A comparative Study of Mathematics Education in the United States of America and Nepal

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Abstract

The purpose of this paper is to compare four domains of mathematics education- curricular materials, pedagogical process, teacher education, and assessment of students' learning in the United States of America (USA) and Nepal. I applied categorical thinking for document analysis from the literature to find some key concepts related to the four categories of comparison. The Common Core State Standards for Mathematics (CCSSM) is a major curriculum standard implemented in many states in the USA, whereas, the National Curriculum Framework (NCF) is the major policy document that guides school mathematics curricula in Nepal. Mostly, classroom practices are student-centered with problem-solving, reasoning, and critical thinking in the USA, but it is mostly drill-and-practice in Nepal. Preservice mathematics teacher education in the USA and Nepal are conducted by universities, but there is a vast difference in the courses offered in these countries. Assessment of students' learning in mathematics is continuously done in classroom activities and exams including some standardized exams in selected grades in the USA, whereas, assessment in Nepal is done with periodic and final exams including standardized district and national tests in selected grades. I discussed some implications of the study.

Keywords: Comparative study, mathematics education, Nepal, USA.

Introduction

The United States of America (USA) and Nepal have many differences in terms of geographical area, demographic characteristics, and socio-economic status. The USA has a total land area of 9.834 million sq. km. with a population of about 325 million (The World Bank, 2017). Nepal has a total land area of 147,181 sq. km. with a population of 29.3 million (The World Bank, 2017). The per capita GDP of the USA is about 59,928 USD and it is about 849 USD in Nepal (The World Bank, 2017). These figures show that there is a vast difference between the USA and Nepal geographically and economically. These differences are also reflected in social, cultural and technological aspects. These differences further create variations in school education in general and mathematics education in particular. In this context, first I reviewed comparative mathematics education in brief and outlined the purpose and research question for this study. Second, I explained the method of study. Third, I analyzed the mathematics education of the USA and Nepal in terms of curricular matters (e.g., standards, curricula, curriculum framework). Fourth, I discussed some pedagogical aspects with reference to teaching-learning school mathematics in the USA and Nepal. Fifth, I reviewed teacher education practices in the USA with reference to pre-service mathematics teacher education in Texas State University in the USA and Tribhuvan University in Nepal. Sixth, I compared the assessment practices in mathematics education in the USA and Nepal in terms of formative and summative assessments in practice. Finally, I stated some limitations of this study followed by implication and conclusion.

Comparative in Mathematics Education

Comparative mathematics education is a growing field of research in the mathematics education. Mathematics education practices across countries and cultures have been studied in the past. These studies focused on different aspects of mathematics education, for example, curriculum practices, textbooks, teaching-learning, teacher preparation, assessment, and other sociocultural aspects. In this context, several international research articles have been published and widely discussed in the literature (Son et al., 2017). Most of these comparative studies compared curriculum and pedagogy of mathematics across the nations and cultures (Ibrahim & Othman, 2010; Wu & Dianzhu, 2006). I discussed selected comparative studies in mathematics education to give a sense of what kind of studies were in researchers' focus in the past in this field.

Wu and Dianzhu (2006) compared the school mathematics curricula in terms of centralized or decentralized, involvement of stakeholders in curriculum design, process of curriculum design with consultation of people of different sectors and contexts, and mechanism of curriculum development in the West and East. In the study, they found that countries such as Japan, Korea, Singapore, France, and China have centralized curricula whereas the countries such as the USA, Russia, Brazil, The Netherlands, and Australia have widely decentralized mathematics curricula. There was a considerable influence of NCTM's Principles and Standards for School Mathematics (NCTM, 2000) in the standards of different states in the USA. Russia after the collapse of the Soviet Union began decentralized curricula in mathematics and therefore there is variation in mathematics curricula and textbooks across the regions or federations. Brazilian school mathematics curricula are guided by National Curricular Parameters. However, the parameter could not fix the problems of a discrepancy between intended and implemented mathematics curricula. In the East, for example Japan, Korea, and Singapore, mathematics curricula are designed and implemented centrally by the Ministry of Education (Son et al., 2017).

Cao, Wu and Dong (2017) and Watanabe, Lo and Son (2017) compared mathematics textbooks of some Asian countries and the USA. Watanabe et al. (2017) compared the textbooks of Japan, Korea, and Taiwan with reference to fractions and operations in mathematics. They analyzed student performance in the content of fraction using TIMSS-2011 grade 8 problems and they found that Korea had a better performance than Japan, Taiwan, and the USA in mathematics. The textbook analysis of three countries included nature of fraction problems in terms of part-whole, measure, operator, quotient, and ratio. Analysis of the selected textbooks from the three Asian countries showed that the countries had all the five kinds of fraction components across different grade levels from grades 2-6. Only Japan introduced fraction concept in terms of part-whole in grade two whereas the other two countries introduced fraction concepts from grade three and upward (Watanabe et al., 2017).

