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Mathematics Textbook: Motivation, Experiences, and Didactical Aspect from Authors' Perspectives

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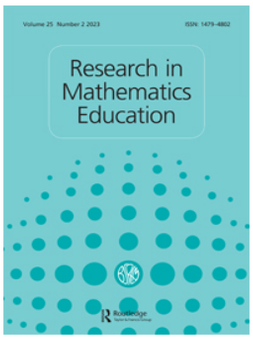

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Mathematics textbook: motivation, experiences, and didactical aspect from authors' perspectives

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ABSTRACT

Textbooks play a vital role in the Nepali education system since they are one of the main resources for teaching and learning mathematics. Because of poor physical infrastructure and inadequate educational resources, both teachers and students heavily rely on textbooks. In this regard, this study investigated the mathematics textbook authors' experiences and motivation, and what types of didactical knowledge were utilised while writing textbooks. A convenient yet purposeful sampling method was utilised to select four participants. The data analysis unveiled that each textbook author had different types of motivation and experiences, and only one participant was aware of the ideas of didactical knowledge and utilised them to some extent in textbooks. The writing process was more influenced by the examination, mathematical content, and classroom experiences. As a result, textbooks seemed to be content-heavy and examination-oriented. Additional professional development programmes likely would help authors to produce more effective textbooks in Nepal.

KEYWORDS

Textbook writers; didactical knowledge; mathematics in Nepal

Introduction

Textbooks are one of the important components of curriculum reforms and are considered to have a prominent role in implementing curriculum around the globe (Valverde, Bianchi, Wolfe, & Schmidt, 2002). Mathematics textbooks in particular have a major role in teaching and learning mathematics because of their close relationship to the instructional strategies in the classroom (Johansson, 2003). The impact of textbooks in the mathematics classroom is substantial and their content is highly correlated with students' achievement, yet individual textbooks differ in their effects in teaching and learning mathematics (Bozkurt & Yılmaz, 2020; Hussain, 2012; Törnroos, 2005; van den Ham & Heinze, 2018; Xin, 2007). A number of studies have reported a positive correlation between textbook usage and achievement in mathematics, particularly in developing countries (Hussain, 2012; Lockheed, Vail, & Fuller, 1986). "Nothing has ever replaced the printed word as the key element in the educational process and, as a result, textbooks are central to schooling system at all levels" (Altbach, 1983, p. 315).

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In fact, the textbook influences instructors' educational decisions in the selection of the mathematical content and corresponding tasks used in class, forming the aim of the lesson in day-to-day teaching (Skott, 2001). Thus, the mathematics education community has a general consensus that textbooks play a vital role in the teaching and learning of mathematics. Textbooks are even more important in developing countries such as Nepal, because it is one of the main resources for teaching and learning mathematics. However, attention has not been given as to why authors are motivated to write textbooks, what issues they encounter while writing the textbooks, and what didactical knowledge authors utilise in writing textbooks?

Mathematics curriculum and textbooks in Nepal

The public education system in Nepal flourished only after the demise of the Rana regime in 1951. Many schools, colleges, and universities started to emerge after this major political change. The formal writing of mathematics textbooks in Nepali language began as early as 1884 (Basyal, 2020). After restoration of the multiparty system in 1990, the government of Nepal adopted a more liberal policy in the education sector. As a result, private schools expanded considerably, and the demand for school-level textbooks increased (Caddell, 2007; Thapa, 2011).

In 2007, the Ministry of Education (MoE) Nepal conceptualised a National Curriculum Framework (NCF) which outlines the multiple aspects of the school education system. With a centralised education system in place, the NCF is a guiding document that lists the procedures and policies for creating and implementing curriculum in schools around the country. NCF aims to make students competent to cope with the challenges of the twenty-first century (MoE, 2007). In relation to the production and distribution of textbooks, NCF states that "A policy to involve private sectors on the basis of open competition will be adopted in developing, producing and distributing textbooks addressing students' interests, ability, and pace of learning (MoE, 2007, p. 51)". NCF policy documents (MoE, 2009, 2012, 2014) further mandate which mathematics content standards need to be taught at each grade level; however, it does not dictate what types of examples, problems, text, syntax, graphs, figures, etc., need to be included in the mathematics textbook. Nine mathematics content areas for primary grades (grades 1-5) and eight content areas for middle to lower secondary grades (grades 6-10) are listed in the documents. Additionally, NCF policy documents specify the objectives of the curriculum at the various levels: objectives at the national level, school level (elementary to high school), and at each grade level. Moreover, it also includes time allocation for each mathematics topic, weightage of each content area, processes for student evaluation, and a template for the final examination.

