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Roberto Mange: An Expert of Industrial Education

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ABSTRACT

This paper resulted from an unfolding of an ongoing doctoral research that deals with the characterization of a specific type of arithmetic in times of Brazilian industrial education, that is, between 1942 and 1968. The objective is to analyze knowledge produced by Roberto Mange for training, aiming not only to recognize them as such, but also to situate the social place of the producing agent, Roberto Mange, an *expert* in industrial education. The concepts mobilized are in line with the studies by Hofstetter, Schneuwly and Freymond (2017), and the methodological guidelines of Morais (2020). The research reveals that Roberto Mange introduced in Brazil new ways of teaching Mathematics, using the Occupational Methodological Series, the Instruction Sheets, and the Individualized Instruction Method. The conclusion is that Roberto Mange is an *expert* in industrial education

Keywords: teachers professional knowledge, industrial education, occupational methodological series, instruction sheets, individualized instruction method

INTRODUCTION

Writing always begins with one or more insights. For example, when carrying out an analysis, you are inspired by something. This something is the driving force for ideas to become words. The insight here is the writings of Domoulin, La Branche, Robert and Warin (2005, p. 12): "*Le recours et l'usage politiques de l'expertise tiennent au degré d'impuissance des gouvernés et des gouvernants à dire seuls le réel*." [1]

Notably, this discussion is about *expertise.* This entry is dear for current studies related to the History of Mathematics Education and that allows different points of view adopted in the analyses, both in strong ideological critical positions for political purposes and in those with a more pragmatic view, such as the excerpt in French above. For Hofstetter, Schneuwly and Freymond (2017, p. 57), "(...) our own analyses are inspired by this second position." Therefore, this work also does so.

Expertise is a term of studies that cannot be separated from the term *expert*, which is, in fact, the current concern of research conducted by the Associate Group for Studies and Research on the History of Mathematics Education (GHEMAT-Brazil)[2] and the Research Group of the History of Mathematics Education of Santa Catarina (GHEMAT-SC).[3]

Coordinated by Professor Wagner Rodrigues Valente, GHEMAT-Brasil conducts two major research projects, namely: "A matemática no ensino e na formação de professores: processos e dinâmicas de produção de um saber profissional, 1890-1990" (Mathematics in teaching and teacher training: processes and dynamics of the production of professional knowledge, 1890-1990) and "Os *experts* e sistematização da matemática para o ensino e para a formação de professores, 1890-1990" (The experts and systematization of mathematics for education and teacher training, 1890-1990) (Valente, 2020, p. 603-604).

This work is within the scope of the second project cited by Valente (2020): it deals with *experts* and the production of knowledge for training and, as it were, consequently about *expertise.*

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[1] "The political recourse and use of expertise are due to the degree of incapacity of the governed and those who govern to say what is real" (Dumoulin; La Branche; Robert; Warin, 2005, p. 12) According to the authors, the concept of *expertise* is not a consensus. Some works adopt the point of view among the strong ideological critical positions of instrumentalization of *expertise* for political ends (Poupeau, 2003). And others, like the one we quote here, give way to a more pragmatic view. Hofstetter, Schneuwly, and Freymond (2017) are inspired by the pragmatic perspective.
[2] https://www.ghemat-brasil.com/
[3] https://ghemat.paginas.ufsc.br/

These concepts have been mobilized by the group based on the theorizations of Rita Hofstetter, Bernard Schneuwly and Mathilde de Freymond, with the collaboration of François Bos, Swiss researchers who are part of the University of Geneva. Rita Hofstetter leads a research group called *Équipe de Recherche en Histoire Sociale de l'Éducation* – ERHISE (Research team on social history of education) in Geneva.[4] The text "*Pénétrer dans la vérité de l'école pour la juger pièces en main - L'irrésistible institutionnalisation de l'expertise dans le champ pédagogique (XIXe. - XX siècles)*,"[5] explains what the authors understand by *expertise:*

> (...) an instance, in principle recognized as legitimate, attributed to one or more specialists - supposedly distinguished by their knowledge, attitudes, experiences - aiming to examine a situation, to evaluate a phenomenon, to verify facts. The education authorities demand this *expertise* when they need to make decisions. (Hofstetter, Schneuwly & Freymond, 2017, p. 57)

In their closing lines, the authors still ponder that the *expertise* "(...) is outside administration, they are attributions that deal with the scientific analysis of data produced by the players from the very school system, administration and inspectorate notably" (Hofstetter, Schneuwly & Freymond, 2017, p. 105). In simple lines, the conclusion is that it is something the State demands to support a technical decision or, still, "(...) one that recognizes an institution, or a person, as capable of resolving a practical demand of the State" (Morais, 2019, p. 9).

