ETHNOMATHEMATICS IN THE 1930S - THE CONTRIBUTION OF EWALD FETTWEIS TO THE HISTORY OF ETHNOMATHEMATICS

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Ewald Fettweis (1881-1967) was the first researcher to develop and establish the term ethnomathematics. This article presents his contribution to ethnomathematics and its development as a scientific theory. We will show that he was the first researcher to realize and practice ethnomathematics in his research and to explain it in his lectures, thus giving a disciplinary status to ethnomathematics. Fettweis's conceptualization of ethnomathematics was developed in the 1930s, much earlier than Ubiratan D'Ambrosio's subsequent, independent introduction of the same term. Based on this work, we argue for the existence of a pre-paradigm period in the development of ethnomathematics

Ethnomathematics as a scientific theory

Kuhn (1962) analyzed the development of scientific theories as following certain recurrent patterns. He established four concepts to characterize these patterns: *normal science, paradigm, scientific community* and *scientific revolution.* The main characteristic of a mature science, *i.e.* normal science, is that it is governed by a paradigm. During the early development of a science, an established paradigm has not yet been found. Kuhn (1962) calls these early stages pre-paradigm periods. During these periods, pre-paradigm scientists develop their research independently. Kuhn's theory of scientific development is relevant to the study of ethnomathematics in two ways: first, to establish the theoretical status of ethnomathematics; and second, to understand the relation of ethnomathematics with mathematics.

Although ethnomathematics has not yet achieved the status of mature or normal science, Kuhn's ideas can be used to determine the present state of development of ethnomathematics. The first of these ideas is the existence of a pre-paradigm period. The term "ethnomathematics" was already established in the 1930s as we will show. This pre-paradigmatic stage lasted until about the 1960s. Immediately after this period, more intense and differentiated research was initiated, resulting in the emergence of communication networks and the creation of a scientific community of researchers and teachers of the discipline. For example, the International Study Group on Ethnomathematics (ISGEm) was created in 1985 (see D'Ambrosio, 1985)

Gerdes (1997) was probably the first researcher to acknowledge Ewald Fettweis (1881-1967), Otto Friedrich Raum (1903-2002) and Georges-Henri Luquet (1876-1965) as some of the forerunners, *i.e.*, pre-paradigm scientists of ethnomathematics

Figure 1. A portrait of Ewald Fettweis (date unknown) Reprinted from Reich, Folkerts and Scriba, C. (1989, p. 361) with permission from Elsevier © 1989.

The relation of ethnomathematics with mathematics is related to changes that occurred as a result of historical, epistemological and sociological studies of science. In particular, the "mathematics" and "science" knowledge of *Naturvölker* or "primitive people" [1] constitute not only elements of curiosity, cataloged as ethnology, but contributions to ethnoscience, and in our case to ethnomathematics; they are elements of science, and hence of mathematics, too. The status of the relation between ethnomathematics and mathematics presents a challenge for the self-understanding of mathematics. In our opinion, the various kinds of mathematics that developed according to definite cultural and/or national contexts should constitute a "worldmathematics" and, once an effective means of communication has been established, a relatively universal and objective mathematics. Ethnomathematics challenges this mathematics to be conscious and aware of its culturally defined elements (see Rohrer, 2010)

Fettweis presented a true surprise in our historiographical research. In particular, we found that he had pursued ethnomathematical research much earlier than the emergence of ethnomathematics as a research program in the 1980s.

Some biographical notes on Ewald Fettweis

Ewald Fettweis was born in Eupen [2] on 23 July 1881, and studied mathematics at the Universities of Münster and Bonn from 1902 to 1906 He qualified as a secondary school teacher and became a mathematics teacher, first as *Studienrat* at the *Städtisches Höheres Lehrerinnenbildungsseminar Düsseldorf* from 1911 until 1920 He was thus active in the new branch of secondary schooling for girls leading to academic careers. He then acted as *Oberstudienrat* at the *Auguste-Viktoria-Schule Düsseldorf*. [3] The list of his publications presented by Reich *et al.* (1989) showed that Fettweis became interested in ethnographic research on mathematics after World War I From 1926, he produced numerous publications evaluating ethnographic findings, in particular about numeracy and reckoning procedures (see Fettweis, 1926, 1929a, 1929b)

