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Mathematics Teachers' Perceptions on Higher Order Thinking Skills

Nara Hari Acharya

Abstract

The main objective of this study was to explore mathematics teachers' perception on Higher Order Thinking Skills (HOTS). The explanatory sequential mixed method with Likert scale and interview guideline was used as research tools for data collection. 50 mathematics teachers who were teaching at Higher Education were conveniently selected for the survey and 5 of them were interviewed. The mean and standard deviation of different views on Likert scale were calculated and the results from quantitative data are presented in language with the help of qualitative data obtained from the interview. The teachers' perception was gathered about concept or understanding, needs, clarity, and practice about the HOTS. The study found that most of the teachers viewed HOTS as a commonly known idea of analyzing and synthesizing skills together with logical thinking and decision making skills. In depth, teachers were clear about the meanings, strategies and the use of HOTS but weak in implementation. Majority of the teachers viewed the practice of HOTS in mathematics classrooms as necessary but they were rarely used. Only a few of them were partially practicing them in classroom instruction. The teachers felt complexity in practicing HOTS due to students' basic knowledge, approach and access to different materials, teachers' training, curriculum and time of implementation in development of HOTS in students.

यस अध्ययनको मुख्य उद्देश्य हायर अर्डर थिंकिङ स्किल (HOTS) मा गणित शिक्षकहरूको धारणा अन्वेषण गर्नु थियो। लाइकर्ट स्केल र अन्तर्वार्ता दिशानिर्देशको साथ व्याख्यात्मक अनुक्रमिक मिश्रित विधि डेटा संग्रहको लागि अनुसन्धान उपकरणको रूपमा प्रयोग गरिएको थियो। उच्च शिक्षामा पढाउने ५० गणित शिक्षकलाई सहज रूपमा सर्वेक्षणका लागि छनोट गरिएको थियो र तीमध्ये ५ जनाको अन्तर्वार्ता लिइएको थियो । लाइकर्ट स्केलमा विभिन्न विचारहरूको औसत र मानक विचलन गणना गरियो र अन्तर्वार्ताबाट प्राप्त गुणात्मक तथ्याङ्कको सहायताले मात्रात्मक तथ्याङ्कबाट प्राप्त नतिजाहरूलाई भाषामा प्रस्तुत गरिन्छ। HOTS बारे अवधारणा वा बुझाइ, आवश्यकता, स्पष्टता र अभ्यासको बारेमा शिक्षकहरूको धारणा जम्मा गरिएको थियो। अध्ययनले पत्ता लगायो कि धेरै जसो शिक्षकहरूले HOTS लाई तार्किक सोच र निर्णय गर्ने सीपहरू सँगै विश्लेषण र संश्लेषण गर्ने सामान्य रूपमा ज्ञात विचारको रूपमा हेरे। गहिराइमा, शिक्षकहरू HOTS को अर्थ, रणनीति र प्रयोगको बारेमा स्पष्ट थिए तर कार्यान्वयनमा कमजोर थिए। धेरैजसो शिक्षकहरूले गणित कक्षाकोठामा HOTS को अभ्यासलाई आवश्यक ठान्थे तर तिनीहरू विरलै प्रयोग भएका थिए। तिनीहरूमध्ये केहीले मात्र कक्षाकोठा निर्देशनमा आंशिक रूपमा अभ्यास गरिरहेका थिए। विद्यार्थीहरूको आधारभूत ज्ञान, दृष्टिकोण र विभिन्न सामग्रीहरूमा पहुँच, शिक्षकहरूको तालिम, पाठ्यक्रम र विद्यार्थीहरूमा HOTS विकासको लागि कार्यान्वयनको समयका कारण शिक्षकहरूले HOTS अभ्यास गर्न जटिलता महसुस गरे।

Keywords: pedagogy, strategies, taxonomy, assessment, constructivism, higher ability

Introduction

The exposition of information and its globalization *needs* not only reform in the curriculum but also pedagogy from traditional methods of instruction to new methods (Afandi et al., 2018). The incorporation of the new aspects of the innovation in teaching and learning is crucial to develop qualified and appropriate human resources for the nation to make it successful and well developed (Retno et al., 2019). Teaching and learning different skills are directly proportional to teaching and learning mathematics because of the integration of mathematics and mathematical concepts and its contents in different disciplines like pure science, applied science and social science (Anthony et al., 2007). Most of our teachers as well as learners have been taking mathematics as a hard and arid subject and teachers have been teaching mathematics through traditional methods of teaching like rote teaching and algorithmic methods of teaching and learning (Anthony & Walshaw, 2009). Teachers have been encouraging the students to memorize the formula written by themselves on the board and the rules of solving mathematics with deductive memorization (Lessani et al., 2017). Teachers' thinking is

concerned about higher scoring or obtaining a higher grade in their formative evaluation at a higher level. Furthermore, students have been asked to solve problems from textbooks rather than solving their daily life problems by using creative and critical thinking skills. That is why the student's achievement is less satisfactory (Kafle et al., 2019). This situation has become a great global challenge in incorporating the well participatory approaches as well as developing different skills for a meaningful way in teaching and learning mathematics.