The term *expertise* has been used at different times in intellectual and cultural history. It goes through an interpretation focused on the legal field and, later, it is also mobilized in the areas of medicine. However, in the pedagogical field, the term has been inserted in discussions since the 19th century. It should be noted that in specific surveys, the "[...] first *expertises* are carried out by the teaching profession (school assessment, exams of recruits). Then, thanks to the *Bureau* of archives in Geneva and the pedagogical researchers, *expertise* developed" (Porret, Brandli, & Lozat, 2013, p. 19)[6].

For Porret, Brandli, and Lozat (2013, p. 19), "The *expertise* then boils down to scientists who base their analysis on the data produced by the actors in the school system itself." In the 19th and 20th centuries, pedagogical *expertise* became more strongly institutionalized. This is due to three main factors: the nationalization of the school system; *expertise* as a mode of scientific production; and the "social demand," which reinforced and accelerated the institutionalization of *experts* in pedagogical science (Porret, Brandli, & Lozat, 2013).

And who, then, is this person that can put an end to the questions raised by the State? According to Morais (2019, p. 9), the *expert* is "(...) the subject of the expertise that legitimises the demands of the State". Then, we can say an *expert* has *expertise* and, when called, he/she solves a problem and produces knowledge for the new training or education: "In short, a demand from the State will imply the convening of an expertise, whose subjects are the experts. This call is triggered by the recognition of the community to which this instance joins" (Morais, 2019, p. 10).

This knowledge production is not random. It is knowledge related either to education or to the school system. Here, guidance of the literature is also adopted: "(...) the expertise is recognized for its competence in producing knowledge about the school system" (Morais, 2019, p. 11). And it is in this context that we understand knowledge: more than being classified as an *expert,* what matters is the knowledge he/she produces in the pedagogical field. This is what researchers in the field state:

> Those new theoretical and methodological bases mobilized to make intelligible processes and dynamics of the teachers' professional knowledge production and, in particular, the professional knowledge of the teacher who teaches mathematics puts knowledge at the center of discussions, brings epistemology, treated in the pedagogical field, to the debate, problematizes pedagogical knowledge in terms of objectification processes, gives meaning to investigations that aims to understand how the objectified knowledge is constituted in its articulation with the knowledge of action. (Valente, 2019, p. 19)

We start this discussion with Lacki, Catinaud & Hurni's (2013, p. 155) question: "[...] how did the *experts*, called to comment on the conceptions, construction and exploitation of machines, conducted their *expertise*?". These authors also pose another important question related to the *experts*: "The question of how an *expert* works in the absence of a "fundamental theory" brings beforehand, more generally, the links between theory and practice and, later, the way in which the field of the *expertise* particularizes this issue" (Lacki, Catinaud, & Hurni, 2013, p. 156, free translation by the authors). Further, in this discussion, fundamental theory is understood as "[...] a body of knowledge founded on the fundamental principles recognized as true and which allow the universal laws to be derived from a class of phenomena" (Lacki, Catinaud & Hurni, 2013, p. 156).

In other words, the authors want to problematize the relationship between both theory and practice and *expert* and their *expertise*. In Daniel Parrochia's studies, in conclusion, it is evident that "[...] an *expertise* cannot be based solely on the knowledge of theoretical rules or facts of the experience, but must fundamentally involve a judgment on the applicability of this knowledge "in a precise case in a given situation" (Lacki, Catinaudi, & Hunri, 2013, p. 158). Therefore, the purpose is to identify which knowledge the subject has produced, verify his/her *expertise* and, if possible, classify him/her as an *expert*.

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[4] https://www.unige.ch/fapse/erhise/fr/accueil/

[5] "Access the school truth to have actual elements for its evaluation – The irresistible institutionalization of the expert in education (19th and 20th century) - title of Chapter 2 of Hofstetter e Valente's work (2017).

[6] "All citations in foreign language have been translated by the authors".

For this, in a recent study, Morais (2020) sought to contribute in a theoretical-methodological way to investigations that analyze the production and systematization of knowledge on both education and teacher training by education specialists, that is, by *experts*.

According to the author, the project "Os *experts* e sistematização da matemática para o ensino e para a formação de professores, 1890-1990" (Experts and systematization of mathematics for teaching and teacher training, 1890-1990) has its own methodological strategy:[7]

> *i)* always starting from a figure that has had an active participation in teacher training or in teaching, assuming, as a research hypothesis, that he or she is an expert;
>
> *ii)* reconstructing his or her trajectory, relating it to the contexts in which he or she circulated;
>
> *iii)* highlighting his or her participation in the elaboration of new knowledge of mathematics to and for teaching. (Morais, 2020, p. 5)

If this third step is confirmed, the author determines that the following will be: "*iv)* acknowledge such figure as an expert, thus confirming the research hypothesis" (Morais, 2020, p. 5).