In the Nepali education system, there are two types of schools: public and private. Normally, government-funded public schools are obliged to adopt the mathematics textbook which has been published by a government-controlled publisher company, namely Janak Shikshyaa Saamagri Kendra (Janak Educational Materials Center). Private schools, however, are at liberty to adopt any textbooks. Oftentimes the decision of adopting textbooks, particularly in private schools is largely based on the personal connection of the school to the textbook writers, publishers, and other underlying financial benefits. The financial benefits include, but are not limited to, the price of the books, discount on

the price, and commission received by schools from publishers. In fact, textbook publishing is a business aiming for a large market share rather than following curriculum guidelines (Johansson, 2003; Kim, 2009). Additionally, it has been suggested publishers do not really care about curriculum guidelines and framework, rather they are more concerned with increasing the marketability of their textbooks (Woodward, 1993). Nepal, it appears, is no exception.

Rationale of the study

Although Nepal has not participated in large-scale assessments such as the Trends in International Mathematics and Science Study (TIMSS) and the Programme for International Student Assessment (PISA), the education system in Nepal has been evaluated and assessed regularly by the Education Review Office (ERO). Moreover, Secondary Education Examination (SEE), an annual examination has been conducted nationwide at the end of the 10th grade. The SEE is often utilised as a measuring rod for the success of the education system in Nepal. The ERO and SEE results have pointed out various issues in mathematics education in Nepal. For example, many students were incompetent in solving contextual problems requiring a higher level of cognitive thinking (ERO, 2013, 2015). The majority of fifth-graders, for example, were categorised as underperforming and about half of the student population could not perform simple mathematics operations and lacked basic numeracy skills (ERO, 2019). Similarly, most of the public-schools' students were underperforming in the recent SEE examination (Chapagain, 2021). Moreover, studies suggest that the majority of problems in Nepali mathematics textbook are of low cognitive demand, and a worked-out example similar to most problems is readily available (Basyal, Jones, & Thapa, 2022; Jäder, Lithner, & Sidenvall, 2020: Jones & Basyal, 2019). Coupling the discouraging results of NASA and SEE with textbook-bound teaching practices in Nepal (Bajracharya & Brouwer, 1997) naturally, raises a question of whether the mathematics textbooks written by the Nepali textbook authors provide adequate opportunities to learn mathematical concepts that are tested in these examinations.

The report of the National Advisory Panel, USA (2008, p. 55) pointed out errors and ambiguities in recently published mathematics textbooks as well as the scarcity of research in mathematics textbooks. For example, the report states that "many of the detected errors and ambiguities arose in word problems that were intended to elicit use of the mathematical concepts and procedures in real-world contexts" (p. 83). A number of studies reported that mathematics textbooks analysis and cross-national comparison of textbooks provide valuable insights to explore issues in textbooks (Charalambous, Delaney, Hsu, & Mesa, 2010; Howson, 2013; Törnroos, 2005). Fan (2013), however, suggested that researchers need to go beyond just textbook analysis and comparison in order to investigate more about the textbooks' role in teaching and learning mathematics. One of the important components regarding textbooks that can be investigated is the authors of the textbooks since their role in creating appropriate and effective textbooks is paramount. It is important to understand from an educational perspective why authors write textbooks. Are the writers motivated intrinsically or extrinsically? What resources do they use to inform their writing? What didactical knowledge do authors utilise while writing textbooks?

Theoretical framework

Shulman (1986) states that three types of knowledge: Content Knowledge (CK), Pedagogical Knowledge (PK), and Pedagogical Content Knowledge (PCK) actually help to understand textbook writers' subject expertise. CK refers to various aspects of mathematical knowledge: structure of the knowledge, the principles, theories, and the concept of mathematics (Shulman, 1986). PK refers to creating effective instructional strategies and a conducive learning environment for all students in the class. PCK is the combination of content and pedagogical knowledge, which consists of two central ideas: knowledge of instructional strategies and representations and knowledge of students' (mis)conceptions (Shulman, 1986). These three types of knowledge are equally applicable and potentially important both for teachers and textbook authors.

Teachers take into consideration their own knowledge, PCK, goals, beliefs and classroom needs, and they evaluate the affordance, relevance, practicality and constraints of the curriculum materials in relation to their students, and the textbook writers do much the same; however, they may not necessarily be the classroom teachers (Lee & Catling, 2016).

Different scholars modified Shulman's knowledge framework. For example, Grossman (1990) further added two other components to PCK: knowledge of students' understanding and curricular knowledge and resources. Carrillo-Yañez et al. (2018) suggest that PCK is the combination of knowledge of content and teaching, knowledge of content and students, and knowledge of content and curriculum. Ball, Thames, and Phelps (2008) further refined Shuman's Knowledge framework. They introduced a different domain of knowledge called Specialized Content Knowledge (SCK), which is essential for effective teaching yet not a part of PCK. SCK refers to mathematical knowledge and skill unique to teaching (p. 400). They further added knowledge of content and students, knowledge of content and teaching, and knowledge of content and curriculum within the domain of PCK. In fact, they equally emphasise the importance of curricular resources along with a curriculum framework for the effective teaching of mathematics.