Kim and Ham (2017) studied how mathematics teachers are prepared in South Korea and the USA and Koyama and Lew (2017) studied pre-service secondary mathematics teacher education in Japan and Korea. In another study, Kim and Ham (2017) outlined key ideas associated with teacher knowledge in terms of -- disciplinary knowledge, content knowledge, instructional knowledge, knowledge of student diversity, and situational analysis in the classroom as critical in mathematics teacher education in South Korea and the USA. They found that American preservice mathematics teachers have a wider range of disciplinary knowledge compared to their Korean counterparts. However, the mathematics teachers of South Korea have deeper content knowledge than their American counterparts. There is not much difference in the knowledge of instructional methods among South Korean and American mathematics teachers but the difference is very high in the area of knowledge of student diversity and equity and situational experiences favoring American teachers more than South Korean teachers (Kim & Ham, 2017).

There are several comparative studies in mathematics education that compare student performance in mathematics across the countries, for example Trends in International Mathematics and Science (TIMSS) and Program for International Student Assessment (PISA) studies. However, there is a lack of literature on the comparative study of mathematics education in the USA and Nepal. Because of their unique nature with different geopolitical and socioeconomic conditions, comparative study of mathematics education in these countries is difficult. However, I attempted to compare mathematics education of these countries to explore some fundamental differences in curriculum and standards, teaching-learning, preservice teacher education, and assessment practices. The comparison of these domains in this paper is partial because it is not possible to discuss them depth in a single paper. Therefore, the primary purpose of this study is to compare mathematics education of the United States of America and Nepal in terms of curriculum and standards, teaching and learning, preservice teacher education, and assessment practices in brief. The guiding research question for this review based study was-- What are the similarities and differences in American and Nepalese mathematics education in terms of curricula and standards, teaching-learning, pre-service teacher education, and assessment practices?

Method of Study

This study is based on review of relevant documents and research literature. Therefore, the method of the study was document analysis (Bowen, 2009). Document analysis is a process of collecting, sorting, reviewing, coding and decoding, eliciting meaning and extracting key ideas as categories from the document of different forms (Bowen, 2009). I employed Freeman's (2017) categorical thinking approach to identify the main concepts from the documents relevant to the topic of the study. I reviewed book chapters, journal articles and website contents relevant to mathematics education practices in the USA and Nepal. Then, I identified concepts related to four major categories of mathematics education-- curricular materials (e.g., curriculum framework, standards and textbooks), teaching and learning, teacher education, and assessment of student learning. I tabulated the main concepts in a matrix in order to compare the four categories. These concepts were used to describe and interpret the four comparative categories (Freeman, 2017).

Results and Discussion

The results of document analysis have been outlined in the four comparative categories-- curriculum standards/frameworks, teaching-learning, teacher education, and assessment practices in the USA and Nepal.

Mathematics Curricula and Standards

Actors for curriculum and standards. There is, apparently, no unified national curriculum of school mathematics in the USA (Cuoco, 2003). The National Council of Teachers of Mathematics (NCTM) commenced the standard movement in the late 80s and early 90s by publishing Curriculum and Evaluation Standards in 1989, Standards for Teaching Mathematics in 1991, and Process Standards in 1995. Then, it continued working on reforming the standards and published Principles and Standards for School Mathematics in 2000 (NCTM, 2000). This standard was used by all the states in the USA in different versions in the forms of state standards for school mathematics until the Common Core State Standards for Mathematics (CCSSM) was initiated by the National Governors' Association Center for Best Practices and the Council of Chief State School Officers (NGACBP & CCSSO) in 2010. This standard has been implemented in 41 states and the District of Columbia. But, there is no common national curriculum or framework of mathematics in the USA.

Modern education history started in Nepal in 1952 after the formation of the Education Board by the Government of Nepal to expand the educational opportunities for the public (The Nepal National Education Planning Commission, 1955). This commission suggested the Government of Nepal to form a high-level education commission to study and plan for the national education system. With this suggestion, the government formed the National Education Planning Commission in 1954. This commission advised mathematics to be an integral component of school education. The next thrust in the education system in Nepal was the National Education System Plan (NESP) of 1971-76. This document mandated mathematics curriculum for primary, lower secondary, and secondary level. At the same time, it offered a provision of optional mathematics in the secondary level curriculum (Ministry of Education, 1971). After the implementation of NESP, the Government of Nepal revised school mathematics curricula whenever there was a political transition from one system to the other. But there was no National Curriculum Framework to guide the school curricula in Nepal. Curriculum Development Center (CDC) under the Ministry of Education functioned as the sole entity to formulate and implement school curricula in Nepal. The Nepal prepared and implemented a National Curriculum Framework (NCF) for school education since 2007. The current school mathematics curriculum has been prepared and implemented by the Curriculum Development Center (CDC) within the Ministry of Education, Science, and Technology as per the guidelines of NCF (CDC Nepal, 2007; 2015).