Morais bases this methodological path on Valente (2018), who considers steps in the characterization of processes that take the subjects' experiences to scientific knowledge: "(...) recompilation of teaching experiences, comparative analysis of teachers' knowledge, systematization and use of knowledge as knowledge" (Valente, 2018, p. 380).

By *recompiling teaching experiences*, this researcher understands them as the moment that

> involves the selection and separation of information reported in educational magazines; organized in textbooks and teaching manuals; standardized in teaching laws; contained in students' and teachers' personal documentation; materialized in pedagogical devices for teaching, among other types of documentation that may reveal information about teachers' pedagogical work. (Valente, 2018, p. 380)

In other words: "(...) to analyze a whole group of documents in order to form a collection that will be analyzed in search of proposition tendencies and construction of pedagogical consensus about teachers' work" (Morais, 2020, p. 6).

For Morais, the next step of the research consists of: "(...) systematizing the use of knowledge through an analysis guided by theoretical references that have knowledge as a main theme. The product of this operation is "objectification" (...)" (Morais, 2020, p. 6).

This researcher also provides questions that can be asked by the researchers to help them identify whether knowledge was objectified or not:

> What is the nature of this knowledge in terms of teacher's objects of work and tools, that is, in terms of mathematics to and for teaching? Does the analysis allow the researcher to state that they constitute new training knowledge? If so, the researcher will be able to acknowledge the knowledge producer as an expert. (Morais, 2020, p. 6)

Without wishing to end the discussion here, this work is limited to analyzing the professional trajectory of Roberto Mange, aiming to verify the knowledge he produced and, if possible, classify him as an *expert*. This study adopted the theoretical-methodological path of Morais (2020). Thus, the first part of the route is taken.

1st STEP: RESEARCH HYPOTHESIS - ROBERTO MANGE IS AN *EXPERT*

Following Morais's guidelines (2020), this section assumes, by hypothesis, that Roberto Mange is an *expert,* a personality who participated actively in education and teacher training. Therefore, this work brings elements of his personal and professional life related to educational issues.

Robert Auguste Edmond Mange (Roberto Mange) was born in Villard Mégroz, La Tour de Peilz, Canton of Vaud, Switzerland, on December 31, 1885 (SENAI, 1991b, p. 1). He attended the first years of elementary school at the Canton School of Neuchatel, between 1895 and 1899, and completed the elementary primary instruction examination, high school, on August 22, 1899 in Lisbon, Portugal. In the middle of 1900, he continued his studies in Minden, Germany. Mange returned to Switzerland in 1904 and received a degree in Mechanical Engineering at the Polytechnic School – *Eidgenoessischen Polytechnischen Schule* - on July 4, 1910, in Zurich (SENAI, 1991b, p. 9).

[7]The research on *experts* as vectors of objectification of knowledge is not limited to a single methodological path. In the Project in question, for example, the following objectives are placed: *i)* To elaborate a mapping of characters that can be considered *experts* in the formulation of mathematical knowledge for the training of teachers of the first school years in different Brazilian states; *ii)* Build professional biographies of the characters considered *experts* in different Brazilian locations; *iii)* Inventory the production of *experts* in terms of bibliography for the mathematical training of teachers who teach mathematics; *iv)* Build a mapping that identifies the circulation of knowledge coming from texts prepared by the list of *experts* inventoried in the project; *v)* Identify themes chosen for teacher training in the *experts* ' texts and, in a comparative way, capture the differences and similarities in a given school time when the texts had circulation to verify the establishment or not of consensus on mathematics to be present in the training of teachers of the first school years.

> It was at that time that a former student of the *polytechnikum*, the Brazilian engineer Antônio Francisco de Paula Souza, asked that school in Zurich to appoint two former students who might be interested in moving to Brazil to teach engineering. They indicated two names: Félix Hegg and Robert Mange. (SENAI, 1991a, p. 41)

Roberto Mange accepted the invitation, and arrived in São Paulo in June 1913, settling in a pension close to the Escola Politécnica, where he would teach. He got married and went back to Switzerland in 1914, returning to Brazil in 1915 (SENAI, 1991a, p. 49-50). He had his Mechanical Engineer Diploma translated on January 13, 1935 and became a naturalized Brazilian citizen on September 30, 1939 (SENAI, 1991b, p. 5).

