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Tikaram and Chandrakala Dhananjaya: A collaborative couple in mathematics from Nepal

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ABSTRACT

Within the history of mathematics and mathematics education in Nepal, Tikaram and Chandrakala Dhananjaya are relatively well-known figures for their two books *Śiśubodha Taraṅgiṇī* and *Līlāvatī*. This is despite there being almost no archival or manuscript materials offering a window into their lives: we have no letters, notebooks, diaries, or school records. Rather than focusing on either individual in isolation, in this article we present an argument for considering the Dhananjayas as an analytically indivisible collaborative couple in mathematics. Of the two aforementioned books, one is attributed to Chandrakala and the other to Tikaram; but in fact, both are translations of the same Sanskrit source text, *Līlāvatī*, into Nepali. By comparing the mathematical contents of these two works, which were published within a few years of each other, we explore what it means to be an author or translator of a mathematical text and propose different models of spousal collaboration which could plausibly have been adopted by the Dhananjayas. In the absence of documentary evidence, the impossibility of delineating each individual's contributions removes the temptation to focus exclusively on apportioning credit. Instead, we offer the alternative perspective of considering what labour must have been undertaken to bring their books to publication.

Introduction

Within the history of mathematics and mathematics education in Nepal, Tikaram and Chandrakala Dhananjaya are relatively well-known figures for their two books *Śiśubodha Taraṅgiṇī* and *Līlāvatī*. This is despite there being almost no archival or manuscript materials offering a window into their lives: we have no letters, notebooks, diaries, or school records. A unique and vital biographical source on the Dhananjayas is the oral history collected by Modanath Prashrit, and published the year Chandrakala died (Prashrit, 2002). Prashrit, a former Education Minister of Nepal, interviewed Chandrakala in February 1998, sixty years after Tikaram died and the Dhananjayas' last work was written. His depiction is notably biased towards Tikaram, with no authorial attribution given to Chandrakala, even for the poetry and mathematics books published under her own name.

Rather than focusing on either individual in isolation, in this paper we present an argument for considering the Dhananjayas as an analytically indivisible collaborative couple in mathematics. Of the two aforementioned books, one is attributed to Chandrakala and the other to Tikaram; but in fact, both are translations of the same Sanskrit source text, *Līlāvatī*, into Nepali. By comparing the mathematical contents of these two works, which were published within a few years of each other, we explore what it means to be an author or translator of a mathematical text and propose different models of spousal collaboration which could plausibly have been adopted by the Dhananjayas.

Mathematics education in Nepal

In Nepal, as in other places on the Indian subcontinent, Sanskrit was a major scientific and intellectual language. Numerous early Sanskrit mathematics treatises were built around verse treatments of arithmetic, geometry, and first- and second-degree indeterminate equations (Plofker, 2009). From the seventh to the fourteenth centuries, the concise verses—which also circulated as part of an oral tradition—were generally accompanied by commentaries containing explanatory prose. These prose commentaries could be written by the author of the original verse treatise or be added and amended by later writers. They provided worked examples or demonstrations, which could have a numerical or notational layout, and often restated the computational formulae from the verses in a less ambiguous way (Plofker, 2009, pp. 66–67, 212;

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Plofker, 2009b, pp. 521–24). The use of condensed verse in scientific treatises enabled the memorisation of a concept and the preservation of the text, as errors could be identified through the deformation of the verse structure as well as through scientific inaccuracies (Knudsen, 2008, p.6).

Education in Nepal was markedly affected by the changing political regimes throughout the nineteenth and twentieth centuries. From 1846 until 1951, Nepal was under the control of the authoritarian Rana dynasty. Jung Bahadur Rana seized power through a violent coup, rendered the monarchy little more than a figurehead, and took for himself the position of permanent prime minister. Rana consolidated his power by appointing his male relatives to government roles, and then making these positions and his own hereditary. Under the Rana dynasty there was almost no education provision for the general public, especially outside of the Kathmandu Valley, and by the end of their rule as little as one percent of the population was literate (Burchfield,et al., 2002,p. 4). What few educational institutions were founded during this time were socially elite and imported curricula from Britain and India, thereby suppressing pre-existing mathematical practices in Nepal (Lamichhane & Luitel, 2023, p. 10).

In the late nineteenth and early twentieth centuries, there were successful efforts to publish Nepali editions of at least two major Sanskrit resources for mathematical learning, *Bhāsvatī* and *Līlāvatī*. The former was written by Śatānanda in the eleventh century, and contains 128 verses in eight chapters which provide methods for calculating positions and movements of celestial bodies. A translation of this work into Nepali was published in 1933 (Dhananjaya & Satanandācārya, 1933). The latter, *Līlāvatī*, was written by twelfth century Indian astronomer and mathematician Bhāskarāchārya (1114–1185). *Līlāvatī* consists of around 270 verses and covers a range of areas in mathematics. The first modern book on mathematics in the Nepali language, *Vyakta Chandrika* by Pandit Gopal Pandey, contained translations from Sanskrit to Nepali of many verses from *Līlāvatī,* alongside novel material such as a new method for finding cube and square roots using the rule of three (Jha et al., 2006; Pandey, 1895; Basyal, 2016; Panta, 1980). Pahalaman Singh Swara's, 1900 book *Ankendushekhara*, again written in Nepali verse, contains many rules on arithmetic similar to those found in *Līlāvatī* (Basyal, 2019; Panta, 1980; Swara, 1900). *Līlāvatī* formed a cornerstone of the published mathematical works of married couple Chandrakala and Tikaram Marashini, who both used the penname Dhananjaya, an ancestral name of Tikaram's family.