The National Governors Association Center for Best Practices and the Council of Chief State School Officers initiated the formulation of a common standard for all states with consistent, real-world learning goals to help prepare high school students for college, career, and life. The standard was prepared by integrating two components -- college and career readiness standards, and the K-12 standards. There were contributions from teachers, parents, teacher educators, administrators, citizens and the State Department of Education of each state (NGACBP & CCSSO, 2010).

In case of Nepal, an advisory committee had been formed under the coordination of Executive Director of CDC which conducted national and regional workshops to get input from teachers, parents, students and other education stakeholders while preparing NCF. The committee also conducted a study of literature and past curricula, and best practices of other countries to have a background study for the NCF. It organized several thematic discussions and meetings among policy makers at the Ministry of Education which then formalized the draft of NCF (CDC Nepal, 2007).

Mathematics for pre-primary level. The focal content areas in Kindergarten level in CCSSM are counting and cardinality, operations and algebraic thinking, number operations in base ten, measurement and data, and geometry. The CCSSM outlines the details of each content standard (NGACBP & CCSSO, 2010). Whereas, the focal content areas in the Early Childhood Development Handbook (2006) published by the Ministry of Education of Nepal includes numbers and counting; measurement (comparing quantity, shapes, sizes); time; geometrical shapes; qualitative and quantitative comparisons. For each of these content areas, expected learning outcomes for three and four-year-old children have been outlined (MOE Nepal, 2006). The analysis of the CCSSM for K-mathematics in the USA has seven content standards for counting and cardinality, whereas there are too many learning outcomes for ECD curriculum for numbers and counting in Nepal. However, the seven content standards combined with the eight process standards in CCSSM for K-level mathematics for counting and cardinality seems a strongly founded by supporting and informing each other if applied with the same intent in the classroom. In this sense, the learning outcomes for numbers and counting with a breakdown of the processes into many expected outcomes do not seem coherent and logically connected to each other and hence achieving these outcomes in the classroom is a big challenge. These differences may not be the same for other content areas.

Mathematics for elementary level. The focal content areas in elementary level (grades 1-5) in CCSSM include operations and algebraic thinking, number operations in base ten, fractions, measurement and data, and geometry. The main content areas in the primary level mathematics curriculum in Nepal include the topics in geometry, number sense, basic mathematics operations, money measurement, time, length, area, volume and weight, fraction decimal, simple interest, unitary method, bills and budget, statistics, sets, and algebra. This clearly shows that the content width seems broader in Nepelese mathematics curriculum for grades 1-5 than in American curriculum standards as per CCSSM.

I selected one of the most critical area of contents that is fractions in grade five to compare the American and Nepali standards and curriculum in terms of the distribution of content standards and associated processes for actions. The comparison of content standards or learning outcomes in the curriculum for content fraction such that CCSSM includes the specific seven standards with detailed explanation of what is expected to teach this content area integrated with the eight processes for actions (e.g., making sense of problems and persevere in solving them, …., look for and express regularity in repeated reasoning). It also indicates that teachers and students can use visual fraction models and equations to represent the problem and solve them with the help of manipulatives or figures (visual objects) (NGACBP & CCSSO, 2010).

The four learning outcomes set by the CDC Nepal in grade five curriculum for the content fraction has a very limited scope of understanding the varieties of fraction problems. It does not include fraction division at all and it does not specify what kind of materials can be useful in teaching-learning fraction in the classroom although it lists some common teaching approaches (e.g., inductive method, simple to complex, concrete to abstract, problem-solving method, and mathematical thinking) and instructional materials (e.g., base ten blocks, models, real things, standard units of weight, and measurement) in the curriculum (CDC Nepal, 2015).

Mathematics for middle level. The major topic areas in the CCSSM for middle grades (grades 6-8) include ratios and proportional relationships, number systems, expressions and equations, functions, geometry, statistics, and probability. The curriculum for grades 6-8 in Nepal includes the major contents as geometry, coordinate geometry, mensuration, transformation, sets, arithmetic, algebra, and statistics (CDC Nepal, 2015). The distribution of contents in grades 6-8 in the CCSSM and CDC curriculum shows a great deal of disparity. For example, the CCSSM has a topic on 'functions' in the content standards which is not the case for the CDC curriculum of Nepal. The contents in the CDC curriculum for grades 6-8 include sets, but is not included in the CCSSM.

While analyzing statistics content (as a sample) in the CCSSM of the USA and CDC Nepal curriculum for grade eight shows some differences. The content of statistics in CCSSM focuses correlation of two variables with scatter plot, line of best fit, degree of correlation, the direction of correlation, and interpretation of the linear association of two variables with tables and graphs. There is much depth and width of problems associated with the correlation of two variables in CCSSM. However, the CDC curriculum of Nepal for grade eight focuses on the central tendencies, and range of individual data without a group. There is no explanation of analysis and interpretation of data or making sense of data using these measures. The curriculum includes the pie chart and line graph to present data for analysis and interpretation but there is no further detail in the learning outcomes. The interpretation of other contents and grades could be different.