In the educational field, besides teaching at the Polytechnic School, Roberto Mange created the Mechanics Course at the Lyceum of Arts and Crafts in 1923 (SENAI, 1991a, p. 61-62). Mange was interested in following the developments of educational reforms both in Brazil and abroad:

> During the 1920s, Mange traveled a few time to Europe, to specifically update his knowledge in the pedagogy of vocational training and find out about the issues that occupied the center of the debates that, in that continent, had already advanced much. (SENAI, 1991a, p. 79)

The excerpt shows Mange's interest and personal involvement in educational issues. "Even with a focus on technical education, Roberto Mange did not fail to point out, between the lines, the precariousness of the official elementary education that, in fact, did not fulfill its function of literacy even with the minority that had access to school" (SENAI, 1991a, p. 87).

It is important to mention that, in the 1930s, Brazil experienced the *Escola Nova* (New School) Movement, as well as the *Pioneiros da Educação* (Education Pioneers) Manifesto. In this regard,

> Roberto Mange followed closely the debate that culminated in the manifesto, having participated more actively in the discussions on vocational education (aiming to provide students with a specific skill for a profession). According to his son, Roger Mange, his name is not among the subscribers because, at that time, Mange had not yet chosen Brazilian citizenship, and was therefore prevented from signing documents of a political nature. (SENAI, 1991a, p. 89-90)

Roberto Mange's relevance in the Brazilian educational scene is evidenced by his alignment with people like Fernando de Azevedo, Anísio Teixeira, Lourenço Filho, Cecília Meirelles, among others. It should be noted that, "in the late 1930s, he was publicly acknowledged as an authority on vocational education issues" (SENAI, 1991a, p. 113).

Still in the 1930s, Antônio Prudente de Moraes, director of the *Estrada de Ferro Sorocabana*, indicated Roberto Mange head of the *Serviço de Ensino e Seleção Profissional* (Education and Vocational Selection Service) of that body, on September 1, 1934. On April 1, 1936 he was again appointed to the same position (SENAI, 1991b, p. 4).

Robert Mange received several honors for his 25th anniversary as a professor at the Polytechnic School of the University of São Paulo, and in 1953, he was awarded the title of Professor Emeritus of the Polytechnic School of USP (SENAI, 1991b, p. 13).

In his archives, some documents show Mange's importance in the educational area: a) an excerpt from the article entitled *Homenagem ao Semeador de Escolas* (Homage to the School Sower); b) an article in German, entitled "Roberto Mange - *Begründer der Brasilianischen Berufsausbildung"* (Founder of Brazilian vocational education) (SENAI, 1991b, p. 19); c) an article in French, entitled "*Les pionniers suisses au Brésil"*, about the Swiss who worked in Brazil, from the 16th to the 20th century; among them, Roberto Mange (SENAI, 1991b, p. 21).

There is also a letter from the then Minister of Health and Education, Gustavo Capanema, dated August 27, 1941, "(...) in which he refers to Roberto Mange, appointed by the Ministry to obtain contacts of technicians in Switzerland for vocational education in Brazil, praising his performance in the task" (SENAI, 1991b, p. 23). Mange traveled to France in 1940 to visit schools specialized in vocational education (SENAI, 1991b, p. 6).

In short, in this section, focused on the character's biography concerning teacher training and/or performance in education. Therefore, besides his functions as engineer and professor, Mange was also acknowledged as a "sower of schools" and "founder of Brazilian vocational education", and is remembered for having participated in the debates that culminated in the publication of the Pioneer's Manifesto.

Consequently, the first step of the characterization process suggested by Morais (2020) was fulfilled. The next step is to focus on the reconstruction of Mange's trajectory, relating it to the context in which he circulated.

2nd STEP: RECONSTRUCTING MANGE'S TRAJECTORY

Talking about Roberto Mange's trajectory has become simple, now that the first section highlighted the educational issues. We risk affirming that the first two steps of the methodological path are intertwined, since his performance is strongly acknowledged in the educational debates of the time. However, other elements emerged, besides those already mentioned.

From 1925 through 1929, he worked as a technical consultant for Martins Barros & Cia., in São Paulo. In 1926, Mange participated in the survey on public instruction, promoted by the newspaper "O Estado de São Paulo", and, until 1928, he provided consulting services to the company Hilpert & Cia., in Rio de Janeiro.

In 1931, the engineer and professor Roberto Mange joined a group led by entrepreneurs that created the *Instituto de Organização Racional do Trabalho* - IDORT (Institute of Rational Work Organization), to "address the organizational issues of the work process based on the most modern and updated scientific procedures" (Antonacci, 1987 *apud* SENAI, 1991a, p. 64).