Tikaram and Chandrakala Marashini

A mathematician, astronomer, astrologer, teacher, and poet, Tikaram Marashini was born in Nepalgunj in October 1909, and grew up in the rural town of Pipaldanda, Khidim in the Arghakhanchi district of Nepal (see Fig. 1). Born into a family of priests, Tikaram attended a local Gurukul (residential school) run by his uncle in his village. The school would have catered to students between 4 and 12 years of age. As a Brahmin, Tikaram would have been expected to become a teacher, priest, astrologer, or government official, and thus education was of great importance to his future prospects.[1] In 1926, local businessman Harihar Gautam invested in this Gurukul, which was hence renamed the Harihar Sanskrit Pathashala (school). Harihar also invested in Tikaram, providing him with financial support to attend the Chaukhamba Sanskrit school in Benaras (Varanasi), India, a city with a long tradition as a centre for Sanskrit learning (Raina, 2021, p. 95). Here he gained his Madhyama—the equivalent of a modern high school diploma—with an emphasis in Sanskrit grammar. On Tikaram's return to Khidim in 1929, he began teaching at the Pokharathok Harihar Pathashala, and was soon promoted to head teacher. He died of a heart attack only seven years later, in 1936, when he was just 26 years old.

Chandrakala Paudel (later Marashini, on her marriage to Tikaram) was born in 1915 in Mandre, also in the Arghakhanchi district of Nepal. As was common at the time, Chandrakala received no formal education when growing up. She was seven years old at the time of her marriage to Tikaram, who was then fourteen, but she did not go to live with him until she was thirteen (see Fig. 2).[2] According to Prashrit's interview with Chandrakala she was taught to read and write by her husband (Prashrit, 2002, p. 11). The Marashinis' first and only child, Madhav, was born in 1933; Chandrakala lived with Madhav and later with his family in Nepalgunj until she died in 2002.[3]

Together, Tikaram and Chandrakala are known to have authored at least ten books spanning mathematics, poetry, astrology, and religion. The publication of three further books on poetry, one travel log, and a book on Kamashastra (an ancient text instructing readers on how to attain personal fulfilment) are suspected, but no copies of these books have been located (Basyal, 2015, p. 20). No books written by Chandrakala after the death of Tikaram have as yet been identified, and there is no record of her continuing to study or teach independently of him. We now focus on two mathematical texts written and published in the 1930s.

Śiśubodha Taraṅgiṇī

Śiśubodha Taraṅgiṇī (which roughly translates to *A Series of Lessons for Children*) is a series of three books of mathematics and astrology. Only the second volume of *Śiśubodha Taraṅgiṇī* (henceforth referred to as **ST2**) has been identified as extant. Indeed, although the plan to write a third volume on topics in geometry, grammar, and astrology is stated in ST2, it is unclear if this project was ever realised (Dhananjaya, 1933, p. 78). The copy of ST2 used in this study is a scanned version of that held by the Madan Puraskār Pustakālaya, a major archive of materials in the Nepali language located in Lalitpur, Nepal. The title page of ST2 lists the author as Chandrakala Devi Dhananjaya, and the publisher as Shiva Prasad Raghoram of Gorkhā Pustakālaya, in Benaras, India. No date of publication is given, but the third verse refers to 1933 as the year in which it was written.[4]

ST2 contains about forty pages of mathematics, divided up into twenty chapters, and then a further forty pages on astrology; in this paper we focus on the mathematical content.[5] The mathematics is presented through 137 numbered *slokas,* namely short verses that were usually two lines of sixteen syllables each, or four lines of eight syllables (Basyal, 2015, p. 1). The content includes properties of and operations on: whole numbers; fractions; zero; and then decimals. Later chapters treat more advanced methods of calculation, for example calculating simple interest.

The majority of ST2 consists of direct and indirect translations of eighty-five verses from the Sanskrit text *Līlāvatī* into Nepali.[6] During this translation process the mathematical problems were recontextualised

[1] For more on the history of caste in Nepal, see Bennett et al. (2008), pp. 1–4.

[2] Child marriage was ubiquitous in early-twentieth-century Nepal. In Hinduism, pre-pubertal girls are considered intrinsically pure and there is a significant pressure for women to be virgins at the time of their marriage (Chanana, 2001, pp. 43, 48). Around 9% of girls born around the 1930s were married before their ninth birthday, with twenty-three percent being married before their fourteenth (Acharya and Bennett, 1981, pp. 65–66). As recently as 2011, more than 1.1 million girls in Nepal were married before their fourteenth birthday (Census, 2011, p. 131).

[3] Biographical information for the Marashinis is drawn from Prashrit (2002) and personal communication of D. Basyal on May 24, 2015 with Madhav Marashini (the son of Tikaram and Chandrakala) and his son Dhundiraj Marashini.

[4] In fact, ST2 uses the Hindu calendar Vikrama Samvat rather than the Gregorian calendar, but locates the writing of the book to around 1933 (Basyal, 2015, p. 42).

[5] An introduction to, and English translation of, ST2 is Basyal (2015).

[6] For a full comparison of ST2 and *Līlāvatī*, see Basyal (2015), pp. 27–31.