Curricular resources consist of various materials, including curriculum frameworks. Curriculum is the central guiding document to develop any instructional materials, including textbooks, whereas curricular knowledge refers to relevant knowledge about the curriculum. The fact is that each nation most likely has a national curriculum framework, which is a one of the main components of curricular knowledge. In fact, the curriculum is the programme used to help students meet the standards, and includes the instructional materials, the content standards, the activities, tasks, units, lessons, and assessments (NCTM, 2014, p. 70).

A textbook is one of the primary curricular resources. The various aspects of textbooks such as colour, structure, pictures, representations, cognitive demand, language, task selection, terminology, etc., are essential parts of pedagogical content knowledge. Furthermore, the five process standards (NCTM, 2000) and eight Standards for Mathematical Practices (SMP) (National Governors Association, 2010) are also related to curriculum and effective instructions.

Hashweb (2005) suggested that PCK refers to the collection of teachers' pedagogical constructions, which develop through experience. Experiences would be acquired when teachers, alike authors, engage in instructional activities such as planning, teaching, assessment, etc. In particular, when textbook authors likely have to go through various

steps while writing the textbook, they might have unique experiences in contrast to the teachers. In fact, pedagogical knowledge constructions result from an inventive and iterative process. Indeed, experiences and didactical knowledge influence the way authors write textbooks (Kiai, 2014). Furthermore, Hashweh added a subcategory: aim, purpose, and philosophy under pedagogical content knowledge. The aim and purpose of writing textbooks are likely the results of the motivation of the textbook authors. Motivational factors can be intrinsic or extrinsic, depending on the textbook writers' aim and objective that drive them to write the textbook (Lee & Catling, 2016). Normally, intrinsic motivation refers to doing something because it is inherently interesting or enjoyable; whereas extrinsic motivation refers to motivation arising from the expectation of some kind of rewards (Ryan & Deci, 2000).

In conjunction with the aforementioned theoretical background, we propose the following model as shown in Figure 1.

In order to examine textbook authors' experiences, motivation, and didactical aspects in regards to writing textbooks, we have utilised in the present study a qualitative method to acquire a richer set of data. Pedagogical content knowledge constitutes various types of knowledge and the set of knowledge is the result of an inventive and iterative process, which can be best examined by the qualitative method (Glesne, 2011).

Research questions

Acknowledging the important role of textbook writers in creating curricular materials, this study sought to investigate writers' experiences and various aspects of the textbooks writing process from the authors' perspectives. This includes, but is not limited to, the textbook writers' experiences, motivation, and understanding of various aspects of didactical knowledge. In this regard, the following research questions are posed:

1. What are the textbook writers' motivations and experiences in writing mathematics textbooks?
2. What didactical theory and pedagogical content knowledge are utilised while writing the textbooks?

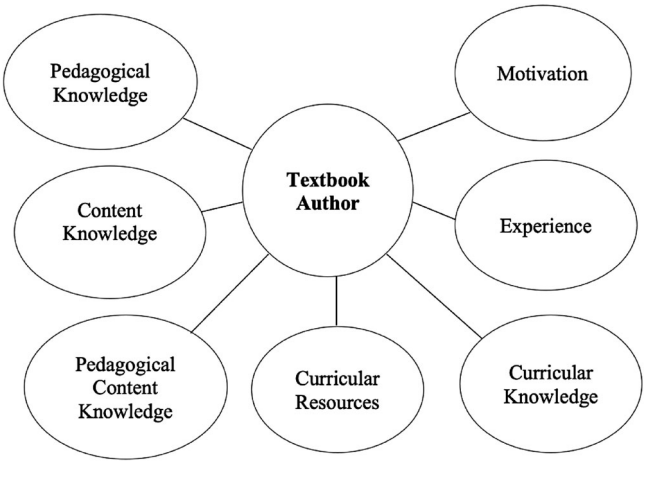

Figure 1. A theoretical model to investigate multiple aspects of textbook authors.

Related literature

Textbook

The concept of the textbook began as early as in an ancient civilisation. For example, Høyrup (2002) reported that Clay tablets with mathematical content from ancient Mesopotamia were used as an equivalent to the textbook in the modern age. The simple definition of a mathematics textbook is a book that can be used for the study of mathematics (Kilpatrick, 2014). Traditionally, textbooks refer to printed materials. With the emergence of new technologies, however, the meaning of textbooks has changed in recent years. For example, the state of Indiana, USA, defined a textbook as:

> "Textbook" means systematically organised material designed to provide a specific level of instruction in a subject matter category, including: (1) books, (2) hardware that will be consumed, accessed, or used by a single student during a semester or school year; (3) computer software, and (4) digital content (Justia, 2022, IC 20-18-2-23).

However, the traditional definition of a textbook is still more relevant in the case of Nepal including the south Asia region, where a centralised textbook system is prevalent (Smart & Jagannathan, 2018). Despite the change in the notion of textbooks, the fact is that textbooks are one of the important resources for teaching and learning mathematics around the globe (Valverde et al., 2002).