> Mange was a delegate of the *Departamento Central de Munições* (Central Ammunition Department), and appointed as a technical consultant to the *Comissão Técnica Civil de Material Bélico* (Civilian Technical Commission on Military Material) to follow the project elaboration, construction and adaptation of the machinery necessary for the assembly of the new gunpowder factory to be built next to the capital of the state (SENAI, 1991a, p. 65).

From the documents found, we could see that Roberto Mange participated in several commissions linked to the ministries, "sometimes linked to the Ministry of Education, sometimes to the Ministry of Labor" (SENAI, 1991a, p. 69).

In 1932, he took over the leadership of the 2nd Division of the IDORT and, in the following year, he participated in the committee of experts who drafted the *Education Code*. In 1934, he participated in the *Comissão Organizadora do Plano de Ensino Profissional* (Organizing Committee for the Vocational Education Plan), of the Ministry of Health and Education, and created the *Centro Ferroviário de Ensino e Seleção Profissional* - CFESP (Railway Center for Education and Vocational Selection) and was appointed permanent professor of psychotechnics at the Free School of Sociology and Politics.

He was appointed supervisor of the psychotechnical office, attached to the Technical School "Getúlio Vargas" (former *Instituto Profissional Masculino* (Vocational Institute for Men)) in 1937, where he remained until 1939. In 1938, he became leader of a commission at the *Repartição de Águas e Esgotos* - ERA (Water and Sewerage Bureau) to study water meters. He took over the leadership of a commission in the *Departamento de Estradas de Rodagem* - DER (Department of Highways), for the reorganization of mechanized services, in 1939.

On January 26, 1940, Mange was appointed in Rio de Janeiro as an engineer for the *Serviço de Prevenção de Acidentes do Trabalho*, belonging to the *Instituto de Aposentadoria e Pensão da Estiva do Ministério do Trabalho, Indústria e Comércio* (Occupational Accident Prevention Service of the Institute of Retirement and Pension of the Stowage of the Ministry of Labor, Industry and Commerce) (SENAI, 1991, p. 4).

He participated in the *Comissão Estadual do Gasogênio* (State Gasogen Commission) in 1941 and, in 1942, he received from the Coordinator of Inter-American Affairs in Washington the task of promoting a plan for the technical preparation of the war effort in Brazil. It was also this year that the technicians selected by Roberto Mange arrived from Switzerland to work mainly at the National Technical School, and two important Decrees were published: Decree-Law No. 4.048, of January 22, creating the *Serviço Nacional de Aprendizagem dos Industriários* - SENAI (National Service of Apprenticeship of Industrialists), in which Roberto Mange took office as director of the Regional Department in São Paulo; and Decree-Law No. 4.073, of January 30, which defined the Organic Law for Industrial Education.

Robert Mange was appointed President of the Psychological Society of São Paulo in 1947, the year he traveled to Europe to study vocational and industrial education.

On November 6, 1950, the French government, through the French Alliance, awarded Roberto Mange the most important decoration in the country, that of *Chevalier de la Légion d'Honneur*[8] (SENAI, 1991b, p. 12-13).

Roberto Mange died in São Paulo on May 31, 1955.

In 1956, the Ministry of Labor, Industry and Commerce awarded the *Medalha do Mérito na Segurança do Trabalho* (Medal of Merit in Occupational Safety) for the relevant services rendered to the cause of the prevention of occupational accidents (SENAI, 1991b, p. 12).

We believe that his most significant trajectory is already exposed in the first section. Despite engineering, Mange found his true professional performance in education.

> He had a strong connection with the type of training offered in France and England, because everything in France should be on time. Mange looked at his watch and said: "Everybody at SENAI is having math class now, everybody is resting now, is having lunch..." Everything on time. (SENAI, 1991a, p. 167)

Given that the second step of the process has been confirmed, we will analyze the knowledge this character produced. If we verify it, he may be called an *expert,* as prescribed by Morais (2020).

3rd STEP: PREPARING NEW KNOWLEDGE

This section is reserved to analyze Roberto Mange's knowledge production. This is the third methodological step based on Morais (2020) to characterize Mange as an *expert*.

First, it was necessary to read some works already carried out about the character in question. From Dominschek's writings (2015), we can affirm that the "new knowledge" concerns his own way of working with vocational education. In other words, a *mathematics to teach* specific to the teacher's work with a specific audience. The author affirms: "According to each discipline, teaching processes that lead the students to think for themselves the problems of their real lives are employed" (Dominschek, 2015, p. 1293).

[8] Knight of the Legion of Honor.