In Nepal's context, there are two different mathematics curricula; compulsory mathematics and optional mathematics in secondary level for grades 9 and 10 (CDC, 2005). Furthermore, different mathematical contents are integrated with different disciplines to develop critical thinking, problem-solving, and decision-making skills. So, we can say that different mathematical skills have been taken as fundamentals for everyday life (Puteh et al., 2018; Tajudin et al., 2018). In the secondary level mathematics curriculum, the items of higher ability should be at least 20% of the total items asked in an examination of formative and summative evaluation (CDC, 2017). This provision has been implemented not only making the item matrix of school level but also in higher level and university level examinations. It is necessary to incorporate higher-order thinking skills as well as critical thinking strategies and skills in teaching and learning mathematics. Teachers' role is more crucial for developing such types of skills in students. So, to incorporate them in classroom instruction, mathematics teachers and other stakeholders should know about higher-order thinking skills and different strategies and methods for developing them in students by implementing them in their teaching and learning process. The incorporation of higher order thinking skills is possible only when the mathematics teacher knows about the concept and understanding, needs, importance, and obstacles as well as barriers and complexities in the practice of teachers and students for acquiring higher-level thinking skills (HOTS).

Literature Review

Examining through the history of thinking, the Socratic method of questioning followed by Plato and Aristotle is now taken as critical thinking. This had been going with Descartes, Newton, and later Comte in the 19th and 20th century in different perspectives such

as logical, rational thinking that has a purpose and collaborative endeavor (Facione, 2011). Interpretation, analysis, evaluation, inference, explanation, and self-regulation are taken as core critical thinking skills. The concept of higher order thinking skills (HOTS) was initiated from Bloom's taxonomy of educational objectives. According to Blooms' taxonomy, the level of thinking is divided into two levels; Lower-order thinking skills (LOTS) and Higher-order thinking skills (HOTS). LOTS consists of the cognitive, comprehension, and application levels of knowledge whereas HOTS includes the levels of analysis, synthesis, and evaluation (Bloom, 1956). Similarly, in the new taxonomy three levels of skills of analyzing, evaluating, and creating together with the cognitive processes of gaining factual, conceptual, procedural, and meta-cognitive knowledge are taken as higher order thinking skills (Krathwohl, 2002). Krathwohl explains that higher order thinking skills mainly contain two kinds of thinking, namely critical thinking skills and creative thinking skills.

Halpern (2008) defined the word critical as a judgmental way of thinking to describe something not to imply finding fault. Thomas and Throne (2011) describe it as the skill of connecting, categorizing, manipulating, rearranging, and using different learned skills to solve new problems. It is higher than rote memorization with the skills of understanding, inferring, estimating, connecting, categorizing, manipulating, and applying learned skills through creative, logical, reflective thinking, problem-solving and mathematical thinking to solve new problems (Wang & Zheng, 2016). According to Binti and Rosli (2016), creative thinking, critical thinking, problem-solving, and meta-cognition are the elements of HOTS that are distinguished from lower order thinking skills (LOTS) based on students' reasoning behavior and reproductive thinking. Shukla and Noen (2016) described higher order thinking as the consequence of Piaget's developmental stages in 1939 followed by Bloom's taxonomy of 1956.

The incorporation and proper implementation of effective questioning techniques and monitoring the students' process of thinking by the instructor help the students to actively engage in cooperative and collaborative activities (Peter, 2012). Restructuring of instructional techniques including different thinking activities in mathematics with contextualization (Kamal, 2016) and social interaction with emotional and cognitive behavior help to develop

higher-order thinking (Mainali, 2013). Mathematics teaching materials including ICT Tools and ICT integrated problem-based materials and worksheets enhance the students' thinking ability. The problem-based learning approach and connection of citizenship education has a significant impact on the ability of student's critical thinking abilities in mathematics in terms of school level and students' prior mathematical abilities (Maass et al., 2019). Using a Contextual teaching approach and visualization mathematics with cooperative strategies among teachers and students can foster problem-solving and HOTS (Abdullah et al., 2016; Hassan et al., 2016). Because the teachers encourage the students in developing confidence as well as critical thinking skills so that they can use their learning in solving mathematical as well as daily life problems . The students' ability of critical thinking, problem-solving and reasoning can be fostered only by reflecting them in mathematics pedagogy (Dahal et al., 2019).

