

## Perception and Experience of Teachers in Implication of Inductive and Deductive Methods in Mathematics Classes

Hari Prasad Sapkota

Mahendra Ratna Multiple Campus, Ilam, Tribhuvan University, Nepal

Email: hpsapkota11@gmail.com

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**Abstract:** This paper aims to explore the teachers' experiences and perceptions towards the implication of inductive and deductive methods in mathematics classes at the primary level. The inductive method is the beginning of all mathematics and derives the formula; the deductive method is the continuity of it and implements those formulas. This article is based on a phenomenological research method under qualitative design, focusing on the lived experience of four primary mathematics teachers on the 'implementation of inductive and deductive method' in elementary mathematics classes and their perceptions towards these methods. The data were analyzed and interpreted by using the thematic analyzing approach. The findings of the study show that the teachers were in a dilemma in the selection of proper teaching methods in mathematics teaching, and they followed the traditional methods. Knowingly or unknowingly, the teachers were using inductive and deductive methods, but they were not sure about the correct implementation of those methods. Their perceptions towards the inductive method was positive and they believed that it helps students for developing permanent concepts; however, the teachers were confused in its implications. Most of the teachers were following the traditional teaching methods in mathematics classes instead of student-centered teaching methods. They argued that for a short-cut and easy for the implementation, they were using the traditional methods. The teachers should be trained for better implementation of the inductive and deductive methods in the proper teaching of mathematics at the primary level.

**Key Keywords:** *Teaching methods, traditional strategies, instruction, inductive method, deductive method, elementary mathematics*

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### Introduction

Teaching and learning mathematics are often difficult as so many students feel mathematics as a hard subject. In this regard, concerning achievement tests, so many students are not able to achieve the standard of the test as the teaching-learning process and teaching method or technique are forced to determine the learning ability of students. Mathematics teacher uses a variety of methods and techniques in his/her daily classroom teaching in order to make his/her teaching more interactive and operative. Teachers and students interact with each other within the school, so to develop this interaction; an educator uses new teaching methods with

substantial procedures and approaches for teaching to make learning pertinent and beneficial (Upadhyaya, 2005). Till now, so many methods and techniques have been launched, but a mathematics teacher selects only the most relevant one, keeping in view the topic, contents, need and ability of the learners. The teaching method is one of the most important parts of teaching mathematics to make students able in the subject matters. There is a common belief that the vast majority of students dislike mathematics for a number of reasons, including education, learners' cognitive, emotional, and psychomotor characteristics, subject matter, and the learning environment (Gafoor & Kurukkan, 2015). So, to make mathematics easy as a learning subject, we should focus on the teaching methods in mathematics classes. Among the teaching methods, inductive and deductive are one of the most important methods in mathematics classes. A study on elementary-level students shows that the teaching mathematics by inductive method is more effective than that of deductive method (Atta et al., 2015). The inductive method is effective, but in all cases, we cannot use the inductive method only. Both the inductive and deductive methods come together, one is at the initial stage and another is in the final stage in teaching math in a classroom.

At the school level, at the beginning stage of mathematics teaching and learning to find formulae and mathematical facts, teachers may use inductive method. But, the induction is not a complete solution, it is only a good beginning. In all conditions of mathematics classes, one cannot use the inductive method. So, the formulae which are derived from inductive method should also be tested by the deductive method. There are some differences between inductive and deductive methods, but in the construction and development of mathematics, these two work together. The inductive method is the beginning of all mathematics learning, and derives the formula; the deductive method is the continuity of it and implements those formulas. Thus, the inductive method derives the formulae, and the deductive method implements those formulae to solve problems.

In primary schools in Nepal, most of the mathematics teachers are not from a mathematics background. In practice, I observed sampled schools and found that they are using both inductive and deductive teaching methods unknowingly. Primary schools are at the very beginning stage of learning mathematics; at this level, most of the mathematical concepts should be taught by an inductive approach (Silas & Bright, 2012). There are many researches on inductive and deductive methods, such as Shoib (2010) suggested how to implement these methods in teaching mathematics classes. But, I found no research to investigate the teachers' perceptions towards the implementation of inductive and deductive approaches at the

elementary level mathematics in Nepal. This study investigates the perceptions of mathematics teachers in inductive and deductive teaching methods, and also finds out the teaching strategies using inductive approach at the primary schools in Ilam district of Eastern Nepal. The research questions were: How primary teachers perceive the implementation of inductive and deductive method in mathematics at the primary level? How do they experience the use of these methods at primary level?