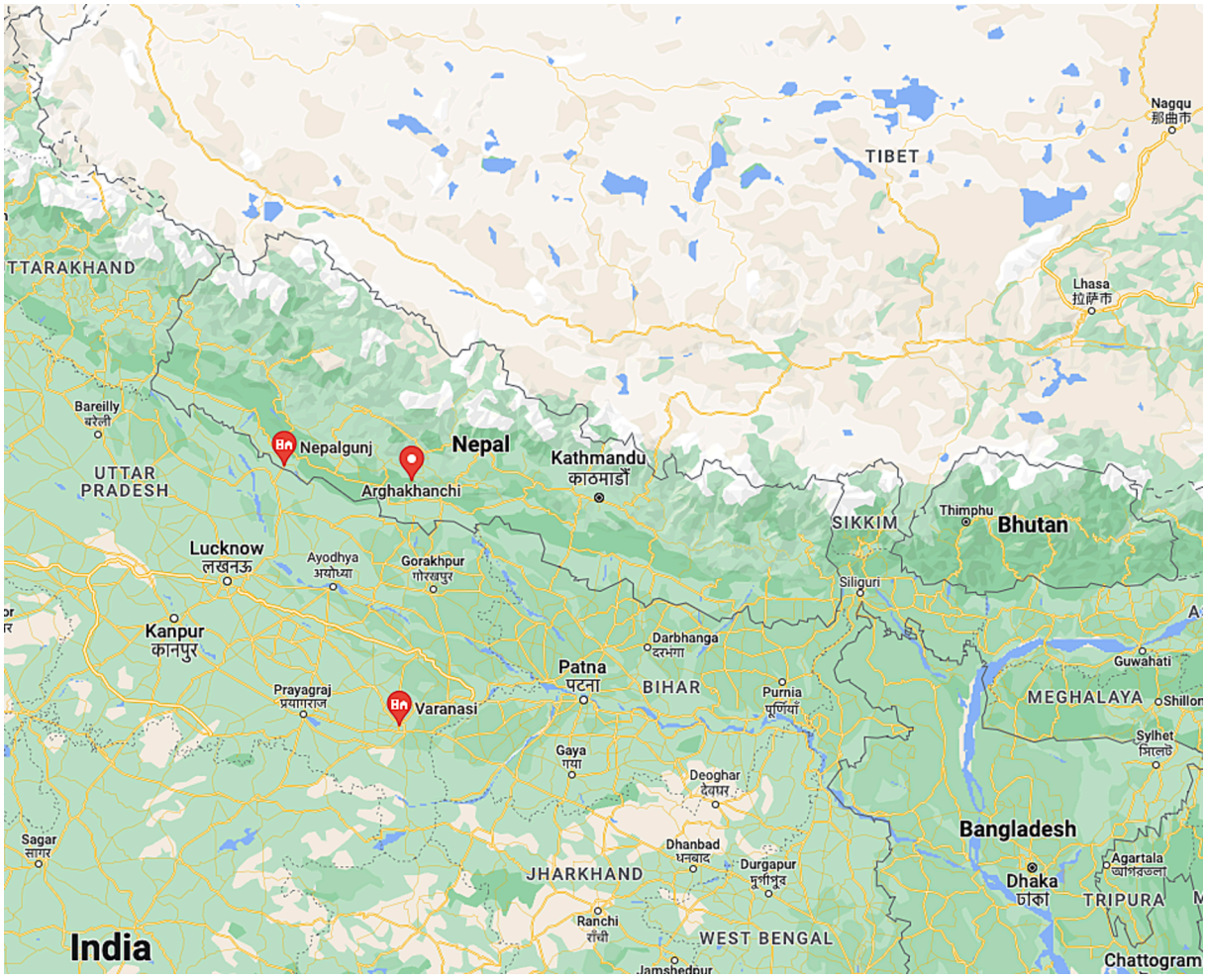


Fig. 1. A map of Nepal and northern India showing Nepalgunj, Varanasi and Arghakhanchi. Map Data © 2023 Google.

through the introduction of Nepali poetry, the changing of currencies and numbers used, and the introduction of common Nepali names (Basyal, 2020, p. 202).

Līlāvatī and *Chandrakala*

In 1936 the first comprehensive Nepali translation of *Līlāvatī*, with commentary, was published in Benaras, India. Prashrit (2002, p. 41) reported it as lost, but an edition[7] has since been identified in the Pingree Collection[8] at Brown University and it is a scanned copy of this version which has been consulted in the preparation of the current paper. Moving forward, we will refer to this Nepali translation of *Līlāvatī* as **L-N**.

The title page names both Tikaram and Chandrakala. The author is given as Tikaram Dhananjaya, headteacher of Pokhrathok Pathashala, whilst the commentary is titled *Chandrakala*. Furthermore, at the end of each chapter is written the expression "explained by Chandrakala" or possibly "attributed to Chandrakala"; there is ambiguity on what would be the correct translation of the words *viracitā* and *vyākhyā* in this context (Basyal, 2015, p. 189). The naming of the commentary after Chandrakala is perhaps a reference to the widely known story which suggests that *Līlāvatī* was itself named after the daughter or wife of the original author, Bhāskarāchārya.[9]

This book shares its publisher with ST2, namely Gorkhā Pustakālaya, and the title page lists Sarba Hitaishi Company (also in Benaras) as a location where the book could be purchased. We lack archival evidence for either text that would elucidate to whom the book was advertised,

[7] This is the only copy of the work known to the authors. Owing to the diacritical marks in the title of the book, it is difficult to search for in digital catalogues and databases, which could be why previous authors believed it to be lost. In the Pingree collection it is classified under the Library-of-Congress-style call number QA32.B48 1936. This call number does not appear in the Library of Congress catalogue, however, though the initial sequence QA32.B48 identifies other translations of *Līlāvatī*. We express our thanks to Kumud Nepal, formerly at Brown University, who kindly provided a scanned copy of the book on 15 October 2013.