Textbooks should provide opportunities to explore mathematical concepts using various ingredients (Kim, 2009) and not just focus on standard algorithms. Earlier studies have shown that various aspects of the textbooks such as representations (Zhu & Fan, 2006), cognitive demands (Jones & Tarr, 2007; Stein & Smith, 1998), contextual contents (Wijaya, van den Heuvel-Panhuizen, & Doorman, 2015), textual and non-textual features (Kim, 2009) play an important role by allowing opportunities for flexible and complex thinking. These aspects of textbook ingredients can also be utilised to examine mathematical and pedagogical aspects of the textbook (Pepin & Haggarty, 2001). Therefore, understanding the nature of problems: those that incorporate high cognitive load vs those with low cognitive load, procedural vs conceptual problems, visual vs nonvisual problems, simple vs complex problems, and so forth should be helpful in writing effective textbooks. Writers with an understanding of these various aspects of textbooks will likely produce textbooks that effectively support student learning.

Grevholm (2014) suggested a theoretical model related to issues on textbooks, where she listed three elements: *factors influencing textbooks*, f*actors influenced by* textbooks, and the *textbook* itself. Two elements of this proposed model seem to be relevant to analyse the writer's perspectives. *Factors influencing textbooks* include various components such as curriculum, authors, theories of learning, and teaching, whereas *textbooks* consist of various factors such as colour, structure, picture, content (visible properties), cognitive demand, language, task selection, terminology (invisible properties) of the textbook. Thus, it is important to understand these various factors as they relate to writing textbooks.

We believe that in order to resolve the various issues in textbooks, it is helpful to understand various aspects of textbooks reported in the research. For example, Dole and Shield (2008) and Shield and Dole (2013) observed that textbooks they

investigated did not support deep learning in mathematics. The mathematics contents of textbook from England analyzed by Haggarty and Pepin (2002b) was lacking in variety, cognitive challenge and linguistic complexity. Sutherland, Winter, and Harries (2001) reported that textbooks from some countries place less emphasis on mathematical structure, mathematical representations, and real-life contexts. Similarly, Makonye (2020) states that the textbooks that are not attuned to learners' social and cultural background were less helpful in learning Financial Mathematics. Kajander and Lovric (2009) warned that the presentation of mathematical materials in textbooks could contribute to students' misconceptions. Various issues in textbooks might have resulted from textbook writers' lack of awareness of such problems, inexperience of dealing with them, inadequate professional development opportunities and insufficient time to process all the information needed to handle them properly. In fact, Friesen and Kuntze (2020) suggest teacher's and in turn, textbook author's knowledge of mathematical content is a significant factor in their ability to properly analyze the classroom situation. Therefore, textbook authors' knowledge and experience seems important in creating curricular contents and deserves further investigation.

Textbook authors

The research studies that investigated textbook authors, motivation, experiences, and decision in writing textbooks is almost non-existent (Lee & Catling, 2016). Furthermore, it was even more difficult to find studies that have focused on mathematics textbook writers' perspectives and overall experiences of writing the textbooks. Additionally, we did not find any related literature that examines mathematics textbook writers' didactical knowledge in conjunction with textbook writing process. Thus, we believe that the exploration of mathematics textbook authors' perspectives and knowledge is quite novel and a study on this area likely makes a significant contribution to the broader body of research on the design of curricular resources in mathematics.

Kim (2009) examined various aspects of mathematics textbook writers in conjunction with non-textual elements in the textbook. He reported that writers paid little attention to non-mathematical contents, such as pictures and illustrations in the textbook. Kim further stated that textbook writers focused more on standard algorithms rather than providing opportunities for conceptual understanding of mathematics. And, publishers provided the pictures for the mathematics textbook, rather than selected or created by writers (Kim, 2009). Similarly, Randahl (2012) reported that one of the main motivating factors for textbook writers for writing a calculus textbook was to make the content easier, simple, and clear for students. In a study pertaining to geography textbooks, Lee and Catling (2016) reported that the textbook writers were motivated to write the textbook because of the intrinsic and extrinsic value of geography. The intrinsic value refers to the general quality of teaching geography by introducing new ideas and approaches, whereas extrinsic value indicates the development of textbooks based on new curricula. The content in the textbooks of France, Germany and England was presented as certain and unquestionable, and the authors of the textbooks presented themselves as the highest authority on that content knowledge (Haggarty & Pepin, 2002a).

Research methodology

Four school mathematics textbook writers participated in this interview study. A convenient yet purposeful sampling method was used to select the participants, and personal connections and relevant networks were used to choose the participants. One of the participants was chosen purposefully since he was a well-known mathematics textbook writer and his textbooks have been widely used all over Nepal. Each participating author was also a teacher during the time of data collection. The participants' teaching experiences ranged from 15 to 35 years, and the number of textbooks that they wrote ranged from 15 to 25. They wrote textbooks for elementary to high school level mathematics. Two participants had master's degrees in mathematics and the other had a master's degree in mathematics education. Another participant had a bachelor degree in mathematics and master's degree in economics. Participants were selected from three different cities in Nepal.