### **Literature Review**

I reviewed the selected literature related to the inductive and deductive methods in teaching-learning process. Especially, in mathematics, there are some core teaching methods, such as problem solving, inductive and deductive methods. Singh and Yadav (2017) discussed about inductive method which is based on the principle of induction. By establishing that as a universal principle, which is true in one particular example, and also holds true in all other cases, this concept is known as induction. As a result, under this method, an issue is initially solved using the learner's prior knowledge, reasoning, and insight. He or she is not yet aware of any formula, principle, or approach for resolving the given problem. When the students are given enough comparable examples, facts, or things, they attempt to draw their own conclusions on their own based on their findings from the examples. As a result, they may reach a generalization or develop a formula using a persuasive line of reasoning, and by resolving numerous issues that are comparable. Therefore, with this method, teachers do not give students rules or formulas. The students are only given a variety of information and instances from which they must deduce rules or create a general formula (Hasibah et al., 2018). As a result of this, it is a technique for creating a formula with the assistance of a sufficient number of real-world instances. As a result, the inductive approach of teaching brings students from the known facts from examples to the unknown (new problems), from the specific to the general, or from an example to a general rule (formula), and from the concrete to the abstract formulation of a rule (Atta et al., 2015). The learners can try generalization once they have grasped a handful of specific situations.

Aryan (2018) describes that inductive method is useful in mathematics class; it is based on logical thinking, observation and application. It reduces rote learning and involves students actively in mathematics class. Mathematical formulae and rules are derived from inductive approaches, so it reduces doubt about the rules and facts. This is an effective approach for helping students understand the concepts and generalizations and for development of their

higher-order thinking skills (Aryan, 2018). Mostly, it is applicable in the lower grades of mathematics because it emphasizes example to generalization.

Deduction is the process by which a particular fact is derived from some general known truth (Singh & Yadav, 2017). Thus, the student proceeds in the deductive method of instruction from a general rule to a specific problem, from an abstract formula to a concrete example, and from the formula to the instances. Here, the learners are given a pre-established rule or formulae, and are instructed to use it to solve issues that are connected to it. In order to obtain the answer to the problem by using this method, the student needs to merely complete calculations or simply substitute known numbers in the formula. The deductive approach is a quick way to resolve the mathematical issue (Pandit, 2013), and hence it helps in saving the time. Since problem-solving involves the direct solution process, it improves memory while helping students remember formulas. The practice and study of mathematical problems using this strategy may improve problem-solving skills, and it can lead students to perfection in their learning. In mathematics instruction, especially at the primary level, the combination of the induction and deduction approaches is very helpful. The conclusion of mathematical concepts is given by using the outcomes of inductive method to the deduction.

Pandit (2013) stated that an argument which is from a specific case to a general one, from a concrete to an affective, or from an example to a general formula is defined as an inductive method. In the inductive method, the logical conclusion is carried out from observations and applications of mathematical processes. And, the argument which is described from a general rule to a specific problem, from an affective to a concrete example, or from a formulae to an example, is defined as a deductive method. Inductive method is an approach of constructing a general formulae with concrete examples. The process of induction provides a generalizable truth of mathematical formula or a theoretical construct (Thiyagu, 2016). Inductive approach is psychological in nature. The opposite type of inductive method is deductive method. This is the final stage of calculation (Silas, 2012). Inductive method of teaching model is found to be more effective for teaching geometry and trigonometry than teaching algebra. So, it is recommended that inductive method of teaching model should be used in teaching of geometry and trigonometry (Shoib, 2010). The deductive method is used in a large classroom setting, while the inductive method is effective when used in a small number of students. The deductive method applies traditional approach to teaching mathematics. It seems more structured in the sequence of activities. It is predictable of the outcomes, while the inductive method is more specific to students. It is more personalized approach in which the concepts are presented for

students to understand from examples and cases (Schadewitz & Jachna, 2007). The deductive method is a way of verification of the process and it comes from a source (such as theory), while the inductive method focuses on discovery of a new rule rather than applying a predetermined rule, and it relies on students' experiences, perceptions, and understanding of the concepts.