[8] The extensive Pingree Collection was assembled by American classicist and historian of mathematics David Pingree (1933–2005). According to the preface of his edition of the astronomy text, *Yavanajataka of Sphujidhvaja* (1978), Pingree travelled to Nepal in December 1957; it is perhaps then that he obtained a copy of the Dhananjaya's *Līlāvatī*.

[9] According to fifteenth-century Persian poet Fyzi, astrologers predicted that unless Bhāskarāchārya's daughter Līlāvatī married at a certain time on a certain day, she would have an unhappy marriage. Her wedding was thus arranged for the destined time. When the special day arrived, Līlāvatī kept watch on a water clock so as not to be late, but when bending over the clock a pearl dropped off her jewellery, blocking the flowing water and stopping the clock. She missed the foretold time for her wedding, and so as to avoid an unhappy marriage she decided to never wed. To provide his daughter with some solace, Bhāskarāchārya named his book after her (Berg, 2001, p. 226). Alternatively, it has been suggested that Bhāskarāchārya named the work after his late wife (Thakura, 1938, p. 2).

Fig. 2. Tikaram and Chandrakala (c. 1930). Photo provided by Dhundiraj Rijal. Used with permission.

Table 1
Table of contents of *Śiśubodha Taraṅgiṇī2* and *Līlāvatī*.

ST2		**L-N**	
Chapter	Topic	Chapter	Topic
1	Invocation	1	Invocation
2	Definitions	2	Definitions
3	Eight operations on whole numbers*	3	Addition and subtraction
		4	Methods of multiplication
		5	Division
		6	Methods of finding squares
		7	Square roots
		8	Methods to find the cubes
		9	Cube roots
4	Greatest common divisor		
5	Least common multiple		
6	Eight operations on fractions	10	Eight operations on fractions
7	Assimilation of sub-fractions		
8	Adding or subtracting a fraction and a whole number		
9	Increasing and decreasing a fraction by a fractional amount		
10	Rule for addition and subtraction of fractions		
11	Eight operations on zero	11	Eight operations on zero
12	Eight operations on decimals		
13	Working backwards		
14	Method for checking if multiplication is correct		
15	Method of supposition	12	Method of supposition
16	Method of transition	13	Method of transition
		14	Square transition
		15	Quadratic equation
17	The rule of three	16	The rule of three
		17	Inverse proportion
		18	The rule of five
18	Simple interest		
19	Investigation of mixtures	19	Investigation of mixtures
20	Series	20	Series
		21	Mensuration
		22	Area of circle
		23	Volume
		24	Volume of a prism
		25	Wood cutting
		26	Volume of a heap of a grain
		27	Shadows
		28	Pulverization
		29	Combinations and partitions
			Conclusion

* The eight operations include addition, subtraction, multiplication, division, square, square root, cube, and cube roots.

Table 2
Transliteration and translation of verse 7 of ST2.

Transliteration*	Translation
ekkaḍorgyāralākh gyāra-haḷjārekśaye gyāramā trihattarle bhāgdeu labdhī huñcha katī jamā 11111111 ÷ 73 = 152207 bhayo.	[If you] divide eleven million, one hundred eleven thousand, one hundred eleven by seventy-three, what is the quotient? 11,111,111 ÷ 73 = 152,207 happened.

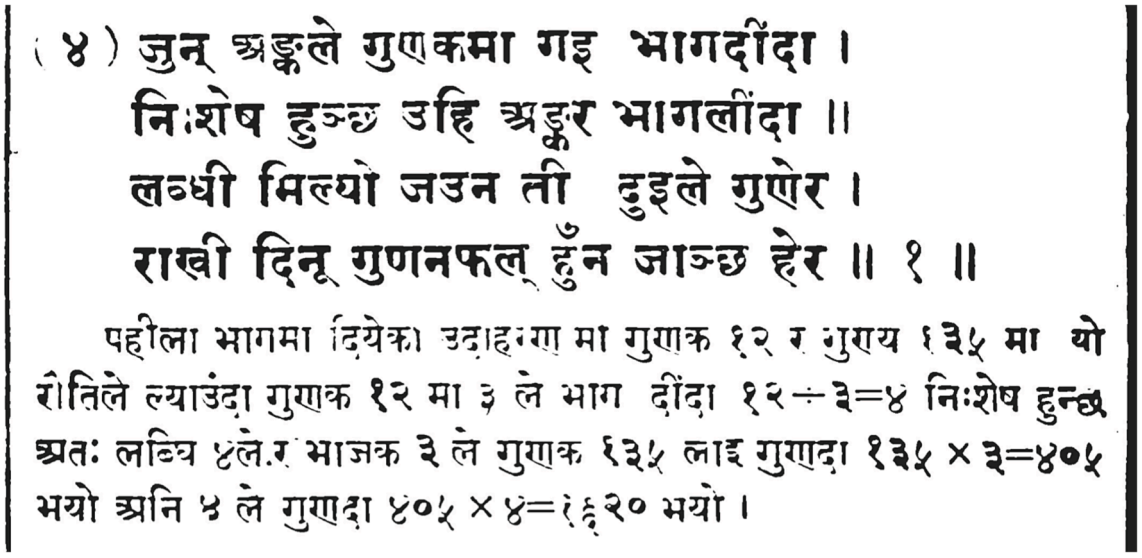
* In L-N the spacing in the first few words of the Nepali text is different. There is also a typo in the numerical equation: 72 is written instead of 73.

how many copies were printed, or indeed how many were sold. That they were printed and sold in Benaras speaks to the limited infrastructure for books and learning in Nepal and indeed the books do not appear to have been well-known at the time of their publication (Basyal, 2015, pp. 195–96). It is thus unlikely that the Dhananjayas were able to use the sales of these books as a source of income.

