.
Deepa: That's good. Now one of you from group B, stand up!
Reporter of Group B: Yes Miss.
Deepa: So, Sharwin. Talk about the same in your task.
Sharwin: Yes, Madam. We had 7 and 12 as two numbers given to us and we found that there were only 2 for 7 and 6 rectangular plots for 12.
Deepa: And Group C and D. Which numbers did you get with just 2 rectangular plots?

Reporter from Group C: Madam, among 3 and 8, 3 had just two rectangular plots.
Reporter from Group D: And Miss, out of 2 and 9, 2 had just two rectangular plots.
Then, Deepa enlisted those numbers having only 2 rectangular plots in board as said by her students.

Then she asked if there were other numbers that could have similar result. And she concluded that these numbers can be called as prime numbers and the numbers that can have more than 2 rectangular plots can be called as composite numbers.

Image 5. Students are exploring mathematical relations

Then she asked her students if they could write the definition of prime numbers and composite numbers. Then comprising the answers from her students she modified it and wrote it as: A prime number is a natural number that is greater than 1 and has only two factors i.e. 1 and itself. Then she gave some examples to check whether the numbers were prime or composite.

From the observation of her classroom activities and the discussion with her, I have come to conclude that the area metaphors really contribute to the teaching and learning of prime and composite numbers. The connection of students' familiar context made to teach the school mathematics can make the regular mathematics class very interesting, and meaningful. The constructivist teaching approach provides the classroom activities more interactive and participatory. The students engages in symbolic play to explore the sources to understand the target (Chiu, 2000). Children involved in collaborative task and engages in finding the areas of given numbers and this activities mediated to connect the target domain. They conceptualized the concepts of prime and composite numbers in connection to the areas of rectangle seems to be effective in the process of knowledge construction.

Third Intervention: Rainbow Factor Metaphor

For teaching prime and composite numbers, she used the colorful rainbow factor metaphor for the better understanding. She further mentioned that; For a prime number, there would be only two factors "I and Me factor metaphor" which means 1 and itself. For a composite number, she created another beautiful colorful rainbow factor metaphor "I, Me and My factor metaphor" suggesting 1, itself and all other factors of the number in a colored rainbow pattern.

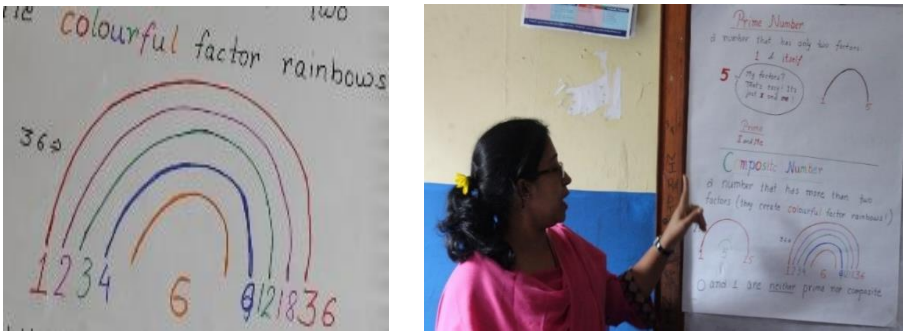

Image 6. Rainbow factors metaphor for teaching of prime and composite

For example, in case of a number 36, it has the factors 1,2,3,4,6,9,12,18 and 36. Then she gave some examples to check whether the numbers were prime or composite.

Then the bell rang and we jointly came out of the class. Then I asked her about how she felt about today's class. She replied the class to be very interesting, participatory and as a whole meaningful. Regarding the effectiveness of incorporation of cultural artefacts in the classroom teaching, she speaks:

> I have been teaching for 10 years, and I always had to think about the class to be a successful class during the time of teaching prime and composite numbers as I really felt difficult to express its essence. I directly used to give definition to the students and instantly jumped to the exercises. This was rather easier for me to end up the class but still I did not found any interest both in me to teach this and in the face of students to learn it. But today after the use of metaphors in teaching of prime and composite numbers I felt really gratified during the teaching of this prime and composite numbers in fact after 10 years of my teaching.

From the interaction to her, metaphor plays significant role in the process of knowledge construction. The cultural artefacts facilitates students to develop the mathematical relation and helps to understand the concepts of prime and composite number. Metaphors contribute to the teaching and learning of abstract concept of mathematics. The connection of students' familiar context made to teach the school mathematics can make the regular mathematics class very interesting, and meaningful.