### **Theoretical Framework**

The major phenomenon of inquiry in this research is based on the teachers who teach basic levels mathematics, especially at the elementary schools in Nepal. The inductive method in modern mathematics was used by Ray Solomonoff around 1960. Solomonoff (1964) described that “previous observations are used to calculate the probability of next observation, and the strongest evidence that one can obtain for the validity of a proposed induction method” (Solomonoff, 1964, p. 4). The induction approach was used in mathematical properties of probability distribution over a countable set. So, Solomonoff established the functional relation of probability distribution by introducing the inductive method by describing  $f(0)$ ,  $f(1)$ ,  $f(2)$ , ...,  $f(n)$  for a computable function.

The contribution in inductive method by Pestalozzi (1819) and Bacon (1623) were the milestones in the inductive method in mathematics teaching. Inductive method is based on induction. Induction is the process of proving universal truth or a theorem by showing that if it is true of any particular case, it is true of the next case in the serial order, and hence true for each such case (Pestalozzi, 1820; Bacon, 1623). If one rule applies to a particular case, and is equally applicable to different similar cases, then it is accepted as a general rule or formulae. So, to determine a formulae, the teacher follows the induction method or approach. Initially, the formula or rules should be formulated by the induction, and then later those formulas should be applied by using deduction approach.

This paper is also built on the foundation of the absolutist view of mathematics education, as Ernest (1991) asserts that mathematics as rigid, absolute, logical, fixed and abstract. Further, Ernest asserts that in teaching mathematics, teachers make mathematics more logical, fixed, and represent them by some rules or formula for making it short and easy to learn. For making short, deductive instruction method is used. Absolutist view guide students to rote memorize formula, and solve problems by using those rules. But, they do not follow the induction approach to establish the formula by a long process. An absolutist view may give a mathematical task that stress the students to find the rigid, unique, fixed and objectively right

answer. This may misguide teachers to provide only formula at the beginning of the courses (Buerk, 2000). Hence, the absolutist view of mathematics is important for induction and deduction methods to determine the real application of it in the primary mathematics.

### **Method**

This study is based on phenomenological research methods under qualitative research design. This study focuses on the lived experiences of mathematics teachers who are teaching at primary level in Nepal. The study focuses on the ‘implementation of inductive and deductive method’ at the elementary mathematics classes and teachers’ perceptions towards them. The phenomenological research design describes ‘the meaning of more than one individuals of their lived experiences of a phenomenon. It focuses on describing participants’ common experiences of a phenomenon under the study (Creswell, 2007, 53). In this study, I explored the in-depth data about the cases to the specific phenomenon in using inductive and deductive methods in mathematics teaching and learning. The participants of this study were mathematics teachers at primary level of Ilam district of Nepal. I selected them purposively from mathematics background of their higher education because my purpose was to find out their perceptions towards inductive and deductive methods in mathematics.

The four participants for the study were teachers teaching primary mathematics as well as higher classes. Two participants were teaching in the rural area of Ilam district and other two participants were from the urban areas of Ilam. As a university lecturer, I was in touch with my students in different geographical areas in Nepal. One of them was my student, who was a teacher at a primary school near to my residence. He discussed with me different topics of teaching and learning activities. One day, he shares his difficulties in making students clear about fraction in a grade three class. He described his teaching processes to me. I become surprised with what he shared with me about teaching mathematics, and I asked him about inductive and deductive methods. He became confused about these ideas, and he was in dilemma to teach by using these methods. This incident aroused my curiosity about the study topic, and I discussed it with his other friends who were teaching at different schools. Then, an idea of this study came to my mind, when we were discussing on inductive and deductive method at elementary mathematics classes. The other three participants were taken through the first participants who were facing the same problem while teaching mathematics at different primary schools of Ilam district.