According to Saido et al. (2017), most of the teachers in the classroom are applying memorization strategies, and least of them are applying problem solving and hands-on activities. Moreover, gender and experience are significant factors for applying different teaching and learning strategies. The HOTS are key elements for students as well as teachers in developing the 21st century skills in students' in learning technical subjects like mathematics and science (Afandi et al., 2018). According to Mustika et al. (2019), the teachers' awareness about the importance of higher order thinking skills in teaching learning measures the mastering of higher order thinking skills of fostering problem solving, critical thinking rather than memorization through rote learning on students. The students' achievement in mathematics is directly proportional if the textbooks include the activities of promoting higher order thinking skill in students. Also, most of the lessons and the different kinds of plans of teachers are prepared on the basis of textbook related to the prescribed curriculum. So, it is necessary to analyze the textbooks on the basis of higher order thinking skills(Pratama & Retnawati, 2018). It means the textbooks are the key materials for the students as well as teachers for the development of higher order thinking skills. A mixed method research in the USA about assessment of higher order thinking skills in *secondary* level by Robinson (2020) found that most of the teachers and educational officers teaching and learning by incorporation of HOTS is crucial. Although, most of the American teachers as well as

officers state the importance of higher levels; analysis, synthesis, and evaluation for assessment of the students, they have been implementing up to application level of Bloom's taxonomy. According to Crowson (2020), most of the teachers in the USA have been using information release methods of teaching mathematics instead of using innovative methods and strategies such as creative and critical thinking strategies for promoting higher order thinking skills. Furthermore, only few teachers have been using such innovative methods instead of traditional, authentic tools containing performance based items. It was also indicated that the use of strategies of students' responses, gradual release, meaning making and associativity of student's concepts and knowledge relating visualization supports fundamental concepts on HOTS termed as soft skills.

The reviewed literature shows that most of the researches on the topic of HOTS conducted inside and abroad had focused on what is HOTS, how can we foster the HOTS to students and teachers, and what are the roles of HOTS in teaching and learning in different disciplinary and interdisciplinary subjects. Along with those incorporation of higher order thinking skills in students' assessment and their impact were analyzed. I was unable to find research reports those were conducted about the teachers' and student's beliefs about the HOTS on different subjects including mathematics in abroad as well as in the Nepalese context. So, I was intended to find out how the secondary mathematics teachers have been taking the HOTS and what their perception is in mathematics teaching and learning. This study was attempted to answer the following research questions:

a) How do the higher level mathematics teachers define higher order thinking skill?

b) What are the perceptions of mathematics teachers regarding the needs and practice of higher order thinking skills?

c) What are the influencing factors for implementation of higher order thinking skills in mathematics instruction?

