Muhammad Aqib Javaid

Professor John Little

17 December 2010

Mont-108N

Looking further into Plimpton 322

Plimpton 322 is a very famous mathematical cuneiform tablet from about 1800 B.C.E from the city of Larsa, which is now southern Iraq. Its purpose for being written is still somewhat unclear, and there have been three major interpretations of the tablet, all that are mathematically correct, but still retain historically uncertainty. Otto Neugebauer said that the tablet consisted of Pythagorean triples that came from a certain p and q, and that the tablet purely consisted of algebra. David Joyce and others believe that Plimpton 322 is actually a trigonometry table. Lastly Evert Bruins showed that Plimpton 322 was a table of reciprocal pairs. Eleanor Robson has written a very convincing paper showing that Plimpton 322 is actually a tablet much like YBC 6967, written by a teacher, consisting of reciprocal pairs, and that math should be interpreted in context of its time period not in context of modern math.

Eleanor Robson begins her paper by showing that mathematics is indeed different over cultures and that we cannot relate our modern math with the one of the past. She uses an example of how, we in the modern world think of common triangle to be equilateral and with a horizontal base while the Mesopotamians drew triangles that, “all point right and are much longer than they are tall.” (Robson). Robson argues that although all the interpretations are correct mathematically, they cannot be correct historically. She uses comparisons between Plimpton 322 and many other mathematical tablets found in the same area and dated to the same time frame as support for her argument. She shows how many tablets of the time of the temple administration in Larsa are similar and that Plimpton 322 is no exception. All tablets consisted of written words as a heading and then followed the mathematics.

Robson first starts off by showing her interpretation of the information on the tablet. She defines the second and third rows as the short side and hypotenuse of a right triangle and the last column as a line count. Since the first column has a quite significant part missing it uncertain what is exactly contains, but Robson interprets the first column as, “the square of *either* the hypotenuse *or* the shortest side of the triangle divided by the square of the longer side.”(Robson). The heading has been translated into English words, but there is still uncertainty about what it actually says.

In class I learned that the trigonometry table interpretation was probably the least possible because it was historically inaccurate. Robson shows that the trigonometry interpretation interprets columns two and three as tan2 and 1/cos2 and that the table has acute angles of a triangle decreasing my approximately 1° from line to line. Robson first starts off my examining a tablet, YBC 7302, which is from the same time period as Plimpton 322 and seems to be a tablet used, “by a trainee scribe for school rough work. It shows a picture of a circle with three numbers inscribed in and around it in cuneiform writing.”(Robson). She examines how the trainee went about finding the area of the circle, and shows that he would have used the equation A= c2/4π. She goes on further to explain how the two time frames are different and how modern mathematics differs from the past. She says how in modern math we generate the area of a circle by rotating the radius. “In ancient Mesopotamia, by contrast, a circle was the shape contained within an equidistant circumference: note that there is no radius drawn on YBC 7302.” (Robson).

She goes on to say that, “We run into big interpretational problems if we ignore these crucial terminological differences between ancient Mesopotamian and our own mathematics.” (Robson). Thus Robson rejects the idea that Plimpton 322 was a trigonometry table because “rotating radius could not have played an important part in Mesopotamian circle, then there was no conceptual framework for measured angle or trigonometry.” (Robson). Robson however did know that the Mesopotamians knew that circles could be created by rotating radii, and there was much evidence supporting that, like BM 15285 which shows that the circle drawn on it were probably created using a compass. She also points out that, “Gradients were used to measure the external slope of walls and ramps.” Showing that the Mesopotamians had a concept of angles.

In order to show that Otto Neugebauer’s interpretation for Plimpton 322 as primarily a number-theoretic investigation of Pythagorean triples along the algebraic lines, Robson refers to the other tablets found around the same time as Plimpton 322 and from the same location. In order to explain that Plimpton 322 could not have been a tablet of Pythagorean triples, she says, “Admittedly we know of no other ancient *table* of Pythagorean triples, but Pythagorean triangles were a common subject for school mathematics problems in ancient Mesopotamia.” But Robson also admits that her point has been made before, but hasn’t provided help in deciding which interpretation is the most accurate. Robson looks at a Mesopotamian tablet YBC 4721 that had an account of grain destined for various cities. “Like Plimpton 322 it is written on a ‘landscape’ format tablet (that is, the writing runs along the longer axis) with a heading at the top of each column. Entries in the first column are sorted in descending numerical order.” (Robson). Additionally the final column of both Plimpton 322 and YBC 4721 has the same Sumerian writing. But the text on YBC 4721 is dated unlike Plimpton 322. But since they carry so many similarities it is very possible that Plimpton was written somewhere within 1822-1784 B.C.E. Robson concludes that Plimpton 322 had to be written by someone who was familiar with the temple administration in the city of Larsa around 1800 B.C.E before it was conquered by Babylon in 1762 B.C.E. These formatting rules that Plimpton 322 evidently followed leads Robson to reject Neugebauer’s theory. She says, “If the missing columns at the left of the tablet had listed p and q, they would not have been in descending numerical order and would thus have violated these formatting rules. Nor, under this theory, has anyone satisfactorily explained the presence of Column I in the table.”(Robson).