Mathematics for highschool level. The contents for the high school mathematics in CCSSM focused number and quantity, algebra, functions, modeling, geometry, statistics and probability. These contents are taught in the sequence of Algebra I, Algebra II, Geometry, Trigonometry, and Pre-calculus (Dossey et al., 2016). However, students who are good in mathematics and wish to take further mathematics for college credits, they can take advanced placement courses in calculus and statistics (AP Calculus AB, AP Calculus BC, AP Statistics) (Dossey et al., 2016). The high school mathematics curriculum of Nepal has mandated a compulsory study of mathematics until grade 10 that include major topics such as-- sets, arithmetic, mensuration, algebra, geometry, trigonometry, statistics, and probability. The students who prefer to continue studying mathematics can take major mathematics in grades 11 and 12. These optional mathematics include contents such as-- relations, functions, graphs, trigonometry, sequences and series, calculus, combinatorics, vectors, analytic geometry, statics, dynamics, linear programming, and basic computing.

Issues with curriculum and standard. There are issues related to the implementation of CCSSM from the viewpoints of parents and teachers. These issues are-- inadequate funding, lack of clear guidance to implement CCSSM, resistance from the communities, lack of mathematics knowledge in teachers, lack of parental support, lack of textbooks that support standards, and lack of state assessments aligned to standards (Center on Education Policy, 2011). The other issues are related to the quality, equality, the readiness of mathematics teachers, and adopting standards for disabled students (Akkus, 2016; Opfer et al., 2017; Smidt, n.d.). Likewise, there are issues associated with mathematics curricula in Nepal too. These issues are related to the curriculum development process, consistency and continuity of curriculum, norms and value-based education, life-skills based education, ICT based education, mother tongue issues, inclusiveness, local needs, quality and relevance of education in general and mathematics education in particular (CDC Nepal, 2007).

"In particular, in comparison with the top performing countries, US curriculum materials are less focused and more repetitive, and US curriculum policy is less authoritative, less specific and less consistent" (Wang & Lin, 2005, p. 3). However, compared to mathematics curricular materials of Nepal, the CCSSM provides a detailed description of contents and actions to be taken. The mathematics textbooks of the USA seem to have better qualities in terms of outlining conceptual clarity and sophistication of explanations with guiding questions for reasoning and justifications compared to the textbooks of Nepal. For example, Algebra 1 Common Core textbook by Charles et al. (2015) and grade 8 mathematics textbook of Nepal by Archarya (2015) demonstrate a sharp contrast in terms of book quality, quality of content layout, examples, and exercises. A separate analysis of these textbooks would reveal much detailed analysis which is beyond the scope of this paper.

Teaching and Learning of Mathematics

Approach to teaching mathematics. The teaching of mathematics is guided by four dimensions-- tasks, discourse, environment, and analysis (NCTM, 1989). The CCSSM has eight process standards for mathematics --make sense of problems and persevere in solving them, reason abstractly and quantitatively, construct viable arguments and critique the reasoning of others, model with mathematics, use appropriate tools strategically, attend to precision, look for and make use of structure, and look for and express regularity in repeated reasoning (NGACBP & CCSSO, 2010). Mathematics curriculum of Nepal states that teaching should be facilitating students' learning through within or out of classroom discussion, contextualization to daily life, remedial teaching, and creation of appropriate learning environment. Methods of teaching include-- inductive-deductive, demonstration, exploration, analysis and synthesis, problem-solving, local tour for observation, experimentation, case studies and projects, collaborative and cooperative teaching, and discussing and questioning (CDC Nepal, 2015). Observation of a TIMSS video demonstrates that mathematics teachers in the USA play the role of facilitator-cum-instructor. Observation of a sample video of Nepali mathematics classroom by NCED Nepal demonstrates that teacher role is instructor-cum-facilitator. That means mathematics teachers in the USA have a more facilitating role and less instructing role, whereas in Nepal they have a more instructing role than facilitating in the mathematics classroom.

Student participation. In the mathematics classroom in the USA, students have active participation in learning through individual and group works (Kratochwill, 2019). In Nepal, most of the students work individually and sometimes in a group only when there is project work. Teachers rarely encourage or organize peer-learning or group activities in the class (NCED, 2014). Teachers make expected classroom behavior explicit and they set classroom rules with the help of students in the USA. The teachers display classroom rules and goals on a chart (Kratochwill, 2019). There are a few documents and literature on classroom management in Nepal. These literature do not specify classroom values, norms, and roles (Rijal, 2014) except stating that there is a lack of proper arrangement of furniture, and lack of use of other facilities (Khatri, 2016). Some teachers may learn classroom management through professional development (Pokharel & Behera, 2016), but rarely these practices are materialized in the mathematics classroom due to lack of resources and inflexible curriculum and classroom structure (Pokharel & Behera, 2016).