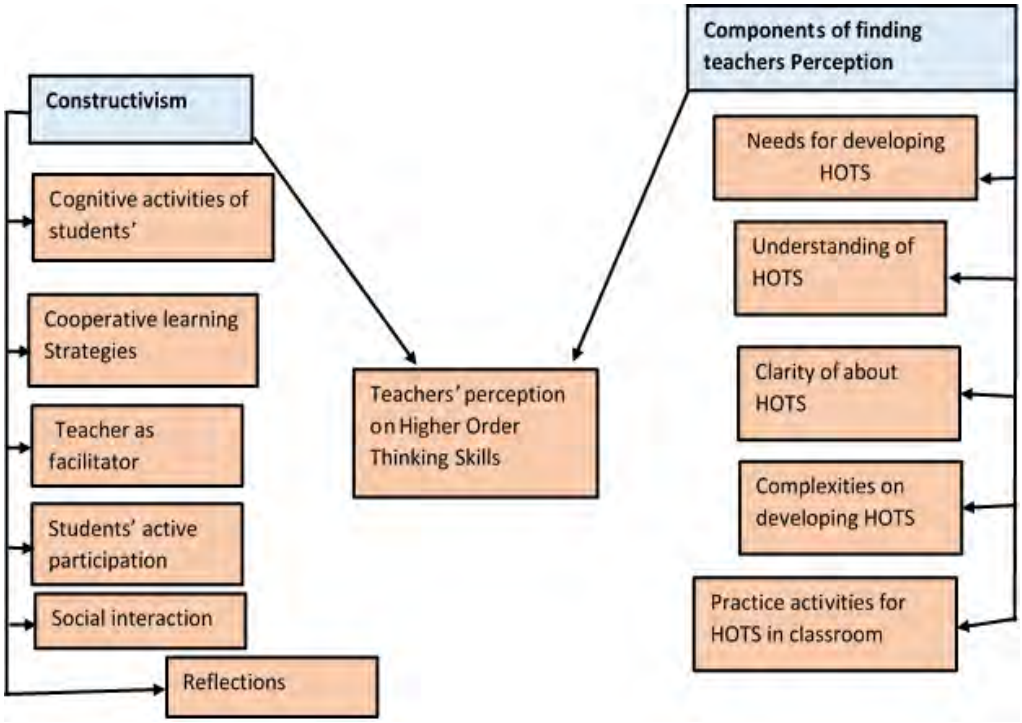
Theoretical Framework

The shift in paradigm of teaching and learning leans towards a constructivist paradigm from behaviorism along with cognitive paradigm. Mainly, Piagetian (focus on individual construction and cognitive construction), Vygotsky (social constructivism by interaction of learner and society), social and holistic perspectives of

constructivism are four perspectives of constructivism (Green & Gredler, 2002). Cognitive and social constructivism is the main area for the study of the HOTS in mathematics (Schlechty, 1990). Constructivism originated at the time of Socrates by the Socratic model of questioning. Later Bruner's discovery learning and Piaget's cognitive psychology revised and allowed students to create knowledge into practice (Caffarella & Merriam, 1999). The knowledge processing by the individual mind for knowledge construction is the perception Golotti (2015) explained Vygotsky's view as; higher-order cognitive skill includes reasoning, decision making, problem-solving, and creative and critical thinking skills (Galotti, 2015). The main aspects for finding the teachers' perception on higher order thinking skills are inductive, deductive, conditional reasoning, decision making and creative and critical thinking.

The conceptual framework for identifying mathematics teachers' perception on HOTS is here in figure 1.

Fig 1: *Conceptual framework of the teachers' per*ception *on HOTS*



Research Methods

The main intent of my study was to explore the mathematics teachers' perception on higher order thinking skills. It was a sequential explanatory mixed method design in which the results from quantitative data were explained with the help of qualitative data. The

quantitative data were collected and then analyzed with descriptive statistical measures such as mean and standard deviation. After that, the outputs of quantitative data were explained through qualitative data (Creswell & Creswell, 2017).

All the mathematics teachers teaching in grades 11 and 12 and higher level of Bagmati province were taken as the population of the study. Due to the pandemic situation, out of 50 mathematics teachers, only 5 teachers were selected for the in-depth interview about higher-order thinking skills by convenient sampling technique.

According to Nemoto and Beglar (2014), the Likert scale questionnaire gathers data about the opinion, feeling, and attitudes about the particular issue as well as the practice in the classroom. So, surveys with Likert scales as well as the interview guidelines were used for data collection. The survey, the demography of the teachers such as address qualification, the experience of teaching along with five-point Likert scale with strongly agree (SA) = 5, Agree (A) s = 4, Neutral (N) = 3, disagree (D) = 2, and Strongly Disagree (SD) =1 was included. The statements of the scales were designed based on the concept of needs, clarity, complexity, and quality, and practicality of higher-order thinking skills of mathematics teachers. The interview guidelines were prepared for the interview with the mathematics teachers who are involved in teaching as well as developing different curricular materials. The Cronbach Alpha (0.773), from pilot study of the tools in the non-sample group of teachers, showed the items have internal consistency as well as the reliability of the statements of the Likert scale. I have finalized the items and statements of the Likert scale and interview guidelines with the help of a mentor.

The quantitative data from Likert scale were collected from the email responses of the sample teachers through the survey. Based on the result of the survey the interview guidelines were prepared. The focus group interview was conducted with sampled teachers based on the guidelines prepared.

The data from the survey were analyzed with the help of SPSS 20. Mean and standard deviation with a maximum and minimum value of responses of each statement were calculated. After that, the data from the interview were recorded, transcribed in detail in word documents, and were transferred into segments based on the research questions to investigate teachers' perceptions of HOTS. The findings are presented by using abbreviations to quote from participants. The triangulation of the findings from the literature review and both kinds

of data with theory was used to analyze data and discussion of results. The pseudo names of T1, T2, ... are assigned for the ethical consideration of the respondents.