In this study, the data were based on interviews with the teachers concerning their classroom experiences, teaching learning activities, access of resources, and their preparations for classes. Focusing on the holistic experiences of the teachers what they faced in the classroom teaching situation and outside the class, the interviews focused on the discussions about the mathematics curriculum, specially about induction and deduction methods with their colleagues and their perceptions towards these methods. During the interview of teachers, I tried to maintain the natural environment.

In first and second seating, I discussed informally about their experiences and perceptions of teaching mathematics. So, I did not use any field notes and other recordings. Instead, I wrote descriptive notes of their interviews as soon as possible. Then, I conducted formal in-depth interviews, separately with each participant. I recorded the interviews. The interviews were verified by other participants and clarified by the sequential interviews, which helped in forming the dialogical and emerging themes. I was aware of the possibility of understating or overstating the teachers' voices. So, I endeavored to 'bracket' my own perceptions and understanding of the implications of inductive and deductive methods. The descriptive notes were coded via identifying key themes in the teachers' perceptions while maintaining ethical integrity and incorporating their voices into the study. I made two major themes from the collected data and the themes were analyzed and interpreted by using the thematic analysis approach (Braun & Clarke, 2006). The collected raw data were transcribed, and then generated the initial codes. From codes and sub-codes the themes were formulated, defined and named, and then analyzing was followed by formulating the thematic results.

## **Results and Discussion**

The results of the study are mainly based on the teachers' perceptions and experiences about the implication of inductive and deductive methods in teaching learning activities, such as starting of lesson, making concepts on the new topics, problem-solving, and the implementation of problems in real-life situation. So, the study focused on two main thematic areas. The results of the two thematic areas are stated separately and discussed them.

### **Dilemma on the selection of methods**

In teaching learning process, the selection of teaching method is a challenging issue. Proper method selection guides the students' attention towards the subject matter. The teachers seem to be confused about the selection of induction and deduction approach in classroom teaching. In mathematics, inductive method should be used at the beginning of of each chapter (Pokhrel,

2020). Most of the participant teachers were not sure that they were clear about the inductive and deductive method. One participant shared, *“I become confused when to use inductive method; at the starting new chapter, I used to write formula for that chapter and teach the students by using those formulae. In my view, writing of formula is inductive and applying formula is deductive.”* It shows that the teachers were not aware of use inductive methods in their classes. Teachers thought that inductive is used only at the beginning of the chapter, but they were not familiar with the process of induction. Giving example and finding formula is not exactly what the inductive method is about. It would be better to follow the proper process of induction, as Pokhrel (2020) provides four steps for induction method. These steps are: a) Representation of example, b) Observation/reflection, c) Generalization/simplification, and d) Testing and verification. The teachers were thinking of what they used inductive method, but actually they were using the deductive one because the steps were not followed.

At primary level, the course load of mathematics is very heavy. The teachers are engaged to complete the courses in the whole academic year. There isn't sufficient time enough to implement the new methods and techniques. Inductive method is time-consuming method to describe the new concepts of any mathematical content. In induction method, there should be a pre-knowledge of finding out the formula. So, for this reason, the teachers escaped the new approaches and used obviously the deductive method of using the formula. One respondent teacher shared his experience, *“I have the idea to use inductive and deductive method in mathematics teaching, but we don't have enough time to use inductive method at beginning of the lesson. So, to complete lessons, we used deductive method.”* This showed that knowingly teachers used deductive method. They don't want to teach by using long and lengthy process to reduce their workload which ultimately harms the students. So, students were not able to develop the proper concepts of mathematical knowledge.

In elementary level mathematics, student-centered methods are more precisely recommended for instruction. Among those methods, relating with daily life problems, inductive methods can be used in most of the lessons. I found that most of the teachers were in dilemma while selecting teaching methods in mathematics teaching. There are some methods which can be adopted by teachers, especially while teaching mathematics. But, for fixed, rigid and logical answer, the teachers used the methods which do not involve the students. As Lerman (1990) asserts in his absolutist view of mathematics, teachers also want the easy way to teach the subject matters and give the short-cut way as deduction method. My participant teachers accept the way what they were using in their mathematics classes.