As an example of the novelties in the methodology, we can say that

> It was necessary to "give them a feature that clearly suited the student's psychology, eliminating the traditional curricular rigidity, which is summed up in an inversion of the pedagogical line of action. It is not the teacher who must instill the subject matter in the student, but the student who must wish to acquire the knowledge, the how and why of the practice and theory of his/her craft." (Report SENAI-SP, 1951 *apud* SENAI, 1991a, p. 140)

What was intended, in fact, was an exercise in a "school culture for the workshop" (Morais & Ferreira, 2016, p. 2).

Roberto Mange traveled to Germany in 1929 to learn about rational methods of learning and vocational selection. The following year, when he returned to Brazil, together with Gaspar Ricardo Júnior, he organized the *Serviço de Ensino e Seleção Profissional* - SESP (Education and Vocational Selection Service). As Mange worked in Sorocaba, he moved the rational organization of the work there in 1931. According to the Relatório Sorocabana report, dated 1934,

> In the morning, general classes and technical preparation classes are given (...) the former offered by the Escola Profissional de Sorocaba (Vocational School of Sorocaba) and the latter by the Estrada (TN: referring to the Railway). The afternoon is occupied by practical work that is carried out in the learning workshop. (...) The practical works are done by hand in a **methodical series** (emphasized in the original) of drawings of parts, of progressive difficulty (Relatório Sorocabana, 1934: 9 *apud* SENAI, 1991a, p. 97).

These methodical series mentioned above are the *Séries Metódicas Ocupacionais* - SMO (Occupational Methodical Series) introduced in Brazil by Roberto Mange (Pedrosa, 2014, p. 50). "That teaching material used was distributed by SENAI and ordered by a set of instruction sheets – *Folhas de Tarefa* – FT (task sheets), *Folhas de Operação* – FO (operational sheets) and *Folhas de Informação Tecnológic*a – FIT (technological information sheets), elaborated based on the profile of each occupation" (Morais & Ferreira, 2016, p. 2 – emphasis in italics by the translator).

We looked for examples of those instruction sheets for mathematics teaching. This search taught us that, at the time, a teaching method called *Método da Instrução Individual* (method of the individual instruction) was in force. Far from being the best teaching method, it seemed to be the most effective at the time.

> To apply the methodical series and the instruction causally related to the needs imposed by the crafts, he sought a method that combined all the human and material resources that were available to achieve his objectives successfully and safely. He based the method selection on the psychological principles that govern learning, on the objectives of the teaching provided by SENAI, on the study of the students' personality, on the material availability, on the faculty, and on the consideration of other factors that condition the choice of any teaching technique. (Departamento Regional do SENAI - RS, 1970, p. 49)

To develop this method, Mange used a technique called then *the technique of the directed study*. According to the author,

> It is a technique that provides the learner with habits of mental work, favorable attitudes to teaching, reflection and critical sense, highlighting the *way the learner learns*; it teaches the apprentices to *reason before carrying out a task*,[9] leading them to *learn for themselves* and, thus, preparing them to decisively act in the other phases of the development of learning (Departamento Regional do SENAI - RS, 1970, p. 49-50, *emphasis in original*).

There are four distinct phases foreseen for the method described above: task study, demonstration of the new operations, task execution and evaluation. In the first one - task study -, with individual instruction sheets, the apprentices are told what they must do and what they must use for it. Following - demonstration of new operations -, there is the moment of "practical display of how to use the equipment properly". In the third phase - execution of the task -, the apprentices use the knowledge extracted from the individual Instruction Sheets and from the demonstration of the operation, when they have an effective participation. Finally - evaluation - consists of observing all the work in the task execution, that is, to understand the content of the Individual Instruction Sheets (Departamento Regional do SENAI - RS, 1970, p. 52-53).