Results and Discussion

To explore the perception of mathematics teachers on HOTS, quantitative data were collected from a five-point Likert scale. The views and perceptions about the HOTS of teachers were collected with multiple responses and the things required developing HOTS in students' by using an open-ended question. After the interviews with the expert teachers, the results of data from the questionnaire were used to triangulate. The results from both types of tools reveal the teachers' perceptions on understanding, practice, clarity, complexities and needs for developing HOTS.

Understanding about HOTS

The knowledge and understanding are the basis to get perception of techers towards higher order thinking skills. Results of the survey about the teachers' knowledge and understanding of HOTS is presented in the following diagram.

Fig 2: *Teachers understanding about HOTS*

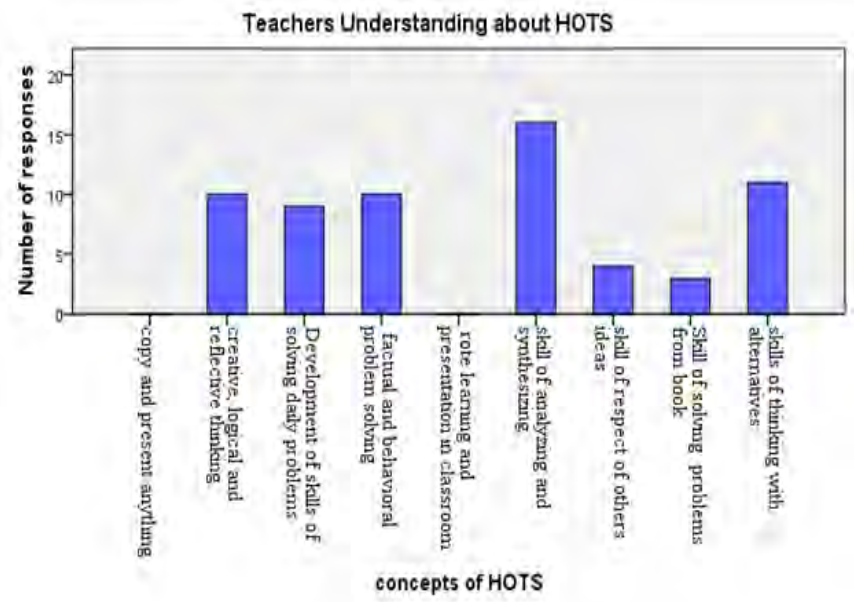


Figure 2 shows that, about half of the participants (48%) teachers' viewed HOTS as the skill of analyzing and synthesizing knowledge based on revised taxonomy (Krathwohl, 2002). About 45% of the teachers said the skill of thinking with alternatives is called HOTS. 40% of the participants put their view on factual and

behavioral problem-solving skills as HOTS. No teachers selected the idea of copy and present anything as well as the only solving of routine problems from a textbook. It seems that secondary level mathematics teachers' have a better, positive, and adequate understanding of HOTS. Regarding the understanding of the HOTS the teachers views are as follows:

> The skills of connection between the learned concepts with daily life problems by the generalization of mathematical knowledge are HOTS. (T1)
>
> The teaching of students to develop logical thinking, the reasoning of complex concepts of mathematics with model teaching methods is the process of developing HOTS. (T2)
>
> Teaching activities that bring students from memory or rote learning to learning for understanding and finally generalization and demonstration by individual, peer, and group efforts. (T3)
>
> The students' ability makes them able to solve different problems of higher ability like analysis, application, synthesis, evaluation level. (T4)

The teachers' views about the concepts and understanding of higher order thinking skills are the skills of students' to solve daily problems creatively and critically. It is above the rote memorization with skills of higher level of Bloom's taxonomy. Based on the definition of HOTS by Thomas and Throne (2011), the skills of creative thinking, logical thinking, reflective thinking, problem-solving with understanding, connecting, categorizing, manipulating, and applying them to new problems are the HOTS. The constructivist approach deals with the method of construction of new knowledge by connecting and interpreting the learned concept in new problem-solving. Because most of the teachers' understanding of HOTS is logical reasoning as well as problem solving skills, we can say they are aware of the developing process of HOTS. According to Lewis and Smith's (1993) view, the collection of new information, memorizing them, and processing that information in multiple ways in confounding situations is the process of the development of HOTS. Furthermore, it was found that mathematics teachers at the secondary level have found theoretically well understood HOTS.