### **Following the traditional strategies**

Traditional teaching learning strategies do not involve students in teaching-learning activities. Traditional teaching methods, often teacher-directed, may not adequately teach valuable learning skills, while non-traditional approaches may better equip students with these skills (Tularam & Machisella, 2018). Most of the teachers were found to imply those traditional strategies in the classroom teaching. Scientific teaching methods focus on new teaching techniques which involve students in their classroom activities and use of pre-knowledge enhanced to get new knowledge. I found most of the teachers promote traditional teaching strategies. One teacher shared, *“we learned by traditional technique when we were primary students. We followed the same technique to teach now.”* This indicated that teachers were not serious about providing quality education to their students. Teachers taught only from the textbooks and what it provided, but they did not apply the latest technique, and they were not able to use inductive method. They were not concerned about the career of the students. Another participant teacher argued, *“I use to apply student-centered method; I provide formula for the students and discuss with them about its application. Then only I start the lesson.”* It showed that teachers were not sure about the method of teaching. They were using deductive method and thinking that they were teaching by student-centered inductive method. They thought student-centered method and inductive method are same. The concept about inductive and deductive method should be made clear to the teachers who were teaching mathematics at the primary level.

This finding reminds me that most of the teachers did not differentiate the curriculum and course syllabus. Curriculum guides the teacher for their regular classroom instruction. Teachers' guide indicated the teaching strategies when to use inductive and deductive method in teaching mathematics. One teacher shared, *“I don't have teachers' guide and curriculum. The preferred text-book is enough to teach; we follow the book and teach exercises from them.”* It indicated that the school administration and district education office were also negligence towards the teaching and learning system. Head teacher of one of my sampled schools accepted that they do not have curriculum materials. The District Education Office did not provide those materials. One teacher surprisingly discussed, *“Curriculum is same as the preferred text-book by the government of Nepal. We teach nothing other than text-book and students also learned from the book only.”* It showed that teachers were not out of the traditional concept over curriculum. They were not aware of new and mathematics related teaching methods like inductive method which makes students clear on any new topic. This also leads to incorporate the traditional teaching methods.

In arithmetic, most of the chapters should be taught by inductive method. I had seen in an observation of a class of my respondent that he started his lesson from exercise given in the text-book. He did not teach any pre-knowledge for those chapters and any examples for that chapter. I discussed with him about it and he shared, *“I don’t waste my time for this pre-discussion part, but I give more time for the exercise. More practice made the students more confident for solving problems.”* It indicated that teachers were following only the traditional strategies. They did not prepare lessons at home. I had seen in those classes some daily life examples made students very clear about the arithmetic problems. From examples to a rule may give them clear concept on mathematical problem and those concepts may remain in their mind for a long period.

### **Conclusion**

The inductive and deductive methods are inter-related methods because inductive method is the beginning of all mathematics and deductive is the conclusion. The inductive method derives the formulae and deductive method implements those formula. This study investigated the perceptions of elementary mathematics teachers about inductive and deductive teaching methods and also found out the teaching strategies using inductive approach at primary schools in Ilam district. The teachers from Ilam district were not clear about the selection of teaching methods in mathematics. Most of the teachers experienced that they were not using inductive method by its proper process. Some teachers used the induction method for describing the concept and to determine the rules for solution. The steps for inductive methods which are mentioned here as: selection of a number of cases, observation of the case under given conditions, investigation and analysis, finding common relations, and arriving at generalization were not followed by any mathematics teachers. The findings showed that the teachers were in dilemma for the selection of inductive, deductive or other methods. They were recognized about the methods and their uses, but they were not using properly those methods. Also, the teachers were following the traditional teaching methods. New teaching techniques may encourage the students for their active participation in the classroom, but the teachers were not following the new methods. They argued that for short-cut and easy for implementation, they were using the traditional methods.

This study explored the teaching strategies of mathematics teachers at primary schools in Ilam district of Nepal. The selection of proper teaching technique may affect the teaching and learning processes. It indicated that teachers, school administration, and the District Education

Office were not being responsible for the students' learning environment. The findings indicate that there is still a need for teacher training for the implementation of different teaching methods in primary mathematics in Nepal.

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