Table 3
Transliteration and translation of Verse 4, ST2.

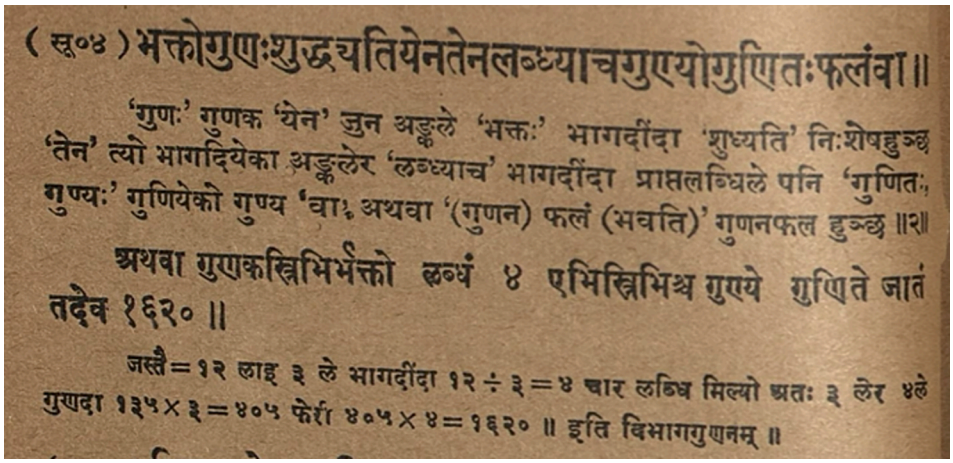
Transliteration	Translation*
jun aṅkale guṇakmā gai bhāgdīndā niḥśeṣa huñcha uhi aṅkara bhāglindā labdhī milyo jauna tī duile guṇera rākhī dinū guṇanfal hūna jāncha hera	[To multiply two numbers, find a number] which divides the multiplier evenly. Take that number and the quotient [thus obtained], and multiplying [the multiplicand] by these two [numbers] yields the product.

* Translation taken from Basyal (2015), p. 45. When multiplying two numbers together, one number is referred to as the multiplier, and the other the multiplicand (meaning, the number that is multiplied).


(४) जुन् अङ्कले गुणकमा गइ भागदींदा ।
निःशेष हुञ्छ उहि अङ्क भागलींदा ॥
लब्धी मिल्यो जउन ती दुइले गुणेर ।
राखी दिनू गुणनफल् हुँन जाञ्छ हेर ॥ १ ॥

पहीला भागमा दियेका उदाहरण मा गुणक १२ र गुणय १३५ मा यो रीतिले ल्याउंदा गुणक १२ मा ३ ले भाग दींदा १२÷३=४ निःशेष हुन्छ अतः लब्धि ४ले.र भाजक ३ ले गुणक १३५ लाइ गुणदा १३५ × ३=४०५ भयो अनि ४ ले गुणदा ४०५ × ४=१६२० भयो ।

Fig. 3. Verse 4 from Dhananjaya, *Śiśubodha Taraṅgiṇī* (Benares City: Gorkhā Pustakālaya, Dhananjaya (1933)), II: p. 4. Madan Puraskār Pustakālaya, Lalitpur, Nepal.


(सू०४) भक्तोगुणःशुद्धयतियेनतेनलब्ध्याचगुण्योगुणितःफलंवा॥

'गुणः' गुणक 'येन' जुन अङ्कले 'भक्तः' भागदींदा 'शुध्यति' निःशेषहुञ्छ 'तेन' त्यो भागदियेका अङ्कलेर 'लब्ध्याच' भागदींदा प्राप्तलब्धिले पनि 'गुणितः, गुण्यः' गुणियेको गुण्य 'वा' अथवा '(गुणन) फलं (भवति)' गुणनफल हुञ्छ ॥२॥

अथवा गुणकस्त्रिभिर्भक्तो लब्धं ४ एभिस्त्रिभिश्च गुण्ये गुणिते जातं तदेव १६२० ॥

जस्तै=१२ लाइ ३ ले भागदींदा १२ ÷ ३ = ४ चार लब्धि मिल्यो अतः ३ लेर ४ले गुणदा १३५×३=४०५ फेरी ४०५×४=१६२० ॥ इति विभागगुणनम् ॥

Fig. 4. Verse 4 from Dhananjaya and Bhāskarāchārya, *Līlāvatī* (Benares City: Gorkhā Pustakālaya, Dhananjaya & Bhāskarāchārya, 1936), p. 10. David E. Pingree Collection, Brown University Library.

In L-N, verses from *Līlāvatī* are reproduced in Sanskrit, followed by a word-by-word translation into Nepali underneath. These verses contain mathematical problems and computational algorithms for their solution. The accompanying prose commentary is mostly written in Nepali, and uses Nepali numerals—which are very similar to Sanskrit numerals—in worked solutions to demonstrate how to solve the problems or to use the methods contained in the verses. The text is divided into thirty chapters, the content of which is described in more detail in Table 1.