Perception on clarity about HOTS

Based on the clarity of HOTS, six statements were asked such as the knowledge, clarity of use; how to use HOTS, teaching techniques, and variability in teaching and learning mathematics. The statistical measure of the value of view of the Likert scale is given in the following table 1.

Table 1: Teacher's Perception on clarity about HOTS

Statements	**Minimum**	**Maximum**	**Mean**	**S. D**
I am known about HOTS in mathematics teaching	2	5	3.86	.848
I am clear about the Higher order thinking skills in mathematics	2	5	3.79	.787
I am clear about the use of HOTS in teaching mathematics	2	5	3.64	.911
I am clear about how we use the HOTS in mathematics	2	5	3.21	1.101
HOTS should be taught differently than other content materials	1	5	3.43	1.317
HOTS brings variability in mathematics teaching and learning	2	5	3.64	1.311

Table 1 shows to what extent the mathematics teachers are clear about HOTS in the mathematics classroom. The statements of measuring the perception of the teacher clarity about what is HOTS in mathematics, what is the use of HOTS, how can we use HOTS, teaching methods, and outcomes of the HOTs. The mean shows the knowledge about HOTS (3.86) which is more than the average (3). It means that the majority of the mathematics teachers are somehow clear about the HOTS. The mean use of HOTS and how to use HOTS in mathematics are respectively 3.64 and 3.21. Furthermore, the value of standard deviation from most statements also seems higher. It means the perception of clarity of HOTS varies widely among the teachers. These values are slightly more than the average value of responses on the Likert scale (3) means most of the teachers do not properly know about the application and process of using HOTS in the mathematics classroom. Furthermore, the teachers are nearly neutral about the different methods and the variability of teaching mathematics by using HOTS.

Based on the clarity of HOTS teachers' expressions are as follows;

> The students who have the HOTS can use their knowledge in society, solving daily life problems, increasing the questioning as well as reasoning capacity. (T1)
> It produces the level of creativity as well as the criticality that makes integration between different mathematical knowledge for new problem-solving. (T2)
> The teaching-learning process starts with the LOTS by the algorithmic method of routine problem solving to HOTS. (T3)
> The students learn and demonstrate HOTS through curricular and extracurricular activities, analyze and synthesize the knowledge and apply the conclusion in solving daily problems. Furthermore, the cooperative learning strategies in classroom instruction are the main driving wheel of HOS. (T5)
> I think HOTS means the ability to solve the problems of higher ability in the course book as well as the long questions and outer questions asked in the examination. (T4)

Most of the teachers are clear about higher order thinking skills. They understood HOTS as the ability of solving real life problems with interaction within and between small groups and communities. This process starts with memorization to questioning skills and develops with analysis, interpretation and judgment of the appropriate solution. In some cases, the capacity of solving complex problems from textbooks is called higher order thinking skill.

According to (Lewis & Smith, 1993) the teachers need more clarity for the development of higher-order thinking skills in mathematics students. It shows the opportunity of exposing their reflection in the classroom by students, and makes them able to develop their different skills. So, collaborative and cooperative teaching-learning strategies in the classroom should be administered during concept teaching and assessment. In some cases, it is found that the capacity of students to solve the problems of higher ability during the assessment or evaluation. Based on Lessani, et. al (2016) view the teachers' clarity and confidence level help to develop higher order thinking skills in students.

Practice of HOTS

In this content, I have collected the views by stating eleven different statements about HOTS. The received responses from the five-point Likert scale were collected from Google sheet. The

summary of statistical measures of responses is presented in the following table.

Table 2: *Teacher's perception on the practice of HOTS*

Statements	**Minimum**	**Maximum**	**Mean**	**S. D**
I am concerned about memorization and rote learning	1	5	2.21	1.449
I am concerned about Bloom's Taxonomy during teaching and assessment.	2	5	2.79	1.101
I encourage the students to present the conclusion from the group discussion.	2	5	3.57	1.069
I use to discuss contemporary subject matters.	2	5	3.57	1.260
I encourage students for creative and critical thinking	2	5	3.79	1.031
I perform the group works among students	2	5	3.86	1.079
I am Using other problems except for the textbooks	2	5	3.86	.848
I am using the student centered methods	2	5	3.93	1.120
I encourage students for development of decision skills	2	5	3.93	.900
I encourage students to apply learned things in solving daily life problems	2	5	4.07	.979
In the classroom, I focus on problem solving and question answering	2	5	4.36	.826