Mathematics classroom set up in the USA is flexible. Students use technology (e.g. computers/calculators), manipulatives, and other materials that are accessible in the classroom. Mathematics teachers use overhead projector and screen in the classroom including other audiovisual materials, charts and graphs and pictures on classroom walls in the USA (TIMSS Video for Mathematics, 1999). Whereas, the mathematics classrooms are fixed (in most cases) for a grade level and section in Nepal. The tables and chairs or desks and benches are not flexible to move and re-organize for group work limiting student participation in group works. If there is a project work or demonstration of mathematical tasks or concepts, the teachers need to bring materials in classrooms themselves because every grade level has a fixed classroom and teachers visit class to class for teaching in every class period (NCED Video on Probability, 2014).

Use of technology and other material. In the USA, teachers and students use computers, smartboards, tablets, document camera and multimedia projectors, and students use calculators and computers while working on mathematics tasks and problems (Watson, 2015). Teachers and students in Nepal rarely use technology such as computers, however, sometimes they may use calculators. “Education technology hardly plays a role at government schools in Nepal” (Mainali & Heck, 2015, p. 488). Programs such as One Laptop Per Child (OLPC) provided laptops to some schools (100+) in 18 districts but there was limited use of these resources for meaningful teaching and learning of mathematics (Karmacharya, 2015; Mainali & Key, 2012). A similar study by Rana (2015) reported that the Government of Nepal invested on ICT in schools through the project School Sector Reform Plan (SSRP) 2009-2015. However, such funding was not adequate and effective for high schools and there was no such funding for primary schools (Rana, 2015). In the USA, besides computers and other technology, teachers and students use real or virtual manipulatives in the classroom to help students grasp abstract mathematics (Moyer, 2001; Taylor, 2009). Teachers and students use manipulatives in early childhood education centers or pre-primary and primary levels in Nepal (Mahato, Morgan, & Ernest, 2019) but such use of manipulatives is very limited in higher grades (NCED Video on Probability, 2014).

Issues in teaching-learning. Two significant challenges/issues in mathematics teaching and learning in the USA are related to technological advancement and rapid change in the social structure. Due to such changes, students might get a different kind of knowledge, even in the same lesson taught (Karp, 2016). The rapid advancement of technology has brought many opportunities for the teachers and students, however many teachers are not updated with technological tools to use in the classroom. The multicultural classrooms create a challenge for teachers to deal with students of different ability, interest, and cultural background. The National Curriculum Framework of Nepal mentions some issues such as -- language, instructional approach, classroom structure, and resources in the classroom among others in general without specifying these issues related to mathematics classrooms or others (CDC Nepal, 2007). These challenges have been identified as equity and social justice in mathematics classroom, effect of gender and ethnicity in mathematics achievement, language issue, and issues associated with teacher preparation and trainings (Panthi, Luitel, & Belbase, 2018).

Pre-service Mathematics Teacher Education

Requirements to be a mathematics teacher. The qualification to be an elementary, middle school or high school mathematics teacher is a bachelor's degree and teaching certificate required to teach any level in K-12 in the USA. An alternative route (e.g., Teach for America) to be a teacher is available to suitable candidates based on educational background and additional training (internships) and coursework in the USA (Dossey et al., 2016). As per the NCF (2007) for the primary level teacher, the qualification required is certificate level or grade 12 with a teaching license, for basic level (lower secondary) mathematics teacher require qualification of bachelor's degree in mathematics teacher education and teaching license, and secondary level teacher-- master's degree with a teaching license.

In the USA, the universities are involved in preservice teacher education. Normally, Mathematics Department offers most of the content courses for mathematics teachers and College of Education offers pedagogical and professional courses (Dossey et al., 2016). Faculty of Education at Tribhuvan University and similar units in other universities provide both content and pedagogical/professional courses. However, for the PGDE or one-year B.Ed. program, the prospective teachers take content courses in the mathematics department in other faculties/colleges and take only pedagogical/professional courses in FOE. Higher Secondary Education Board provides +2 (Grades 11-12) education program for basic level teachers (CDC Nepal, 2007; Pradhan, 2011).

Courses for preservice teachers. As per Texas State University mathematics teacher education program, a total of 120 credit hours of coursework required for a Bachelor's degree with teaching certification that includes 42 credit hours of general education ranging from college writing, natural science, language, philosophy and culture, creative arts, literature, history, social, behavioral and political science. Prospective teachers have to take 21 credit hours of professional/pedagogical courses that include teaching methods, classroom management, psychology, and teaching readiness. Preservice teachers have to take 38 credit hours of major courses (in contents) that include-- calculus, algebra, geometry, statistics, analysis, history of mathematics, and mathematics for secondary teachers. Prospective teachers have to teach at least 40 contact hours in a school for 16 weeks during their practicum (Texas

State University, 2019).