With the interaction with Deepa, I found that there is a need of providing workshop and training to the teachers of mathematics. She was heartly convinced about the contribution of the metaphors in the teaching and learning of abstract concept of mathematics. Mathematics is not so abstract concepts. It can be made concrete by connecting it to the familiar contexts of the students. The connection of students' familiar context to the school mathematics can make the regular mathematics class very interesting, and meaningful. There are different metaphor for teaching and learning of abstract concepts of mathematics. But the teachers of matheamtics should know the students household activities to contextualize the school mathematics.

After the class, I asked about the effectiveness of cultural artefacts in the process of learning with the group member of each group. The reporter of group A viewed that

> This class seems very interesting. We are working collaboratively. This is providing us the opportunity in learning together. The collaborative learning situations and group discussions enhance the level of confidence.

From the above view of student participants, I have come to conclude that the constructivist learning situations encourages in learning mathematics. The collaborative work provides ample opportunities for social interaction and self-expression. They also make their students develop a sense of their active roles as producers not only consumers of knowledge. The learning pedagogy that was used denied the rote and memorization of the definition of prime and composite numbers. The member of another group views that:

> We are having a real fun today. We are learning mathematical concepts just like by playing games. We feel this learning environment to be perhaps student friendly. Our teacher is providing us a great opportunity to work in a group. In fact, the cultural artefacts provides us to understand more mathematical concepts.

From the conversation, I have come to realize that mathematics teacher need to provide opportunity to students for active participation in learning process. Playing games is common to everyone. Games has some sort of rules, procedures and structure, as in the mathematics. The incorporation of games and puzzles play important role to achieve aesthetic sprit of mathematics and to increase mathematical creativity and curiosity. The above mentioned conversation is good evidence that the cultural artefacts mediated for the construction of mathematical ideas and enhance the level of students understanding.

The "Area is Numbers" metaphors link the area of rectangle and the prime and composite numbers. The use of geoboard can be the suitable tools to transfer the concepts of prime and composite numbers and convey the "Area is Numbers" metaphor. The prime and composite numbers can be conceptualized through the different cultural artefacts. The above mentioned conversation is good evidence that the cultural artefacts mediated for the construction of mathematical ideas and enhance the level of students understanding. From the observation in student group work, I have come to see that the more capable student facilitates to learn the prime and composite numbers by manipulating the physical artefacts geoboard and link between area of rectangle to the

prime and composite numbers. This was how the concepts of ZPD in the socio-cultural theory of Vygotsky comprehends the teaching and learning in socio-cultural context.

Mathematics teacher need to provide opportunity to students for active participation in learning process. The student friendly learning environment and project based instructional pedagogy encourages them to construct mathematical meaning. From the observation of students group work while they were engaged to solve mathematical problem, I have agreed with the line of van Harmelen (2008) who argued that the social constructivism has a central precept that the knowledge is created by the learners as a result of social interaction. Thus, the constructivist learning pedagogy encourages students to create mathematical knowledge and develop creativity and curiosity to solve mathematical problem.

From the interaction with students participants, it was found that some teachers generally lack in the understanding of children's psychology. Every teacher to gain a successful career must take care of the thing that is the knowledge one is providing being effective to the learning of the class or not. The teacher must use child-centered pedagogy for applying those bulks of theories in the teaching. This can really uplift the level of understanding of students to a great extent. As the teacher used special approaches while she taught prime and composite numbers today, the students were really pleased as they could understand those concepts so easily. She had never used this way of teaching approach till now. She always used chalk and talk method only inside the classroom. But after this special approach i.e. the use of metaphors in teaching today, I could see the active participation of the students and constructivist learning framework flourishing in the classroom environment. The children were really pleased. İt was found that different metaphors help to conceptualize the concept of prime and composite numbers. The metaphors help teachers to teach concepts effectively and meaningfully and students appeal the approaches of teacher's teaching with the use of metaphors.

Concludıng Remarks

Metaphor is a communication tool and hence mediate to link with the abstract mathematical concepts. Different artefacts like geoboard, chart board materials regarding mathematical ideas are considered as the conceptual metaphors for the teaching and learning abstract concepts of mathematics. The constructivist lesson provides a great opportunity to students regarding to the knowledge construction and to solve mathematical problems. The students were encouraged to investigate the mathematical ideas in activity based instruction design. The series of interventions regarding students everyday practices and experience were used to communicate abstract concepts of prime and composite numbers at basic level of education. The color metaphor, area metaphor and colorful factor rainbow metaphor were intervented in the classroom on the basis of observations and reflections. Pre-class and psot-class interview was taken both to studnets and teachers . From the observation of the classroom and interviewed with teachers and students, it was concluded that the incorporation of conceptual metaphors in mathematics classroom can be mediated in the process of teaching and learning, and develop mathematical concepts.

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