Translating mathematics

Both L-N and ST2 were written in the early 1930 s, in the household of the Dhananjayas, and are heavily based upon the Sanskrit text *Līlāvatī*.[10] Tikaram had only recently returned from his time studying in Benaras, funded by Harihar Gautam, and begun teaching at school level. As there was virtually no governmental support for education of the general population under the Rana dynasty, it seemingly fell to local teachers at Gurukul and Pathashala to produce their own teaching resources. It is thus very likely that the "lessons for children" in ST2 and the more literal translation of *Līlāvatī* were designed to be teaching materials for use by Tikaram and his colleagues.

The two works share a significant number of textual similarities. A comparison of the chapter topics in Table 1 shows that the content is broadly shared between the works, as is to be expected by their mutual link to *Līlāvatī*. Early on in both books there is an introduction to mathematical units, notation, and local currency: in ST2, on pp. 1–3; in L-N, on pp. 4–5. Moreover, there are problems included in both ST2 and L-N that are not from the original source text.

Two verses are in fact copied verbatim between ST2 and L-N. The verses in L-N, on pp. 12 and 19, are almost identical to verses 7 and 26 of ST2 respectively. In Table 2, we present the first of these, a verse on the division of large numbers.

No explanation is given for how to carry out the division of 11,111,111 by 73, in either text. ST2 does encourage the reader to use this—somewhat obscure—standard result to calculate other difficult divisions. The reader is told to "learn some other [similar] results" and given the example that 22,222,222 ÷ 146 = 152,207 (which can be

[10] It is not known which version or edition of *Līlāvatī* the Dhananjayas would have had access to, but Tikaram almost certainly would have studied this text during his time in Benaras.

Table 4
Transliteration and translation of Verse 4 of L-N.

Transliteration (Sanskrit)	Transliteration (Nepali)	Translation (English)
guṇaḥ	guṇak	multiplier
yena	juna aṅkale	that number
bhaktaḥ	bhāg dīndā	when divided
śudhyati	niḥśeṣa huñcha	evenly divides
tena	tyo bhāga diyekā aṅkale	the number by which [we] divided
labdhyāca	bhāgadīndā prāpta labdhile pani	also, by the quotient obtained when divided
guṇitaḥ guṇyaḥ	guṇiyeko guṇya	multiplicand thus multiplied
vā	athavā	or
(guṇan) falaṃ (bhavati)*	guṇanfal huñcha	is the product

* The words in brackets are not in the original Sanskrit rule but were introduced into the word-by-word translation in L-N to improve the readability, by rendering the sentence complete.

deduced from the original result by multiplying both the divisor and the dividend by 2). Here the focus very much seems to be on rote memorisation of particular results rather than an understanding of division more broadly.

Though nominally translations of the same source text into the same target language—*Līlāvatī* into Nepali—ST2 and L-N do broadly differ in style. To demonstrate, we present here the translations of a single verse giving a rule for multiplying two numbers together, which appears in different forms in the two works.

In ST2 the verse appears as *sloka* 4 and is presented as a verse in vasantatilaka meter (see Table 3). This popular meter consists of fourteen syllables, with a pattern of heavy (guru) and light (laghu) syllables as follows: g g l g l l l g l l g l g g.[11] Beneath the verse, which is printed in bold font, are four lines of prose (see Fig. 3) which give further insight into the rule just given. Specifically, the text refers back to an example given in ST1 where the multiplier is 12 and the multiplicand is 135 (that is, an example which looks at 12×135) and applies the method from *sloka* 4. First, find a number which divides 12 with no remainder, for example the number 3. As $12 \div 3 = 4$, the quotient of 12 and 3 is 4. Multiply the multiplicand by the quotient, that is multiply 135 by 4, to obtain 540. Now multiply 540 by the divisor to get the final answer, $540 \times 3 = 1620$.

In *Līlāvatī,* this rule is in fact part of a verse in which five different methods are given for multiplying two whole numbers together. Whereas in ST2 only one method appears, all five methods of multiplication are given in L-N. Each verse line in Sanskrit is separated and presented as an individual rule, with the rule under consideration printed in large bold font at the top (see Fig. 4). The transliteration of the Sanskrit rule is as follows: *Bhakto guṇaḥ śudhyati yena tena labdhyāca guṇyo guṇitaḥ falaṃ vā*. Underneath the rule, there is a word-by-word translation into Nepali, in which the Sanskrit words are repeated in single quotes and immediately followed by their translation into Nepali (see Table 4). Following this word-by-word translation are lines of prose in which the method is applied to the same example of 12×135, although the explanation is shorter and unlike in ST2 there is no reference to the similar example in ST1.

The two differing translation styles on display in ST2 and L-N are suggestive of the different intentions which underpinned the writing of each book. ST2 presents the method of multiplication in a complete verse accompanied by a detailed prose explanation, indicating that the book was designed to teach the reader a new mathematical concept. In contrast, for multiple verses in L-N which are translated word for word from the Sanskrit and never reformulated into fluent Nepali verse or prose, the text provides the reader with an understanding of the precise content of the original *Līlāvatī* text.[12] The priority for this work is thus seemingly to make the literal text of *Līlāvatī* as a work of literature more accessible to a Nepali readership, rather than to teach the mathematics it contained.