Fettweis was awarded a doctoral degree from the Philosophy Faculty of the University of Bonn, Germany, in 1927 with a thesis (later published as a book) on an ethnomathematical subject, namely *Das Rechnen der Naturvölker* (The Numeracy of the Primitive People) [4]

This doctorate provoked our curiosity about academic acknowledgment of ethnomathematical research at that time in Germany. This led to a search for his academic supervisor at the University of Bonn, to find who had inspired and encouraged him with such an unusual subject – and whether it was a mathematician. This research proved to be difficult: contrary to the usual practice, the published thesis did not contain a curriculum vitae and the archives of the University of Bonn no longer had the files relating to his doctorate, due to losses in World War II Likewise, no files of his later professional positions, if preserved, contained such biographical data. [5]

Eventually, it became clear that there had been no supervisor in the traditional function of a *Doktorvater*, that is, of instigating and guiding the elaboration of the thesis: Fettweis had developed this research program by himself.

Fettweis's career as a mathematics educator and ethnomathematician

A decisive step in Fettweis's professional career was prompted by a radical reform in the German school system. In 1920, the traditional social separation between primary schooling for lower social classes and a preparatory system for the secondary schooling of the other social strata was abolished, and teacher training for the new primary schools was elevated to higher education In Prussia, new institutions called *Pädagogische Akademien* were established for this academic form of teacher training. In 1926, Fettweis became professor (*Dozent*) responsible for mathematical education at one of them, in Bonn. Besides lecturing on the basics of mathematics (*e.g.*, number theory) and on teaching methodology and practical exercises, Fettweis also announced his intention to tackle historical and cultural issues (Fettweis, 1926, pp. 453-454). Based on the research he had pursued independently for some years, Fettweis, then aged 46, submitted his thesis in 1927 at the nearby University of Bonn and obtained his doctoral degree from the Philosophy Faculty. [6] The entry on Fettweis in Poggendorff's (1937) *Handwörterbuch*, which is based on Fettweis's own communication, calls him a disciple of Ernst Study and of Adolf Dyroff (pp 731-732) With Ernst Study (1862-1930), who specialized in the geometry of complex numbers, he had studied mathematics in Bonn, and Dyroff (1866-1943) was a philosopher who had also published on the history of art. Neither of them is known to have promoted ethnology or ethnography.

In 1928, Fettweis moved to the position of *Fachberater* (adviser for mathematics teaching) at the *Provinzialschulkollegium Koblenz*, the regional school administration for secondary schools

From 1929 on, he included geometry in his ethnographic interests He also published two handbooks on teaching arithmetic and geometry in primary grades in which he included references to ethnographic findings on the origins of concepts in arithmetic and geometry. [7] Both became standard textbooks, re-published many times until the 1970s. In 1932, he moved again and became vice-director of the *Fürstenwall-Oberrealschule* in Düsseldorf, where he served until 1945

The first publication of the term ethnomathematics in 1959

Fettweis claimed to have suffered during the Nazi period and to have resisted their ideology. [8] After the end of World War II, in 1945, he obtained a professor position at the *Pädagogische Akademie* in Aachen and was actively lecturing until 1954 (Poggendorff, 1958, p. 30) According to the Italian ethnologist Falsirol, he lectured there on, among other things, ethnomathematics (Reich *et al.*, 1989). In fact, Falsirol used, in the original Italian paper of 1959 that appraised Fettweis's achievements, the exact notion *etnomatematica*, (*i.e.*, ethnomathematics) and thus used this term in print for the first time:

> Professore all'Accademia Pedagogica di Aachen, dove tenne lezioni di didattica, di storia delle matematiche e di etnomatematica fino al 1954, egli dedicò e viene dedicando parte considerevole della sua attività scientifica alla matematica e all'astronomia dei popoli considetti primitivi.
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> [Professor at the *Paedagogische Akademie* in Aachen, he lectured on mathematical education, history of mathematics, and ethnomathematics until 1954 He focused his research on the study of the mathematics and astronomy of primitive people] (Falsirol, 1959, p 262, our translation)

Although the published lists with announcements of the lectures of the *Pädagogische Akademie* up to 1954 are no longer preserved, Heinrich Winter, a retired professor from the *Rheinisch-Westfaelische Technische Hochschule Aachen,* student of Fettweis and his successor as a professor of mathematics education, confirmed to us that Fettweis had given seminars on the subject of ethnomathematics for advanced students. [9]