Research instrument and data collection

We constructed a survey with open-ended questions (provided in appendix) primarily geared towards examining various aspects of textbook writers. The survey was a modified version of the questionnaire developed by Kim (2009). Kim investigated the role of the non-textual element from the perspectives of both mathematics teachers and writers and also examined the experiences of curriculum developers while writing mathematics textbooks. Kim's (2009) interview protocol was divided into five sections: introduction, curriculum development, in your textbooks, future works and demographic information. In our modified interview protocol, however, we adopted Kim's questions that are relevant to the textbook writing process and textbook authors. In the meantime, we added some additional questions, which aimed to examine about writer's motivational aspects for writing textbooks. The data were collected via semi-structured interviews that lasted approximately 25 min. In order to collect more accurate data, the audio-taped interview was conducted in the Nepali language.

Data analysis

The recorded audio-taped interviews were transcribed word by word into the Nepali language and then translated into the English language by the researchers. Firstly, the response of each participant was entered into a Microsoft Excel sheet, where the name of each participant was placed in rows and their corresponding response of each question was placed in the column. For ease and transparency, different colours were used for each participant and for each question in the Excel sheet. Each researcher developed their own codebook to independently analyze the data. First, the data were compared horizontally and vertically for each survey question as well as for each participant. In the second step, preliminary themes for each participant for each question were derived, and eventually, themes were further verified across the participants before deriving the final themes. With independently derived final themes, both researchers discussed multiple times to finalise the common themes. Regardless of the variation in the themes, the essence of the themes of both researchers turned out to be similar. Lastly, both researchers

agreed and final themes were derived. The codebook was modified and refined a number of times as we analyzed the data. The fact is that coding is a process of sorting and defining collected data (Glesne, 2011, p. 152).

Results and findings

The following four themes emerged from the data analysis: (1) motivation and experience, (2) unawareness of didactical knowledge, (3) content heavy textbooks and exam-oriented teaching, and (4) inadequate professional development.

Motivation and experience

The data analysis revealed that each participant had different types of motivation to write the mathematics textbooks. Unavailability of suitable textbooks, encouragement from colleagues and students, and support by publishing companies were reported as the main motivational factors for textbook writing. One of the participants stated that, "I had some genius students in my class and I always needed to make more complex problems to challenge them. Eventually, I compiled all the resources/problems that I utilized in my classroom teaching and wrote a textbook". Another participant stated that he developed a kind of handbook for the purpose of his everyday teaching lessons. A publisher then encouraged him to write a comprehensive book once he showed the lesson materials to the publisher because the publisher was interested to publish the book. However, the third participant stated that he was encouraged by a well-known mathematics writer who already had written many mathematics books. He further stated:

> My teacher at college asked me to revise and modify a mathematics book that he has been writing, and eventually I was involved in writing textbooks with my teachers in some capacities. I was fully engaged in writing textbooks when my teacher passed away.

The fourth participant stated that he did not find a suitable mathematics textbook when he was teaching mathematics at a high school. Therefore, he decided to write a textbook that would fulfil his requirement and be used in his own classroom. Thus, the data revealed that each participant had unique motivations for writing mathematics textbooks.

During the process of writing textbooks, each participant had different types of experiences. The data contended that each participant encountered various challenges before, during, and after writing. One participant stated that the writing process was very tedious and time-consuming. They also encountered technological challenges while writing textbooks. One of the participants stated that "it was difficult to find computer-skilled manpower who can understand mathematical symbols and syntax. As a result, there were many errors in typing the content of the textbook". Similarly, another participant stated that the "language editor and typist altered the mathematical interpretation of the given content while they worked on the computer. For example, in some instances the computer person used different mathematics symbols and designed different figures than the one I intended to use in the textbook." One of the participants stated that he created graphs and figures by himself using a software tool. He further claimed that his books had relatively minimal to no errors.

The data suggested that the writers wanted to have various kinds of modifications if they were to rewrite the textbook because they experienced various issues while writing the textbook. One of the participants stated that he wanted to include as many activity-based problems as possible. Another participant stated that he wanted to change the presentation style of the textbooks in order to make them more appealing to learners. Similarly, the third participant wanted to include mathematical problems/examples that were proven effective. He further stated that "by adding the research-based activities in the textbook, learning would be more effective, and that will provide students more opportunities to explore mathematical ideas".

The data analysis revealed that the participants consulted multiple resources while writing the textbooks. The first and foremost resource that they used was the National Curriculum Framework (NCF) of Nepal. Participants stated that they need to follow the national curriculum framework of mathematics while writing textbooks. At the same time, participants utilised various other mathematics textbooks that were available in the local market. Two participants constantly stated that they relied on internet search engines to find various mathematics content-related activities and examples. Another important resource for writing textbooks was the participants' own teaching experiences. All but one participant stated that they took various types of feedback into account that they received from both mathematics teachers and students while writing the textbooks. Similarly, all participants indicated that they consulted their work with mathematics content experts. One of the participants stated that:

> Before I published the book, I utilized it in my own classes as a pilot book. And then I revised the book to make it final for publication. I removed several mathematics problems that seemed to be too difficult for students during the pilot phase.