Robson points out that reciprocal pairs played a key role in ancient Mesopotamian mathematics. She says,

Thousands of surviving practice copies show that scribal students had to learn their sexagesimal multiplication tables in the correct order and by heart. The first part of the series was the set of thirty standard reciprocal pairs encompassing all the sexagesimally regular inters from 2 to 81 (thereby including the squares of the integers 1 and 9). The trainees also learned how to calculate the reciprocals of regular numbers that were not in the standard list and practiced division by means of finding reciprocals, as this was how all Mesopotamian divisions were carried out.(Robson).

She then explains that Plimpton 322 only consisted of five pairs of reciprocals from the standard list. But the other ten were evident from other Mesopotamian mathematics and could be calculated using methods that were taught in scribal schools. She says, “None of them is more than four sexagesimal places long, and they are listed in decreasing numerical order, thereby fulfilling our tabular expectations.” Furthermore she starts to analyze the heading of Plimpton 322 because that would tell us more about what is in each column. As she had said earlier the second and third column has the shortest sides and the hypotenuses (diagonals) of right-angled triangles. The heading about column two and three as she translates it says, “(‘square of the short side’ and ‘square of the diagonal,’ respectively).” In order to get rid of a contradiction she says, “This contradiction disappears when we recall the Mesopotamian plane figures are defined and named for their key external line. We can thus adjust our translation to read ‘square-side’ of the short side and diagonal, respectively. (I am using the translation ‘diagonal’ here rather than ‘hypotenuse’ to indicate that this is a general word for the transversal of a figure, not restricted to a triangle.)” (Robson). The beginning part of the heading which has been quite torn makes for a very difficult translation. Comparing Plimpton 322 with various other mathematical documents Robson leads to the conclusion that the heading is much similar to another tablet called YBC 6967 which is from the same time period as Plimpton 322 and a teacher’s problem in which a student is instructed on how to find a reciprocal pair. Robson claims that like YBC 6967, Plimpton 322 can be conceptualized as cut-and-paste geometry which obeys the Pythagorean rule *d2* = *s2 + l2* and the heading of the first column “describes the area of a large square, composed of 1 plus the small square.” (Robson).

Eleanor Robson believes that the person who wrote Plimpton 322 was probably a teacher, and that “the methods used to construct Plimpton 322---reciprocal pairs, cut-and-paste geometry, completing the square, dividing by regular common factors---were all simple techniques taught in scribal schools.” (Robson). Her argument is very clear and convincing. She has used prime example of how different our modern mathematics is from 3000 years back. Her comparisons of Plimpton 322 with other similar mathematical tablets of Larsa truly show that there was a similar format that all tablets followed. Although Plimpton 322 is a very unique tablet, it still follows much of the same format and thus should not be compared and interpreted using modern mathematics. She says that we today in the modern world are seeing the author of this tablet as a mathematic genius. But she makes it clear that although the author’s way of writing the tablet is quite unique it still followed the common format of writing in Mesopotamia. I would argue that since there is an evident scribal mistake in the last row. That a teacher might not have written this, as the other works of teachers seem very neat and mistake free. But the neatness and organization of Plimpton 322 with the fifteen set of reciprocal pairs make it more likely it was probably a teacher who wrote this tablet to teach his students.

Works Cited

Robson, Eleanor. “Words and Pictures: New Light on Plimpton 322.” *American Mathematical*

*Monthly.* February 2002. Web. 13 Dec. 2010.

<http://mathdl.maa.org/images/upload\_library/22/Ford/Robson105-120.pdf>

Rudman, Peter Strom. *The Babylonian Theorem: the Mathematical Journey to Pythagoras and*

*Euclid*. Amherst, NY: Prometheus, 2010. Print.