In a programmatic paper published in 1937, Fettweis fervently pleaded for a close collaboration between ethnology and the history of mathematics. He argued that in the cultures researched by ethnologists, one should be able to unravel the roots of mathematical developments in the first civilizations of Antiquity. And he insisted that the history of science has to embrace the entirety of humanity, so that the developments of the so-called "lower degree civilizations" *(niedere Kulturen)* should also contribute to the "tree of mathematical science" (Fettweis, 1937a, pp. 277-278). This position neatly corresponds to the modern program of ethnomathematics, which challenges the one-sided restrictions of mathematics to Western cultures only. Actually, Fettweis never undertook his own field research, but he was eager to assess as much ethnographic research as possible.

Fettweis's work and many of his publications were very innovative for the first half of the 20th century, especially in Germany; his legacy may be considered as a preparation for what is nowadays understood as ethnomathematics. One of his research interests was, as his PhD thesis shows, to study how and why "primitive people" developed mathematical concepts and knowledge; for this he reviewed available publications in ethnology and linguistics, evaluating a considerable number of different cultures from all continents, including Europe (Fettweis, 1927).

Fettweis organized this work systematically according to families of peoples and/or single peoples from: 1) North America and Northern Mexico, 2) Central America, 3) South America, 4) Australia, and 5) Asia.

Fettweis's further contributions

Articles published by Fettweis include:

- *Über die erste Entstehung der einfachen geometrischen Formen* (On the emergence of elementary geometrical shapes [10]) published in 1929,
- *Ueber das Verhältnis des Mathematischen Denkens zum Mysthischen Denken auf niederen Kultur-Stufen* (On the relation between the mathematical and the mystical thinking in lower degree cultures) published in 1932, and
- *Arithmetik, Rasse und Kultur* (Arithmetic, race and culture) published in 1935.

In these works he mainly studied the origins of mathematical objects and concepts, and of numbering and counting (Fettweis, 1929a, 1932, 1935).

The titles of some of Fettweis's publications can easily lead to misinterpretations of his position in favor of the relevance and importance of studying and researching non-European cultures, particularly because of the use of terms such as "race", "nigger" and "lower degree cultures". These terms were crucial within the scope of National Socialist principles and the Nazi party's strongly racist policy against all non-Aryan "races". Fettweis's intention was not to reinforce the belief that these cultures could be inferior; on the contrary, he claimed that non-European cultures have, for example, a higher ability with respect to spatial perception (Fettweis, 1927, p. 18). Some of the articles where he strongly defended his position include:

- *Was lernt unsere Rechenmethodik aus dem Rechnen der Naturvölker?* (What can our methodology for teaching reckoning learn from the numeracy of primitive people?) published in 1929, and
- *Ueber die Entwicklung des Räumlichen Vorstellungsvermögens bei völkern nichteuropider Rasse und in der europäischen Vorzeit* (On the development of spatial perception by non-Caucasian people during the European antiquity) published in 1937 (Fettweis, 1929b, 1937b).

One of Fettweis's main arguments was that it is important to study the mathematical knowledge of the living "primitive cultures" in order to obtain a fuller understanding of the state of mathematics in the old "high" cultures (Fettweis, 1932, p. 207). A concrete example of mathematical constructions from Fettweis's work refers to the indigenous people from the Xingu region, in the Brazilian Amazon: when girls menstruate for the first time, they receive a piece of cloth called *uluri* (an isosceles triangle with a base of 7 cm and a height of 3 cm) that will be put on her pubic area and will be held with cords coming out from the three corners of the triangle, in order to protect this part of the body against witchcraft. A rhombus is drawn on this *uluri* representing the *meréschu* fish, [12] which is a symbol of fertility to be transmitted to the girl who will one day become a mother (Kunike, in Fettweis, 1929a, pp. 114-115).

Fettweis also discussed how the construction of the rectangle was derived from the cardinal points, which were commonly venerated in almost the whole world. For example, the hut of the fortune-teller in Imerina, Madagascar, has the form of a rectangle pointing north and south in its longest side, and both the door and the window are on the west side (Soury-Lavergne & de la Devèze, in Fettweis, 1929a, pp. 117-118). Finally, the development of housing construction also shows a source for the appearance of simple geometrical forms. House construction has been, throughout human history, a natural and empirical mathematical problem of optimization: how can I build a big room using the least amount of material possible? Fettweis concluded that "primitive people" having bendable material available built beehive huts, *i.e.*, a half sphere, whereas peoples having inflexible material would build huts with a cone roof (see Schmidt & Koppers, in Fettweis, 1929a, pp. 119-120).