In Nepal, pre-service mathematics teachers take two language courses that are compulsory Nepali and English offered as general courses at B.Ed. level in the Faculty of Education of Tribhuvan University. Pre-service teachers have to take a philosophical and social foundation, educational psychology, curriculum and evaluation, and methods of teaching mathematics. Prospective teachers have to take mathematics content courses such as foundation of mathematics, calculus, geometry, real analysis, history, modern algebra, analytic geometry, linear algebra and vector analysis, advanced calculus. Prospective teachers in Nepal have to teach at least 12 lessons in a school during their practicum(Tribhuvan University, 2019). The details of course distribution for pre-service middle grades and secondary mathematics teachers at Texas State University and Tribhuvan University are compared in Table 1.

Table 1. Categorical distribution for Bachelor in Mathematics Education at Texas State University and Tribhuvan University in terms of general education, professional education, mathematics content, and teaching practicum.

Courses	Texas State University	Tribhuvan University
1, General Education courses	US1100- University Seminar, ENG1310- College Writing I, CS1428- Foundation of Com.Science I, POSI2310- Principles of American Government, ENG1320-College Writing II, HIST1310 - History of the US to 1877, SOBS080- Soc. and Beh. Sciences, PHIL1305- Philosophy and Critical Thinking or PHIL1320- Ethics and Society, HIST1320 - History of the US 1877 to Date, LPHS030 - Life and Physical Science, COMM1310- Fundamentals of Human Communication, ENG090/094- English Literature, POSI2320- Functions of American Government, ART2313- Introduction to Fine Arts or other Arts Component, ENG3303 - Technical Writing, and Elective (Altogether 55 Cr. Hrs.)	COM Nepali (100), GEN English (100)
2.Professional/ Pedagogical Courses	CI4332- Sec. Teaching - Curriculum and Technology, CI3325- Adolescent Growth and Development, CI4370- Classroom Management, Ethics, and Legal Issues in Sec. Teaching, CI4343- Instructional Strategies for Secondary Teachers, RDG3323- Teaching Reading in Mathematics, Two Elective Courses (Altogether 21 Cr. Hrs)	Phil. & Social Foundation (100), Ed. Psychology (100), Curriculum and Eva. (100), Teaching Mathematics (100), ICT in Math Edu. (100)

3.Mathematics Content courses and Minor Courses	MATH2471- Calculus I, MATH2472- Calculus II, MATH3330- Introduction to Advanced Mathematics, MATH3315- Modern Geometry, MATH3306- Introduction to Statistical Method, MATH3377- Linear Algebra, MATH3380- Analysis I, MTH4311- Introduction to History of Mathematics, MATH4307- Modern Algebra, MATH4304- Capstone Mathematics for Secondary Teachers, MATH3323- Differential Equations, MATH3373 - Calculus III (other adv. math) (Altogether 38 Cr. Hrs)	Minors 1-5 (500), Calculus (100), Foundation of Math (100), Geometry (100), Real Analysis (100), Historical Dev. of Math (100), Modern Algebra (100), Analytic Geometry (100), Linear Algebra (100), Advanced Calculus (100)
4. Practice Teaching	EDST4681- Student Teaching 7-12 (6 Cr. Hrs)	Teaching Practice (100)
Total	120 Cr. Hrs.	2200 Full Marks

Comparison of preservice teacher education courses. Table 1 above shows that there is a large number of general education courses to be taken by preservice mathematics teachers during their undergraduate teacher preparation program at Texas State University. Whereas, there are only two language courses to be taken as general education courses by the pre-service mathematics teachers at Tribhuvan University. The professional and pedagogical courses in the Texas State University are more aligned toward teaching and learning of mathematics that cover the areas of classroom management, curriculum and technology, child growth and development, instructional strategies, and teaching reading in the content areas of mathematics (Texas State University, 2019). There is only one pedagogical specific course at Tribhuvan University under professional and pedagogical courses that is directly related to mathematics education. Other professional courses are the foundation of education, curriculum and psychology courses which do not have a direct link with mathematics education (Tribhuvan University, 2019). The provision and focus on ICT, Teaching Method, and Practicum or Teaching Practice seems almost similar although depth and focus might be comparable to each other.

Mathematics educators at Texas State University teach pedagogical and professional courses and supervise student teaching. Preservice teachers work with school teachers (mentors) of respective grade bands during their practice teaching. Student teachers do not take any other courses during clinical practice (Texas State University, 2019). Mathematics teacher educators in Tribhuvan University teach both pedagogical/professional and content courses, and they also supervise student teaching. Preservice teachers work with school teachers (mentors) and mentors assess their teaching in the classroom. Student teachers take some major content and minor courses even when they are doing their practice teaching in Tribhuvan University (Tribhuvan University, 2019). The pre-service or inservice mathematics teacher education could be interpreted differently if chosen other sample from among the US universities other than Texas State University because differences of the number of courses offered and the nature of the courses.