A question of authorship

Previous scholarship on the Dhananjayas presents conflicting accounts of the authorship of ST2. Not unreasonably, it has commonly been attributed to Chandrakala as it is she who is named as the author within the book itself (Adhikari, 2015; Jha et al., 2006; Raikhola et al., 2020). However, in the interview conducted by Prashrit mentioned above, Chandrakala herself declared that she was not the author of the mathematical works bearing her name, as she received only a limited education and hence the contents of the works were inaccessible to her (Prashrit, 2002, p. 11). Based on this interview, Prashrit attributes authorship of ST2 to Tikaram rather than Chandrakala, as do Basyal (2015) and Adhikari (2003). All of these works adopt a binary attitude, designating either Tikaram *or* Chandrakala as a single author, without addressing the possibility of collaboration. The possibility of spousal collaboration between the Dhananjayas in the writing of ST2 was previously posited in (Basyal, 2020) but not explored in any depth.

Prashrit's interview opens questions of unreliable testimony in oral histories and highlights the unreliability of attributing written works solely to the named author.[13] The unclear relationship between authorship and attribution within the Marashini family is also visible in a Nepali commentary on Sanskrit grammar titled *Laghukaumudi*, which was published under the name of Tikaram's father, Ekadeva Marashini. Chandrakala and her son Madhav later claimed that this was in fact written by Tikaram himself (Prashrit, 2002, p. 44).[14] Beyond merely trying to reinstate Chandrakala as a contributor to the book published under her name, we use the unreliability of named authorship to further propose the possibility of spousal collaboration in the writing of L-N.

Justification can be made for each of Tikaram and Chandrakala to have contributed to both ST2 and L-N. Tikaram is explicitly named as the author of L-N, and there is no evidence to raise doubts that he was involved in the writing and publishing of that work. Regarding ST2, Chandrakala's testimony that she was illiterate before being taught to read and write by her husband, and that she was not capable of writing ST2 on her own, strongly suggests that Tikaram at the very least collaborated with her to write this second book. However, we disagree with previous scholars that the Prashrit interview precludes Chandrakala from any involvement whatsoever in translating *Līlāvatī* into

[11] For more on meters in Sanskrit verse see Plofker (2009b), pp. 519–20.

[12] For a discussion on different ways of translating mathematical texts, in the context of translating works from French into English in the early nineteenth century, see Stenhouse (2021), Chapter 4. For a broader discussion of translations of scientific texts, especially astronomical, see Montgomery (2000).

[13] Unreliable memories in oral histories are explored in Thomson (1998).

[14] The Marashini family recalled the existence of *Laghukaumudi,* but no extant copy has been found (Prashrit, 2002, p. 11).

Nepali. As Prashrit was concerned with investigating the contributions of Tikaram to the development of Nepali mathematics, he seemingly did not interrogate Chandrakala's denial of her own authorship nor explore with her other ways in which she may have contributed to these two texts. Moreover, Prashrit himself proposed that Chandrakala may have credited her husband as the author of ST2 out of personal modesty, or in recognition of the role he played in providing her with an education early in their lives together.[15] It cannot be ignored that Chandrakala is explicitly named as the author of ST2, and moreover is credited as a contributor to L-N at the end of each chapter.

The Dhananjayas were recognised in their own time as a collaborative pair. According to their family, in 1933 both Tikaram and Chandrakala were invited by the King of Jajarkot (a province in Nepal) to move to his palace and teach his children. In his letter the King specifically mentioned that he was impressed with her book *Teachings of Chandrakala* (1933–1934), implying that Chandrakala was not merely invited as Tikaram's wife but as a teacher in her own right (Prashrit, 2002, p. 25). Tikaram turned down the King's offer, citing a reading of his horoscope that decreed his life would soon come to an end; he was sadly not wrong as he died only three years later, the same year that L-N was published. In his reply to the King, Tikaram noted that he had several projects he wished to see to completion before he died and it is highly likely that two of these projects were L-N and the volumes of *Śiśubodha Taraṅgiṇī* (Prashrit, 2002, p. 25). The year 1933 also saw the publication of Tikaram's Nepali translation of *Bhāsvatī*, in which he declared that "it is the responsibility of educated persons to write works which promote the language, science, and education of their country" (Dhananjaya & Satanandācārya, 1933, p. 1). There is no reason to believe that Tikaram would have excluded women from this responsibility of educated people (though he likely would have expected gendered differences between contributions). Hence considering the time he had invested in Chandrakala's education, the social responsibility he felt, and his expectation of an early death, it would have been entirely reasonable for him to share the everyday labour of these educational projects with his wife.

Whereas a lack of sources is often a hindrance to historical research, here the impregnable black box of the Dhananjayas intellectual and authorial collaboration offers an opportunity. The impossibility of delineating each individual's contributions removes the temptation to focus exclusively on apportioning credit. Instead, we offer the alternative perspective of considering what labour must have been undertaken to bring their books to publication; their works involved translation from Sanskrit to Nepali, the re-rendering of the translated content into contextualised poetry, and the production of commentaries suitable to explain mathematical concepts to beginners.