The article, *Arithmetik, Rasse und Kultur* (Arithmetic, race and culture) (1935), dealt with the question of whether the development of number and computation modes are "race" dependent or not. Fettweis's main conclusion was that one may find, in all cultures, and from all "race" groups, different beginnings for the numeration process. It is hence not possible to establish a connection between mathematical development and "race". The range of mathematical achievements in a specific culture is related to the level of development in its society. Hence, he argued, if a society becomes more complex, so the arithmetic will also develop accordingly. In Fettweis's own words:

> [...] der Umfang der Rechenkunst bei einem Volk [hängt] von der Höhe seiner Kultur ab, und dass, wenn die kulturellen Bedürfnisse wachsen, die Rechenkunst ganz von selbst mitwächst, gleichgültig um welche Rasse es sich handelt.
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> [[...] The amount of numeration developed by a folk (people) depends on the level of its culture, and if the cultural needs grow, the numeration will adapt accordingly, regardless of which race is concerned.] (Fettweis, 1935, p. 74, our translation)

It is interesting to note that, in the article *Was lernt unsere Rechenmethodik aus dem Rechnen der Naturvölker?* (What can our methodology for teaching reckoning learn from the numeracy of primitive people?), Fettweis admitted that psychology would not be enough to answer many questions in didactics. Ethnology, linguistics (philology) and the history of culture play a strong role within subjects like mathematics and cannot be excluded. And he was convinced that "primitive cultures" in a lower societal stage of development with respect to our mathematics can help us understand how to improve and encourage mathematics education (Fettweis, 1929b, p. 158)

Final remarks

Through Ewald Fettweis's scientific program we are able to confirm the existence of a pre-paradigm period belonging to the development of ethnomathematics. Indeed, Rohrer (2010) has seen that, since the first half of the twentieth century, several scholars developed ethnological research on mathematical practices. They were working as isolated individuals and were unable to communicate with each other, so there was no scientific community. But it was during this period that the term "ethnomathematics" was established as we were able to show.

We have seen that Fettweis's conceptualization of ethnomathematics connected different disciplines: mathematics, ethnology, history of mathematics, history of culture and, above all, mathematics education. Already in 1926, he had attempted to introduce historical and cultural issues into teacher education, in particular in the preparation of mathematics teachers (Fettweis, 1926)

It is possible to establish a parallel between Fettweis's approach to ethnomathematics, and the conceptualizations given by D'Ambrosio, Gerdes, and Ascher and Ascher, after 1985, *i.e.*, after the creation of ISGEm. D'Ambrosio's (*e.g.*, 1992) perspective conceives of ethnomathematics as covering all practices of a mathematical nature performed in different cultural settings. His program consists in establishing a methodology that can track and analyze how mathematical knowledge appears and is diffused (Rosa & Orey, 2006).

Gerdes (2007) conceives of ethnomathematics as a confluence between cultural anthropology, mathematics and mathematics education. He considers it to be a research field that reflects the awareness of the existence of several mathematics (in the plural), each of them belonging to a specific sub-culture. In addition, it should aim to include culturally specific mathematical knowledge in the mathematics curricula. The contribution of Ascher and Ascher (1986) is particularly interesting for our analysis, since they first defined ethnomathematics as "the study of mathematical ideas of non-literate people" (p. 125). They also linked the numeration system of ethnic groups with the needs of its people. Furthermore, they noted that some methodologies used for the study of mathematical knowledge of non-European cultures were promoting the inequity between these and the Western cultures, the latter being considered the highest one (Ascher & Ascher, 1986). [11] Later, Marcia Ascher (1991) referred to the goals of ethnomathematics as being to broaden the history of mathematics to one that has a multicultural perspective.

We see that Fettweis's approach and conceptualization of ethnomathematics is reflected in many of the contributions from after 1985, although these contemporary authors were not aware of Fettweis's work. Fettweis was an isolated researcher aiming at the consideration of mathematics as a cultural element. In spite of this, he managed to teach ethnomathematics in the university.