Issues with preservice teacher education. There are some issues/challenges of mathematics teacher education in the USA. Some of these issues are lack of support to the teachers, lack of collaboration among mathematics teachers, and vague curriculum standards and textbooks. The other challenges are implementing new curriculum standards, making a connection to real-world context, sustainable change, and implementation of technology in teaching and learning mathematics (Chapman, 2012; Swun Math, n. d.). Likewise, there are issues in mathematics teacher education in Nepal. These issues are -- curriculum/syllabus not as per the current need (lack of relevance), lack of research-based courses, lack of technology, lack of motivation of teacher educators, lack of diversification, lack of competent administration and lack of focus on clinical and practical activities in mathematics teacher education in Nepal (ADB, 2013; UNESCO, 1990).

Assessment Practices in Mathematics Education

Assessment types. The CSSM emphasizes student assessment as a continuous process in the class with mental computations and estimations informally, teachers assess student progress throughout the year and at the end of the year. The assessments are based on three fundamental principles- the content principle, the learning principle, and the equity principle (Rosenstein et al., 1996; NGACBP & CCSSO, 2010). Formative assessments in the USA include continuous monitoring, probing and providing feedback to students on their tasks and activities in the classroom. Other forms of formative assessments teachers use are- observations, interviews, show me, hinge questions, and exit tasks in a lesson (NGACBP & CCSSO, 2010; Rosenstein et al., 1996).

In Nepal, the mathematics curriculum suggests both formative and summative assessment, and teachers should identify learning difficulties and help students overcome those difficulties. The assessment should focus on- students' achievement in learning goals, assess students' readiness to learn new concepts, provide feedback to students' work, provide feedback to teachers' teaching effectiveness, evaluate students' learning achievement, and assess transfer of learning in mathematics (CDC Nepal, 2015). The School Sector Reform Plan Programme 2009-2016 recommended for implementation of continuous assessment system (CAS) in schools in Nepal (European Union, 2016). Currently, continuous assessment of students' learning has been implemented in elementary and lower secondary grades in Nepal and it is going to be implemented in the secondary level too (Ministry of Education Nepal, 2016). Some studies (e.g., Pandey, 2016; Pyakurel, 2016) found a positive correlation between successful implementation of CAS on student performance in mathematics.

Assessments in practice. The summative assessments in the USA include teacher-made tests, the district-made tests or state-mandated tests any time or end of year assessment in each grade level; standardized tests conducted by states at 4th, 8th and 12th grades as per Every Student Success Act (ESSA, 2015). Before it, No Child Left Behind (NCLB) (2001) Act had significantly influenced teaching and learning of mathematics. As per ESSA (2015), there should be national-level tests in grades 4, 8, and 12 conducted by NAEP (Dossey et al., 2016). Some sample schools in the USA participated in international tests such as PISA and TIMSS.

The US ranked 14th in TIMSS 2011 for 4th graders and 10 for 8th graders. Mathematics performance in PISA 2015 dropped from average of 481 to 470 compared to 2012 (Dossey et al., 2016). In Nepal, mathematics teachers and schools conduct formative assessments in the form of terminal tests and final exams in each grade level; they also conduct a district-level formative assessment in grade 8 and national-level tests in grades 10, 11, and 12. The CDC (2015) has outlined specification grids for summative assessment purpose. As per current practice, there are standardized national level exams at grades 10, 11, and 12. Nepal did not participate in PISA or TIMSS studies until 2019.

Use of Assessments. The NAEP publishes the nation's report card from the tests in grades 4, 8 and 12. The test results are used for improving and guiding instruction; and to support teachers' work in the USA (National Research Council, 2010). In Nepal, the National Assessment of Student Achievement (NASA)'s findings were used by CDC for curriculum review and reform. Based on the recommendations from NASA (2013), as per the policy of NCF (2007), the subject-specific primary curriculum and textbooks have been integrated into one. The NCED also took account of NASA's study results to assess teacher education and development by specifying teacher competencies (Paudel & Bhattarai, 2018).

Center for Educational Research and Social Development (CERSOD) conducted a Feasibility Study on Nepal's Participation in International Assessment in 2016. The study compared TIMSS, PISA, and PIRLS with the NCF of Nepal to similarities and differences between these international assessments and the national curricula and assessments. The comparison of grade 5 and 8 mathematics curricula of Nepal with TIMSS grade 4 and 8, and mathematics curricula of grade 10 with PISA-2015 had been carried out to find out potential to find Nepal to participate in the international assessments (CERSOD, 2016). However, the analysis of the curricular items with the test items of TIMSS and PISA do not produce comparative domains of student learning in mathematics between students of the USA and Nepal in the respective grades because it only predicts how close or far the national curricula is from the items of the international assessments (CERSOD, 2016).