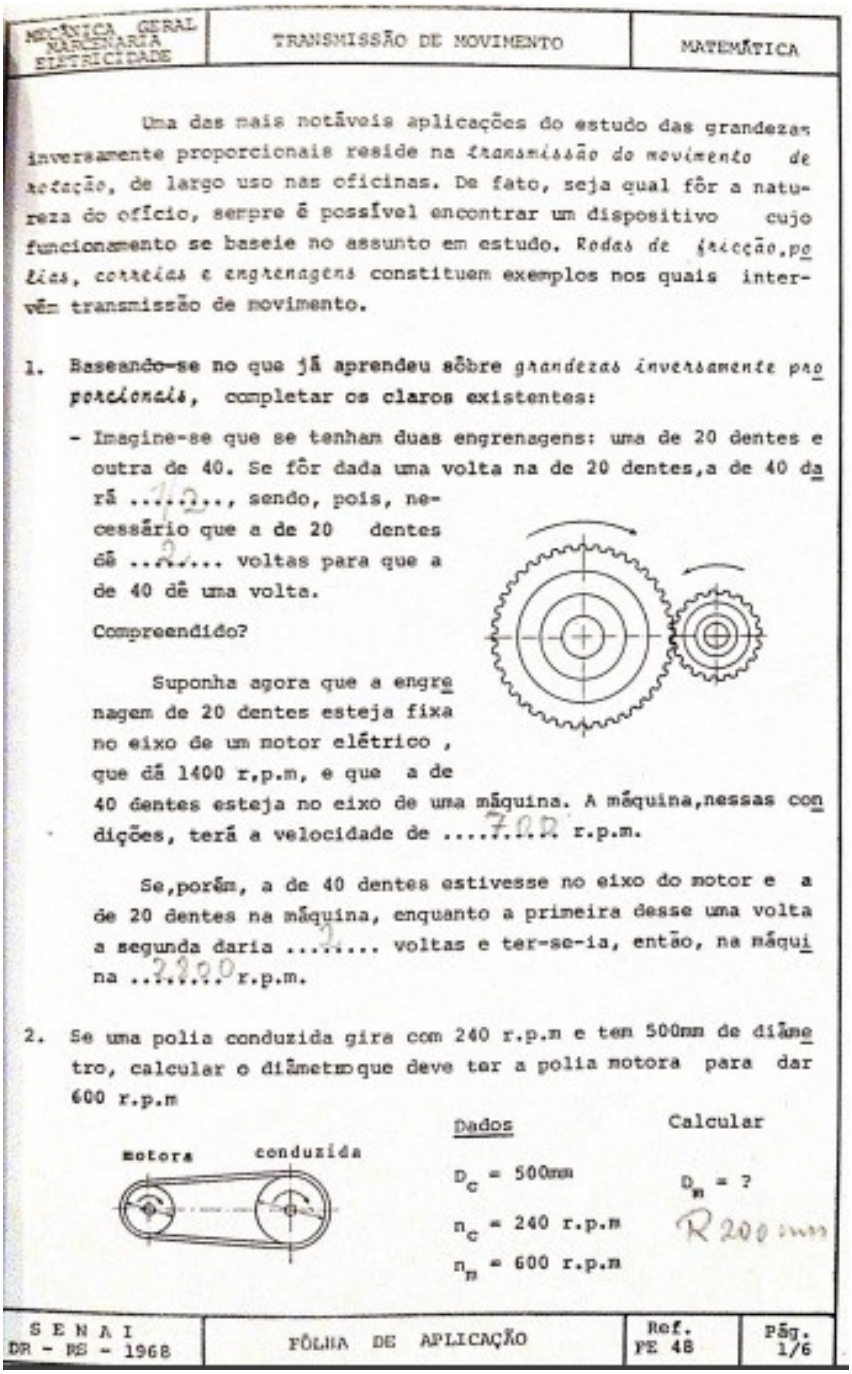
According to the author, in this scenario emerged the didactic materials to be applied by the study technique to teach Portuguese, Mathematics, Sciences, Drawing, Social Sciences and Physical Education. This set of areas was called "*related matters*, as the knowledge provided for in its programming is related to the needs imposed by learning the craft" (Departamento Regional do SENAI - RS, 1970, p. 54).

The following is an example of the Individual Instruction Sheets:

This Individual Instruction Sheet was to be used in General Mechanics, Joinery, and Electricity courses. These are activities related to the "Motion Transmission", which deal with applications to the study of inversely proportional quantities. As an exercise, the following statement appears: "2. If a driven pulley rotates at 240 rpm and its diameter is 500 mm, calculate the diameter that the motor pulley must have to reach 600 rpm." It is an activity that is solved by simply applying the basic rules of inverse proportionality, with problems applied into the daily life in the workshop.

This statement refers to an emerging need to change the literature of the problem to try to bring that problem back to the workshop, since, to propose it to the student, the teacher should bring it "(...) to the workshop class, that is, seeking to choose

[9]In the case of related instruction, consider *before applying question studied (task = subject and operation = knowledge*). (Departamento Regional do SENAI – RS, 1970, p. 50, *emphasis in the original*).



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TRANSMISSÃO DE MOVIMENTO

MATEMÁTICA

Uma das mais notáveis aplicações do estudo das grandezas inversamente proporcionais reside na *transmissão do movimento de rotação*, de largo uso nas oficinas. De fato, seja qual fôr a natureza do ofício, sempre é possível encontrar um dispositivo cujo funcionamento se baseie no assunto em estudo. *Rodas de fricção, polias*, correias e engrenagens constituem exemplos nos quais intervêm transmissão de movimento.