We would also like to emphasize the definition given by Ascher and Ascher (1986) since they referred to non-European cultures as "non-literate people" (p. 125). As in the case of the terms used by Fettweis, such as "primitive people" and "lower degree civilizations", the use of "non-literate people" opened several debates regarding discrimination against other cultures or peoples. If we contextualize this notion within the time it was being used, it should be considered adequate. Furthermore, this term was introduced by Lévi-Strauss as an attempt to avoid and maybe in the long term erase, the term "primitive culture" (see Ritter, 2009).

In conclusion, it is important to reflect on how Fettweis, making use of the terms available at the time, had changed the meaning and interpretation of these terms. This reflection enables us to expand the conceptualization of ethnomathematics to include a historical perspective. This will allow further discussion of the idea of ethnomathematics as a scientific theory in Kuhn's sense.

Finally, we consider it important to highlight, once more, that Fettweis, before the 1930s, had already rejected the traditional notion of the cognitive inferiority of the *Naturvölker* and had instead attributed to them cognitive abilities analogous to the so-called "civilized" people. By considering as a starting point his assertion of humankind taken as a categorical unity, one is led to the assumption that mathematics is a union of numerous, culturally different mathematics. The so-called Western mathematics is just one among many other forms of mathematics; it can no longer be distinguished as having its traditional priority. These ideas immediately open up questions about whether and how it would be possible to claim a universality and an objectivity of mathematics (Rohrer, 2010)

Notes

1. Through this article the terms *Naturvölker*, "primitive people", *niedere Kulturen*, "lower degree civilizations", "nigger", "race" are used to refer to non-European cultures. We consider this to be important because they are

the exact notions appearing in Fettweis s work. By keeping them, we can establish a clearer contrast between the scientific approaches to non-European cultures in the early 20th century and in our modern time.

2. Eupen belonged to the German Empire between 1870 and 1919 The Treaty of Versailles transferred it to Belgium, and it is nowadays part of the province of Liège

3 The German school system differs greatly from others It is, therefore, not easy to translate into English the different officeholder positions; what can be said is that the positions Fettweis occupied were in secondary schools that can be considered as teacher education institutions

4. Actually, the English translation of the title does not at all cover the meaning of the German term *Naturvölker* It literally means nature-bound peoples, as opposed to *Kulturvölker, i e.,* civilized peoples (Fettweis, 1927)

5. Landesarchiv Nordrhein-Westfalen in Düsseldorf, Aktenzeichen: R3M-3-02-1900/09, Signatur: BR PE 7847

6 Landesarchiv Nordrhein-Westfalen in Düsseldorf, Aktenzeichen: R3M-3-02-1900/09, Signatur: BR PE 7847 A transcription of Fettweis's Ph D certificate is in Rohrer (2010)

7 In Fettweis's book *Anleitung zum Unterricht in der Raumlehre,* the first section of chapter II is dedicated to remarks about the cultural history of measuring surfaces and bodies, and chapter VI is dedicated to interpreting the mathematics behind decorative objects (Fettweis, 1951, Inhaltsverzeichnis).

8 Landesarchiv Nordrhein-Westfalen in Düsseldorf Aktenzeichen: R3M-3-02-1900/09, Signatur: BR PE 7847

9. Personal communication.

10 The translations of the titles of these articles are our own.

11 Ascher and Ascher's observation that some research methodologies used for the study of mathematical knowledge in different non-European cultures were promoting an inequity between these and Western culture had already been addressed by Lévi-Strauss with the formulation of his structural anthropology (see Ritter, 2009)

12 The name of the fish *meréschu* is given in the Bakaïri language; it is a flat lagoon fish that belongs to the piranha family (see von den Steinen 1894, pp 101, 260-261).

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The theoretical general questions appear only at the meta-level and are to do with how language, people and systems interact. A theory of mathematics learning which has local virtue - that is, it is highly appropriate to a particular context - is fine when kept within bounds. By extending it to a generality beyond its range of application there is a risk of compromising its virtue. This seems to happen from a kind of endemic urge to be as generalised as possible. [...] I find it useful to observe which of your correspondent's suggestions correspond either to local issues dependent on context, or to genuinely general issues at a meta-level which are useful over a range of contexts.

(W. M. Brookes, FLM 4(3), p. 29)