Student performance. Since there is no such common tests in which students of the USA and Nepal can participate, it is still possible to compare the results of national assessments in these countries in terms of students' performance with respect to race, language, and other socioeconomic factors. In a study of National Assessment of Student Achievement (NASA, 2013) conducted by the Education Review Office (ERO) of Ministry of Education, Nepal found that the performance of grade eight students varied across race, gender, and ethnicity (Education Review Office (ERO), 2013). The study reported that Dalit girls and boys underperformed in mathematics compared to other ethnicities in Nepal. Similarly, Madeshi students' performance in mathematics was lower than the national average. In the same way, the students who received textbooks on time performed better than the students who did not receive mathematics textbooks on time (ERO, 2013). These cases are comparable to the performance of students in the USA.

The National Assessment of Educational Progress (NAEP, 2017) data published by the National Center for Educational Statistics (NCES) shows that the performance of grade eight students in mathematics in the USA varies across the races. The data shows that the average scores in mathematics for the White students in 2017 was 293, Black students was 260, Hispanic students was 269, and Asian/Pacific Islander students was 310. The distribution of the scores was not significantly different from the year 2015 (NCES, 2019) in terms of distribution across the students of different races. The racial discrimination in student performance in mathematics in grades 4 and 12 also supports this finding (NCES, 2019). That means the students' performance in mathematics in both countries are significantly affected by their racial background. Closing this achievement gap is a challenge for the educational policymakers and school leaders in both countries.

Issues with assessments. There are some issues associated with the assessment of students' learning of mathematics in the USA. These issues are-- ensuring the purpose of assessment, improve student learning, integrating mathematical practices with assessment, equitable assessment, and negotiating classroom purpose with large scale assessment (Suurtamm et al., 2016). The issues of mathematics assessment in Nepal are-- mathematics assessment in paper-pencil tests conducted in schools measures only some cognitive skills but they do not measure the multiple intelligence of students, gives high priority in ranking of students, assessment guides the teaching-learning of mathematics in the classroom; lacks gender friendly classroom environment affect assessment, lack of teacher training to construct effective assessment items, and effect of ethnicity and language on students' performance (Bhandari, 2017).

Limitations of the Study

There are several limitations to this study. First, this study is solely based on document analysis of relevant literature and information available on the websites of relevant institutions and organizations. The information may be continuously updated and hence it may cause a discrepancy in the information in the paper and in the respective sources (especially online sources). Second, the comparison of the mathematics curriculum standards/frameworks of the USA and Nepal is partial with small samples of CCSSM-2010 and CDC Nepal (2007 & 2015). I did not use the standards of mathematics in other states which do not adopt CCSSM. Comparison of teaching and learning of mathematics in the USA and Nepal has been performed by using samples of TIMSS Video in Mathematics (1999) and NCED Video Mathematics (2014). To compare the mathematics education, I selected middle and secondary level pre-service mathematics teacher education at Texas State University and Tribhuvan University for the comparison of courses. Hence, the analyses and interpretations cannot be generalized to the entire situation of mathematics education in the USA and Nepal.

Implications and Conclusion

The comparative study of mathematics education in the USA and Nepal have three major implications- pedagogical, policy, and research.

The comparison of mathematics education in the USA and Nepal has a significant pedagogical and research implications for mathematics teachers and teacher educators in both countries. There are no centralized mathematics curricula in the USA although the CCSSM has been adopted in 41 states and the District of Columbia, whereas, there is an NCF for school education in Nepal that guides the process of mathematics curriculum formulation and implementation in Nepal in a centralized process. The decentralized education system in the USA bears some merits with the flexibility for the states and local school districts to either adopt CCSSM or formulate their standards. Despite the decentralized system of education, there is a huge influence of No Child Left Behind (NCLB) Act 2001 and Every Child Succeeds Act (2015). These acts have a significant influence on the teaching-learning of mathematics in the US classrooms to raise the student achievement level because teachers and schools are held accountable for students success through these acts or laws. This kind of accountability can be a good lesson for Nepalese mathematics teachers and schools to be accountable for their classroom teaching and learning activities that have a significant impact in students' performance. Likewise, US mathematics education can benefit from a unified curriculum framework to guide the standards, teaching and learning, and assessment practices across the states.

Nepal is in the process of reforming her educational policies, plans, and rules with the adoption of the federal system of government with three layers of governance-- central, states, and local levels. The mathematics education plans and policies can be decentralized with more autonomy for the states and local government to decide about locally contextualized mathematics curriculum, teaching and learning, and assessment practices. The decentralized policy will provide more autonomy and ownership of mathematics curriculum, textbooks production, distribution, teacher development, adoption of new methods of teaching and learning as per the cultural values, norms and practices in the local communities with different linguistic and ethnic backgrounds. Similarly, the educational community of the USA can learn that a total autonomy of educational policy might have resulted into chaos and complexity with various interests groups playing roles for mathematics education with varied curricula, content standards, pedagogy, and assessments leading to the potential 'math war'.

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