In table no. 2, the mean value of responses on statements shows that most of the teachers are partially clear about the higher-order thinking skill in mathematics instruction. Most of the mathematics teachers have been using different strategies to develop HOTs in students. The responses on the statements are student-centered methods, group works, discussion and presentation of the conclusion of groups and discussion on contemporary calculated 3.86, 3.93, 3.86, 3.57, and 3.57 respectively. The mean values are more than the average 3 and close to 4. Most of the teachers agreed that the discussion among the

small groups in contemporary issues, and presenting the group's conclusion helps to develop higher-order thinking skills in the mathematics classroom. Also, it was found that the teachers encouraged the students to use their knowledge in solving daily problems (mean= 4.07) by using problem-solving and questioning techniques (mean = 4.36). Furthermore, students were encouraged for creative and critical thinking in classroom instruction. Although the average perception of using rote and memorizing learning is below the average (2.21), the teachers have a low concern about Bloom's Taxonomy during teaching and assessment. Regarding the practice of HOTS in classroom teaching the teachers' viewed

> First, I provide some basic conceptual understanding about the topics and then ask them to use this concept for solving the problems of complex order. (T1)
>
> Sometimes I ask students to work in small groups as well as peers to solve different real-world problems and ask to present possible solutions in the classroom. But in most cases, I use mass teaching for mathematics due to the abstract nature of the content of mathematics. (T2)
>
> In mathematics teaching, I spent the most time teaching abstract things. Sometimes, I ask the students to search for alternative techniques and solutions. (T3)
>
> In my opinion, together most of the mathematics teachers are teaching mathematics as an abstract subject by using the lecture methods to get scores and make them able to obtain minimum requirements. There are fewer chances of presenting the students' perceptions and ideas for the solution of problems. (T4)

I realised that the mathematics teachers who have been teaching at a higher level were aware about higher order thinking skills. The teachers expressed that it is necessary for teaching and learning mathematics. But due to different constraints such as; abstract nature of mathematics courses, information release method of teaching, achievement assessment nature of the evaluation, teachers have been using teacher dominated methods. The mean scores of the statements about the practice of higher order thinking skills in the classroom and the teachers' views from interviews show that most of the teachers are worried about the HOTS of students but they are applying different techniques and strategies of developing HOTS rarely. Since the effective questioning skills and classroom strategies foster HOTS in

students ((Peter, 2012), I found it was not properly implemented in our context due to different complications and lacking in different things of students.

The complexity of Using HOTS

Based on the complexity and obstacles faced by the teachers during incorporation of strategies in mathematics class to develop HOTS, altogether seven statements were asked Based on the complexity while using the different strategies in classroom instruction in developing HOTS. Six statements were asked to teachers for rating their perception. The summary of descriptive statistics of teachers' responses is summarized in table no. 3.

Table 3: *Teachers' perception of the complexity of using HOTS*

Statements	**Min**	**Max**	**Mean**	**S. D**
In mathematics classroom, it is easy to develop HOTS	1	5	2.64	1.254
It is easy to understand HOTS	2	5	3.07	1.120
A clear structure of HOTS is necessary to present in the classroom.	1	5	3.79	1.031
We need sufficient times for developing the HOTs	1	5	3.93	1.303
We need adequate standard materials to develop HOTS in the classroom.	1	5	4.07	1.184
We can use low cost no cost materials in developing HOTS	1	5	4.14	1.008
The teacher needs sufficient training for teaching HOTS	2	5	4.14	1.008
A qualified teacher is needed for developing HOTS	2	5	4.14	1.008

Table 3 shows how the teachers feel about implementing the HOTs in mathematics teaching and learning. The mean (2.64) of responses on the statement ‘it is easy to develop HOTS in the classroom is below the average value (3). It means that the teachers feel a bit hard to conduct different strategies in the classroom to develop HOTS in their students. Moreover, the teachers expressed; it requires different training and sufficient materials are necessary to perform indicated

strategies. The majority of the participant teachers indicated that the time factors, standard as well as low/no-cost materials, sufficient training to teachers, and quality of teachers are the necessities for developing HOTS in students.