We may speculate numerous ways in which the Dhananjayas' collaboration could have played out. Tikaram was very likely translating *Līlāvatī* into Nepali to use in his teaching at the Harihar Pathashala and later the Pokhrathok Vidhyalaya. The Dhananjayas had begun living together in 1928, only a few years before the publication of ST2, and it is plausible that it was during these years together when Tikaram taught Chandrakala to read and write, and perhaps a bit of mathematics too. This process of individual tuition would have directly exposed Tikaram to the difficulties for a beginner and non-reader of Sanskrit to study the mathematics of *Līlāvatī*. Such a situation can easily be compared to that of Mary Everest Boole and George Boole only seventy years earlier, in Ireland. Together the Booles produced a textbook on differential equations, with George acting as the mathematical expert and Mary the critical lay reader who highlighted passages of impassable difficulty or ideas which remained obscure and in need of explanation (Boole 1931, p. 28; Dunning, 2023). A similar collaborative process of authorship in Jane Marcet's 1806 work *Conversations on Chemistry* can be witnessed in the notebooks of her husband, Alexander Marcet. Alexander explicitly details the negotiations which took place during the revisions of Jane's text, in order to find a balance between accuracy sufficient for a well-versed practitioner and the clarity required by a novice in the representations of chemical ideas and experiments (Dreifuss and Sigrist, 2012, p. 22). In such a writing dynamic, Chandrakala's ignorance of mathematics and *Līlāvatī* would have been a benefit rather than a hindrance, enabling her to provide guidance on the suitability of the translated text for its intended audience.

Another, potentially more active, role that could have been played by Chandrakala is that of poet. Aside from volumes 1 and 2 of *Śiśubodha Taraṅgiṇī*, Chandrakala is the attributed author of a work titled *Upadesh Chandrakala* (*Teachings of Chandrakala*) (Dhananjaya, 1933–1934), written in verse format.[16] The rendering of Sanskrit poetry into Nepali poetry for *Śiśubodha Taraṅgiṇī* would have been an intensely creative process. Constant choices needed to be made around which literary, religious, or cultural references to preserve from the original source text, and how to do this in the target language whilst maintaining the mathematical meaning. As a testament to the power of poetry for memorization, and thus its importance in this mathematical tradition, in the early 2000s one of the Dhananjayas' students was still able to recite a *sloka* from volume 1 of *Śiśubodha Taraṅgiṇī*, after all copies of the book had been lost (Prashrit, 2002, pp. 44–45). That Chandrakala took a more prominent role in the rewriting of *Līlāvatī* in Nepali poetry is suggested by her authorial attribution on ST2, which more consistently presented the content in verse rather than the disjointed word-by-word translation of L-N.

At a very basic level, Chandrakala contributed her identity, perhaps even her safety, to these mathematical translations. The Rana regime in Nepal restricted access to education for the majority of the population, banned books, and even arrested poet Krishna Lal Adhikari in 1920 for writing a book on maize farming, as it was interpreted as a metaphor for the Rana administrators destroying the country (Seddon, 2014, p. 25). In this context, the Dhananjayas' son Madhav has suggested that publishing ST2 under Chandrakala's name was a conscious decision to avoid threats or pressure from the government.[17] If the government were already aware of Tikaram from his previous educational books, then putting his new work under a different name may have been less conspicuous. This may also have been his motivation to publish *Laghukaumudi* under his father's name, as mentioned above. Whether done to protect Tikaram or not, Chandrakala became visible and vulnerable as a named author of an educational book aimed at a Nepali readership.

As husband and wife, Chandrakala's and Tikaram's lives would have been deeply intertwined. Chandrakala almost certainly would have taken on a substantial role in running their household and raising their son, whilst Tikaram carried out his duties as a headteacher and Brahmin, including overseeing marriages, rice feeding ceremonies, and funerals. Theirs was a social, practical, and legal partnership that formed part of their daily lives, and out of which emanated multiple published works bearing both of their names.

Past scholarship on mathematicians Grace Chisholm Young and William Henry Young has implicitly acknowledged that the most appropriate way to credit their research is to attribute their papers to them jointly as a collaborative pair; this is done in the bibliography of their works compiled by Grattan-Guinness (1975), even though 183 of their 214 papers were published under William's name alone. Outside of mathematics, the artists Fionnuala Boyd and Leslie Evans based in Milton Keynes, UK, provide an example of a collaborative pair who intentionally obscured their individual inputs into their works, instead presenting a body of work that cannot be attributed any more specifically than to the collaborative pair (Foster, 2004). In the case of the

[15] Phone conversations by D. Basyal with Modanath Prashrit on multiple occasions between March 1, 2013 and April 8, 2013.

[16] Chandrakala is recognised as a Nepali poet in Pradhan (1984), p. 64.

[17] Personal communication by D. Basyal with Madhav Marashini 24 May 2015.

Dhananjayas, the historical record—whether consciously constructed in this way or not—does not allow us to disentangle their respective contributions to the translations of *Līlāvatī* published under their names.

Conclusion

By considering the Dhananjayas as a single authorial unit, and by speculating on how this unit functioned, we have gained substantial new historical insight. This insight extends not only to their own published works, but to the realities of collaboration in the writing of mathematical texts more broadly. Further research remains to be done on the astrological sections of ST2: how these are related to the mathematical content and in which ways they may have been influenced by the collaborative writing process. Regarding the Dhananjayas as historical actors, further research is required to locate their pedagogical and scientific practice within their daily home life in a Nepali village. Nevertheless, this paper has covered a new area of enquiry within scientific collaborative couples, as the Dhananjayas are one of few known and studied pairs who were based outside of Europe or North America.

The context within which the Dhananjayas worked led them to forge a joint career as authors of mathematical textbooks, a career that seemingly ended for both of them with the early death of Tikaram at only 26 years of age. This joint career was indivisible during their lives and continues to be indivisible in the historical record. Their choices and actions were shaped by the political climate of the Rana regime, the desire for Nepali mathematics books suitable for school teaching, and the intensive intellectual labour required to translate mathematics and poetry simultaneously. We are thus led to look beyond the simplistic notion of a book being produced by the single author who is credited on the opening pages, in this case and in the history of mathematics more broadly.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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