Didactical knowledge

The data analysis revealed that three participants were unaware of any didactical theories pertaining to teaching and learning mathematics because they did not have a background in mathematics education. One participant, however, was aware of various learning theories and he utilised them to a certain extent while writing the mathematics textbooks. The part of the interview transcript with the author who was aware of the role of teaching and learning theories in writing textbooks is presented below.

Researcher:	Did you know about the teaching and learning theories?
Participant:	Yes, I know about learning theories. In fact, I studied about the learning theories.
Researcher:	Did the theories influence or contribute while you write the textbooks?
Participant:	The learning theories certainly influenced while I write textbook. I took learners' age and their ability into account with regard to the mathematics content. The choice of activities/examples was guided by learning theories. Furthermore, the choice of mathematical activities is also based on local demography as well as on the research findings. Thus, the knowledge I acquired about learning theories helped me select mathematical activities based on students' abilities, age, and geographic location.
Researcher:	What specific theories did you mostly rely upon for your textbook?

Participant: I primarily know about Piaget's constructivism and Bloom' s Taxonomy. I utilised them while creating mathematical content. I also utilised the principle of equality and equity in education.

Another participant stated that he understands that students learn differently. Therefore, he tried to incorporate various types of mathematical activities and tasks: easy, moderate, and difficult in order to address students' needs. However, he did not incorporate concepts of various learning theories while writing the textbooks. In contrast, he stated that he tried to utilise project-based learning as well as the concept of equity in education while writing textbooks. He further stated that:

> I have no background in mathematics education since I have a master degree in pure mathematics. Therefore, I do not know anything about various learning theories. I might have utilized some types of learning theories but I didn't really know for sure what types of theories I utilized. My books are mostly guided by my own experiences as a mathematics teacher.

Another participant stated that he did not know about learning theories and had no ideas about didactical knowledge but he tried to include various types of worked out examples and practice problems in his textbook. He further stated:

> Normally, both teachers and students looked for worked-out examples in the textbooks. Therefore, I tried to incorporate as many worked out examples as possible. I also provided many practice problems in my textbooks. The worked-out examples and practices problems were similar. Both teachers and students liked the worked out problems since whenever students were not able to solve the problem, they could go back to find similar worked out examples. In fact, I wanted students to participate in active learning processes. I think my book encourages students for active learning.

Similarly, another participant stated the following:

> I did not utilize the ideas of any didactic theories in my textbooks. However, my textbook writing was guided by the national curriculum framework, rather than by learning theories. I always thought about how I can make the mathematics content accessible to all students. In fact, I knew about problem-based learning and I tried to incorporate the ideas of problem-based learning in my textbooks. I also knew about equity theory and I tried to use it in my textbooks as well. Moreover, I also took students' interests into account while writing the textbooks.

The analysis suggested that participants to some extent chose various layouts such as graphs, figures, etc., while writing the textbooks. However, the participants were unaware of the appropriate use of representations, and the selection of various types of representations was not guided by didactical knowledge. In fact, they allowed the computer-person (i.e. the one who typed the actual manuscript into the computer) to choose the appropriate graphs, figures etc., in the textbooks. Another participant claimed that he introduced the right content and concepts to the right grade level, and therefore students find his books easy to follow. He further stated that his books were indeed guided by activity and project-based learning and he wanted to promote creative learning in his textbooks. However, he further stated that he had no ideas about learning theories and did not take them into account while writing the textbook.

Content heavy textbooks and examination-oriented teaching

The data also revealed that the writing of the textbooks was guided to a certain extent by students' interest, rather than by didactical knowledge. For example, one of the participants stated that:

> Students did not really care about learning mathematics in a deeper way, instead, they wanted to focus on the problems that were likely to be a part of the exam. They wanted to have higher grades in exams, rather than understanding the underlying mathematical concepts.

Three of the four participants agreed that the mathematics textbooks that they wrote were content-heavy. One of the participants stated:

> I utilized my own textbooks in 8th and 9th grade, which provided me an opportunity to look at my textbooks from the classroom teachers' perspective. I believe that there is a gap in understanding about the textbooks between writers and classroom teachers. I realized as a textbook writer; my textbook had not been implemented in the way I intended as a writer. For example, I provided project-based and problem-based activities in my textbook; however, I found that most of the classroom teachers did not do those activities. I myself struggled to implement those projects that I initially thought would help students learn mathematics. Our curriculum is content-heavy and classroom teachers had time constraints. Moreover, teachers are not well trained to teach mathematics incorporating project and problem-based learning.

One of the participants suggested that his books were more advanced compared to the grade level that the book was written for. Another participant affirmed that "I used an *easy to busy* principle. Meaning, I would rather give easier problems and make students busy in mathematical activities". He further stated that the principle he utilised was based on the teaching experiences, rather than based on didactical knowledge. The participant who had a master's degree in mathematics education stated:

> I found that many textbook writers did not have a basic understanding of writing mathematics textbooks. The teaching and learning activities were more exam-oriented, rather than based on conceptual understanding. Nepal government needs to monitor what students have been learning. Evaluation and monitoring mechanisms need to be in place. Just making rules and regulations by the government of Nepal is not enough to improve the quality of education. Timely evaluation and monitoring is important. Therefore, the Nepal government needs to formulate some specific criteria in order to be a textbook writer.