Concerning the complexity of the HOTS the teachers viewed as;

> To develop higher-order thinking skills, we should evaluate through practical work. In our context, there is not any mark allocation for practice. That is why the students are not highly encouraged in different project works and practical activities although the textbook has inserted the project works. (T1)
>
> The nature of mathematical content as well as the abstract nature of mathematics, we are using the traditional method of teaching and learning in mathematics teaching. So, we provide less time and opportunities for the students for development of HOTS." (T2)
>
> "The time allocated by the curriculum is insufficient for students to develop HOTS. The student's level of intelligence, as well as the foundation on mathematics, is the main component of less development of HOTS. (T3)

The practical work with contextualization of learned concepts should be administered in assessing students' learning. Promotion of rote learning and rote memorization in assessment compelled the teachers to use traditional knowledge releasing methods in teaching and learning mathematics. Furthermore the lengthy course of content and the insufficient time allocated for the completion of the course through alternative techniques prohibited the teachers to use alternative critical and creative strategies with problem solving methods.

These views of teachers show that the nature of curriculum, assessment and evaluation, weekly weightage of mathematics teaching, students' level of prior knowledge as well as the motivation in active participation in teaching-learning activities fosters the HOTS in students. Based on constructivism (Liu & Chen, 2010), it can be described that the process of developing HOTS in students is a collaborative task for both teachers and students. Although the students need group and peer work to develop thinking skills, the physical facilities, and structure of our school. Traditional methodological structures also prevent the students from performing such activities within and between peers. Moreover, the opportunities of creating alternatives with interaction with society and the

environment with active participation and cooperation help to develop HOTS in students.

Needs to Develop HOTS

Regarding the requirements for the teachers and students to develop HOTS, a single open written question was asked in the survey as well as in interview guidelines. The teachers' commitment, readiness, time, training about curriculum as well as teaching methods and our trends of delivering in the classroom, insufficient concrete materials are the most important things, they said. Regarding this concept, the secondary level mathematics teachers said;

> The students' regularity, punctuality, intellectual development, participation along with teachers' facilitation".
>
> "The knowledge, skills, and attitude with creative, practical teaching with integrating ICT in teaching and learning mathematics are the main requirements for developing HOTS.
>
> The use of cooperative, as well as collaborative teaching and learning strategies in mathematics teaching, helps in developing HOTS.
>
> The incorporation of practical evaluation will help the student to develop critical thinking and creative thinking through cooperative learning strategies.

Based on the views, I realized that there are teacher related, student related and institution related needs to develop HOTS. The teacher's and students' supportive and collaborative activities with positive, motivated, and active thinking help them in developing HOTS. Students actively engage in the teaching learning process with different skills of thinking, questioning as well as decision making capacity play crucial roles in developing HOTS. Moreover, Peter (2012) described that the use of manipulative as well as ICT tools and techniques in teaching and learning mathematics are more important for students to acquire critical thinking and creative thinking skills. The student's regularity and punctuality as well as the use of different manipulative and virtual manipulative help them to develop HOTS. Similar to Galotti's (2015) explanation, the Vygotskian view about HOTS, the mathematics teachers viewed that restructuring, reorganizing, and contextualization are necessary for them to develop HOTS. By implementing different cooperative as well as collaborative strategies for teaching and learning mathematics we can develop higher order thinking skills in students.

Conclusion

The main purpose of this study was to explore the mathematics teachers' perception of higher order thinking skills with sequential explanatory design. The data were collected by using the Likert scale and interview guidelines. From data analysis, it is found that most of the teachers define HOTS as logical and reflective thinking skills, decision making skills, and skills of analysis as well as synthesis. Some teachers expressed students' capability of solving long questions and new questions of higher ability as HOTS. Taking the view of Peter (2012), we can generalize that by using different cooperative learning strategies and techniques of constructivist learning, we can develop the HOTS. The consolidation of mathematical knowledge by using non-routine problems with possible alternative solutions is one of the best methods to develop HOTS. Although the teachers believe that cooperative and collaborative learning with group interaction develops HOTS in students but rarely do they implement them in teaching and learning activities in the classrooms. Rather, they use rote as well as lecture methods. Due to the abstract as well as the algorithmic nature of mathematics, teachers are not concerned about Bloom's Taxonomy in teaching and test construction in mathematics. The lengthy syllabus, insufficient time for teaching learning activities, insufficient training for the teachers, students' weak motivation and foundations, availability of materials and physical facilities of the schools are the factors that chunk students into developing HOTS in the mathematics classroom.

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Author Bio

NARA HARI ACHARYA is an Assistant lecturer of Mathematics Education in Tribhuvan University, Sanothimi Campus and a PhD scholar of Mathematics Education. He is a textbook writer of Mathematics in Government of Nepal, Curriculum Development Center. His interested areas of research are classroom practice, classroom strategies for mathematics teaching and learning, curriculum and curricular materials, Mixed method research and quantitative and qualitative techniques of data analysis.