1. Baseando-se no que já aprendeu sôbre *grandezas inversamente proporcionais*, completar os claros existentes:

- Imagine-se que se tenham duas engrenagens: uma de 20 dentes e outra de 40. Se fôr dada uma volta na de 20 dentes, a de 40 dará ..1/2.., sendo, pois, necessário que a de 20 dentes dê ..2.... voltas para que a de 40 dê uma volta.

Compreendido?

Suponha agora que a engrenagem de 20 dentes esteja fixa no eixo de um motor elétrico, que dá 1400 r.p.m, e que a de 40 dentes esteja no eixo de uma máquina. A máquina, nessas condições, terá a velocidade de ..700.. r.p.m.

Se, porém, a de 40 dentes estivesse no eixo do motor e a de 20 dentes na máquina, enquanto a primeira desse uma volta a segunda daria ..2.... voltas e ter-se-ia, então, na máquina ..2800.. r.p.m.

2. Se uma polia conduzida gira com 240 r.p.m e tem 500mm de diâmetro, calcular o diâmetro que deve ter a polia motora para dar 600 r.p.m

motora conduzida

Dados

D_c = 500mm

n_c = 240 r.p.m

n_m = 600 r.p.m

Calcular

D_m = ?

R 200 mm

SENAI
DR - RS - 1968

FÔLHA DE APLICAÇÃO

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Figure 1. Individual Mathematics Instruction Sheet - Motion Transmission
Source: (Departamento Regional do SENAI - RS, 1970, p. 62)

math problems that are the translation of phenomena that take place in the workshop" (Clemente, 1948, p. 86). Clemente also states that "(...) a slight change in the problem literature brings about transformation (...)" (Clemente, 1948, p. 86).

As an example of this transformation, the author explains:

> A hare is sixty leaps ahead of a dog chasing it. While the dog makes two jumps, the hare makes three, but a dog's jump is worth two of the hare's. At the end of how many jumps will the dog reach the hare?" Transforming it, we will have: "Before starting to work, the lap counters on two machines marked 15,000 and 17,000 laps. The first, measuring 3,600 rpm and the second, 2,600 rpm. After how many minutes will they mark the same number of laps? (Clemente, 1948, p. 86)

The example above matches the one proposed in **Figure 1**. What we mean is that "from the abstract problems that they were, they became absolutely concrete problems" (Clemente, 1948, p. 86).

Besides the wording of the problems, the way to expose content and demand knowledge from the student was also considered a problem in industrial education. As a suggestion to solve this conflict, Clemente (1948, p. 87) says: "The minimum choice, within the impossible, of the theorems that are essential to the resolution of practical problems is the means, because the future specialist does not need to know much, rather the essential." And it is by analyzing the Individual Mathematics Instruction Sheet

(**Figure 1**) that these two characteristics are verified: the writing of the problem related to the workshop and the work with mathematical concepts related to the solution of practical problems.

Therefore, we see a new way of teaching mathematical content, that is, we see a *mathematics to teach*. It is possible to perceive, thus, an innovation in the pedagogical field, that is, Roberto Mange produced a new knowledge when he introduced in Brazil the Occupational Methodical Series, the Instruction Sheets, and the Individual Instruction Method. Is he, then, an *expert*?

4th STEP: CONFIRMING THE RESEARCH HYPOTHESIS – CONCLUDING REMARKS

Morais (2020) presents three steps to characterize an individual as an *expert*. The author states that, having confirmed the three previous steps, if the fourth step is also verified, the individual is an *expert*.

After admitting, hypothetically, that Roberto Mange is an *expert* and that he participated actively in teacher training and/or education, and after having analyzed his trajectory and relations with the context in which he was inserted, the researchers went on to analyze his participation in the elaboration and production of a new knowledge.

From the documents analyzed, we found that Roberto Mange introduced a new knowledge into Brazilian industrial education, that is, it was through him that the Occupational Methodical Series, the Instruction Sheets and, with them, the Individual Instruction Method, emerged. Far from being a "fundamental theory," as defined by Lacki, Catinaudi, and Hunri (2013), this knowledge is the result of a systematic and practical knowledge, which gained space in industrial education, i.e., there was a judgment on the applicability of this knowledge in a specific case and in a given situation - the improvement of Brazilian industrial education. This knowledge changed the parameters of Brazilian education between the 1930s and 1940s. Therefore, he produced knowledge, new knowledge.

In view of the methodological path adopted, this research concluded that there is evidence enough to characterize Roberto Mange as an *expert* in industrial education in view of his political relations, his call made by the State and the place he occupied for the specific knowledge to be officialized. Dominschek (2015, p. 1287) states that Roberto Mange is also an "intellectual of the vocational education." But this is subject for another article, since *expert* and intellectual are not synonymous and need different analysis.

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