He further stated that "it is sad to see that the students were not taught the comprehensive contents of the textbook; rather, teachers only focused mainly on the problems/content that is most likely to be the part of the exam". For example, students were taught only the question bank (collection of questions mainly important for the examination), and instructional strategies were not focused on conceptual understanding of mathematics. He further added that "I am involved in teachers' training all over the country and I found that many mathematics teachers did not fully understand the curriculum and textbooks".

Similarly, another participant stated that "I feel my books were a little bit more complex for the students since many problems seemed difficult for them". He further stated that "I have been teaching at a government school and I myself as a teacher realized that my textbooks are not appropriate for public schools in Nepal". Along the same line, another participant added that "I utilized my textbook in order to teach my own children

and I felt myself as a teacher that the content is too heavy and it was difficult to cover the content within the allotted time. As a result, it was difficult to teach every single learning activity included in my textbooks". Thus, analysis of the data further suggested that the writers did not rationalise what types of problems are appropriate for the textbooks. One of the participants, for example, stated that he had no idea about cognitively demanding types of mathematical tasks. The choice of the problems in the textbook was based on their classroom experiences, rather than guided by teaching and learning theories.

Professional development

The participants also offered some suggestions with regard to the improvement of teaching and learning mathematics in Nepal. All participants stated that the textbook writers need to have a professional development programme regarding textbooks writing. All of them stated that the "National Curriculum Framework (NCF) offers minimum guidance." Furthermore, participants agreed that policymakers did not have a clear vision for school education, and they did not know what direction they wanted to move regarding the educational reform in Nepal, particularly in mathematics education. Participants further suggested that the policy level team in education must include people with adequate teaching experiences, knowledge about learners, and expertise in pedagogical knowledge. For example, one of the participants stated that "policymakers need to take students and teachers into account while they develop a curriculum".

One participant suggested that "in order to improve the quality of mathematics education in Nepal, the reform needs to start at elementary school (grade 1-5). And, teachers' involvement in developing the curriculum framework would help to improve the mathematics education in Nepal". He further stated that "the curriculum framework should be guided by national and local needs of the country; rather than importing framework from somewhere else". One of the participants stated that he expected to get training pertaining to writing mathematics textbooks from the government of Nepal. Thus, the data contended that the Nepal government should provide more professional development programmes for both mathematics teachers and textbook writers in order to improve the quality of mathematics education in Nepal.

Discussion

The findings of the study revealed that the textbook authors were motivated intrinsically to write mathematics textbooks. One of the main reasons for the participants to write the textbooks arises from their teaching experiences. The difficulties in finding appropriate problems, practice exercises, and relevant recourses for their lesson motivated participants to write their own textbooks. Similar to Randahl's (2012) findings this study confirms that textbook authors made efforts to make the content easier, simple, and clear for students. In doing so, the textbook authors employed various strategies, such as an easy to busy principle and created many similar worked out examples as exercise problems in their textbooks. Textbook writing was also influenced by the encouragement from the publishers. This hints that the authors were motivated by fame and fortune, supporting the results of Johansson (2003) in which the extrinsic factor was noted as one of the underlying reasons for writing textbooks.

The data suggested that the National Curriculum Framework (NCF) is the main document that guides writing the textbook. The NCF, however, does not dictate instructional strategies in the classroom. Therefore, the writing of textbooks seemed to be influenced by what types of problems students prefer to solve and what types of problems are important for the examination. As a result, the authors seem to include various worked out and similar practice problems as well as examination-oriented problems. This suggests that their writing was heavily influenced by their classroom teaching experiences. Furthermore, the selection of mathematical tasks in the textbook was influenced by students' preferences, which is also in line with results of Kiai's (2014) study.

Since each participant differed with respect to educational background as well as understanding of various aspects of didactical knowledge, it seemed that variations in their textbooks occur even though they followed the NCF as their primary guiding document. The NCF does not dictate the way writers design a textbook, which likely provides leeway to the writers to include various tasks, examples, and other aspects, which could have resulted in variation in textbooks. We note that we did not investigate the textbooks written by the participants, however, our findings suggest that there exists a variation in the textbook written by each participant. Earlier studies pointed out variations in the content of two textbooks even though both books were written based on the same curriculum framework (Bingolbali & Bingolbali, 2019). And, the varying interpretation of the curriculum framework by textbook authors might have contributed to this phenomenon (Kiai, 2014).

It is apparent that participants attempted to incorporate various strategies to make their book unique; however, they seemed to be unaware of the concept of teaching and learning theories. Furthermore, writers were unaware of the process standards of teaching mathematics (NCTM, 2000) since they did not select, for example, what types of representation can be included in the text. The data further suggested that the various types of non-textual elements of the textbooks were chosen by the computer/typist person. Letting computer persons (who typed the textbook) choose the different types of figures/pictures, layout, and setting of the textbooks further indicated that writers were unaware of the importance of representation and non-textual elements. Thus, the findings of this study also supported the result of Kim's (2009) study where writers did focus on the mathematical content but did not really pay attention to the role of non-textual elements.

Three out of the four participants had no background in mathematics education. Indeed, the results revealed that participants were unaware of the concept of pedagogical content knowledge explained by Shulman (1986). The unbalanced presence of lower and higher-level cognitive demand problems in mathematics textbooks (Basyal et al., 2022) might have originated due to lack of PCK in textbook authors. The participants admitted that they are unaware of pedagogical knowledge and pedagogical content knowledge, and they were interested to have the training and relevant professional development programmes that would help them in writing more appropriate mathematics textbooks.

Limitations, implications, and significance

This investigation was based on only four participants, who were chosen using convenient yet purposeful sampling. Choosing a large number of participants with various years of teaching experiences and with different academic backgrounds might have yielded

different emphasis in the results. This study examined mathematics textbook writers, however, did not examine the textbooks that each participant wrote. Investigating textbook authors along with the textbooks they wrote would have provided more robust results. Future studies may investigate textbook authors along with the various facets of actual textbooks they have written. One could explore authors' intentions behind specific presentations of a topic, use of textual and non-textual elements, use of real-world contexts, role of technology, and objectives of incorporated worked-out examples and practice problems. Simultaneously investigating textbooks and corresponding authors, we believe, is another avenue for understanding the author's didactical knowledge.

Additionally, we also suggest authors reflect on what and why certain contents are in their textbooks. We believe mathematics textbook writers would likely benefit from professional development programmes on textbook writing. Future education reform in mathematics education in Nepal should strive to produce suitable mathematics textbooks. In doing so, a professional development programme for textbook authors might have a positive impact.

This study also revealed that the textbooks were not utilised as the writers intended, even in their own classroom. Thus, there appear to be inevitable discrepancies between the way writers envision using the textbook and the actual utilisation of the textbook by teachers. These types of discrepancies are common in the domain of education. We propose the desirability of iterative processes of textbook writing and feedback from their use and for publishers to make time for such processes. Additionally, providing appropriate professional development programmes, both for teachers and writers, could help minimise the discrepancy in understanding of textbooks between teachers and writers.

Even with the limitations discussed earlier, this study contributes to research in mathematics education. Exploring the intentions of mathematics textbook writers and their perspectives in writing textbooks, this study contributes to the broader body of research on the design of curricular resources in mathematics and provides some insights that may be useful in future curriculum design in mathematics.

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Appendix

Part A: Introduction

- My name is Researcher. My study aims to explore how textbook authors become the author. What are the driving factors, what experience they have, what are the considerations they undertook while writing the textbooks?
- This interview will take about 25–40 min.
- Do you mind if I record and transcribe this interview and take some notes from your responses during this interview?
- Please sign the consent form if you agree to participate in this interview.
  (Note to self: Check technology and recording devices)

Part B: Demographic Information

(Name, Address, Gender, Age group (20–30, 30–40, 40–50, 50 and above);
Do you have any teaching experience (in years)?
(What kinds of courses you taught? Optional or compulsory mathematics?
What grade level? Basic (1–8) or Secondary (9–12) schools?)
How many book series have you written? Do you have any other books?
What was your major in undergraduate and graduate levels?
Do you have any previous experience regarding curriculum design/writing/development?

Part C: Curriculum Development

1. What are the driving factors for writing your textbook? (Follow up if needed)
2. What are textbook authors' and publishers' responsibility? How did you collaborate to publish your textbooks?
3. Who made the decisions on what content should be in the textbooks?
4. Who made decisions on selecting the text of your textbook?
5. Who decided on non-textual content (such as images, tables, graphs and such)? How did you decide the number of non-textual contents in your textbooks?
6. How did you decide the number of workout examples and homework problems?
7. How did you decide the sequencing of the chapters in your textbook?
8. What challenges or difficulties did you face before, during, and after writing the textbooks?
9. If you were to rewrite this textbook, what change would you like to make and why?
10. What other resources did you use during textbook writing? Did you consult to any mathematics curriculum experts/mathematics teachers/students/parents? (Follow up)
11. Did you have any learning theory as how students learn mathematics, which will inform the design and writing of your textbook? What didactical theory or knowledge (if any) did you utilise in your textbook?
12. How is your textbook different from others? (Follow up)
13. Who works on correcting, revising, and maintaining the quality of the textbook? Who was responsible in making sure no typographical and mathematical error exists in the textbook?
14. Are you currently teaching? If yes, do you use your textbook in your teaching? If you have been teaching the lesson using your textbook, do you like to comment on your textbook from a teacher's perspective?
15. Do you have any other comments, feedback, and advice pertaining to textbook and textbook writing?