# A PARTICIPATIVE RESEARCH WITH IN-SERVICE SEC-ONDARY SCHOOL TEACHERS ON THE INTRODUCTION OF THE HISTORY OF MATHEMATICS IN MATHEMATICS ED-UCATION: AN OVERVIEW AND SOME PRELIMINARY RE-SULTS

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#### ABSTRACT

In this paper, we present an overview of a study that seeks to better understand the contribution of the historical and cultural dimension of mathematics in the context of secondary school mathematics teaching. Seeking to give mathematics teachers a voice, the study takes the form of participatory research in which teachers and researchers come together to reflect on the educational potential of the history of mathematics and how to implement it within the classroom. The purpose is both to document the didactic and pedagogical reflections of secondary school teachers and to support their practice. A group of four teachers engaged in this collaborative process was formed, and three collaborative meetings were organized. We present here an overview of the study and preliminary results on how teachers see the role and the potential of the history of mathematics in their classroom, their different ways of developing tools, and some of the challenges they face.

### 1 Problematizing elements

In the proceeding of the 2016 HPM meeting, Clark et al. (2016) published an important paper concerning recent developments in the field of research on the history of mathematics in mathematics education. In their concluding remarks (p. 175), the authors mention the needs and issues that are currently central to researchers: 1) emphasizing pre- and in-service teacher education, (2) designing, making available, and disseminating a variety of didactic source material, 3) systematically and carefully performing applied empirical research to examine in detail and convincingly evaluate the effectiveness of the HPM perspective, and 4) acquiring a deeper understanding of theoretical ideas put forward in the HPM domain to carefully develop them into coherent theoretical frameworks and methodological schemes. The study presented here addresses the first three issues more precisely.

#### 5.2 Empirical studies in the HPM literature

In the HPM literature, Guliker and Blom (2001) observe, on the one hand, that theoretical research provides important conceptualizations and, on the other hand, that empirical research tries "to put to the test" the development of certain tools without considering theoretical developments. Theoretical and empirical research seem to walk side-by-side but have a hard time informing each other.

With respect to empirical studies, Jankvist (2009) noted the low number of empirical studies matched with theoretical studies and called for empirical discussions in the field and more rigorous, meticulous, and well-founded approaches. As for teacher education, we have observed that studies on practicing teachers are quite rare. We nevertheless acknowledge the contributions of Moyon (2021) and Vincentini et al. (2019) who show, using large-scale statistical analyses in various European contexts, how in-service secondary teachers are generally interested in introducing mathematical history into their classrooms but encounter difficulties (e.g., lack of time, resources, and mastery).

One way to 1) galvanize the dialectic between theoretical and empirical research and 2) more finely examine the ambiguous relationship that high school teachers seem to have with history may be to develop participatory field research (see Guillemette, 2021). Participatory research focuses on research "with" rather than "on" participants and would not attempt to "test" or "provide" history-based teaching tools to teachers, but to develop these in conjunction with research input and teachers' knowledge and skills. This would improve the relevance, effectiveness, and feasibility of the teaching tools produced, but also the credibility of the research findings. That said, a recent review of the literature (Bellefleur & Guillemette, to be published) shows that of the 37 empirical studies published since 2010 in HPM literature, none takes the form of a proper participatory research.

### 5.3 History of mathematics in curricula in Quebec, Canada

In terms of teaching practice, the history of mathematics is now an integral part of the Quebec (Canada) mathematics secondary school curriculum, which states that "students should be able to place mathematical concepts in a historical and social context, to understand their evolution and identify the issues that led to their development and the concepts served by this process, and to recognize the contribution of mathematics to science, technology, and the culture of societies and individuals" (Ministère de l'Éducation du Loisir et du Sport, 2003, p. 248, our translation). The purpose of a historical perspective is to place mathematics in a broad socio-historical context, while humanizing mathematics.

## 5.4 Research questions

Given these problematizing elements, we pose the following research questions: How do secondary school mathematics teachers intend to meet these expectations? How can research knowledge be mobilized to support their practice while considering the constraints and difficulties experienced and expected?

### 2 Theoretical positioning

Our study is theoretically based on the cultural-historical approach to mathematics education (Radford, 2021). Inspired by Vigotskian psychology, this approach in mathematics education places importance on cultural artifacts (objects, instruments, literary and scientific productions, etc.) and social interaction in teaching-learning. The mathematics classroom is not perceived as a neutral and closed space because the modes of *activity* (objectives, actions, operations) that take place there are mediated by objects, history, and culture (Radford, 2021).

More specifically, our study is theoretically based in a dialogicalethical perspective on the history of mathematics in mathematics education (Guillemette, 2019; Guillemette & Radford, 2022). In this perspective, the main idea is to make dialogical interaction between voices (participants, researchers, voices from the past, curricula, etc.) accessible, assess engagement critically, and investigate the experience and actions of the participants, focusing primarily on the experience of "otherness."

### 3 Research objectives

Within this theoretical framework and having in mind the problematizing elements discussed earlier, we formulated the following research objectives: 1) document the epistemological, didactic, and pedagogical reflections of secondary school teachers around social and political issues in mathematics education, 2) describe dialogically how didactic and pedagogical tools are developed for their classroom through jointly produced activities, and the challenges they face in this regard, and 3) describe their teaching constraints and difficulties experienced and apprehended in the classroom.

## 4 Methodological framework: participative research

Our objectives call for implementing a qualitative study anchored in a comprehensive paradigm. Moreover, our objectives address both the production of research knowledge and the professional development of practicing secondary school teachers in a unified manner. This prompted us to adopt a participatory approach. As presented above, this approach aims to better understand the relationship between research and professional practice through a reciprocal lens. (Desgagné & Bednarz, 2005).

## 4.1 Context of the study

Four secondary school mathematics teachers were recruited (they had taken part in a professional workshop on reading historical texts led by us in 2019). Participants were mid-career teachers (10–25 years of experience; two women, two men). A meeting was held to set goals and working arrangements. Three other meetings (150 minutes) took place in the next month. We discussed "historical situations" to explore together the role and potential of mathematical history, possibilities for classroom implementation, and potential challenges.

These "historical situations" (Cavalieri (volume of the ball), Arbalestrille (Jacob's staff), al-Khawarizmi (4<sup>th</sup> model), Ptolemy's trigonometry, Mesopotamian numeral system) consisted of short excerpts of historical texts (sometimes only one image) derived from HPM literature. There were no historical or pedagogical explanations but only brief introductions by us. The excerpts were essentially a basis for discussion, a catalyst to create dialogue. We were also open to proposals from the group, but no proposals were made and the group focused essentialy on the above "historical situation".

### 4.2 Data collection and analysis

Videotapes of the collaborative meetings, transcription of the audio, and a research diary constituted the data. At this stage, we planned to conduct a dialogical analysis of the transcription focusing on the interaction between emerging "voices," including the researchers' (see Guillemette, 2019).

#### 5 Preliminary results

In this section, we present, as introduced above, some preliminary results based on the notes that we took in the research diary.

In terms of the role and potential of the history of mathematics for teaching and learning mathematics, participants mentioned the need for teachers to demonstrate a certain attitude toward the students, i.e., as teachers interested in various topics and able to think about mathematics more broadly. They were also interested in learning about "how hard it used to be" and emphasizing the effectiveness of modern mathematics. They also mentioned the desire for a feeling of wonder, the need for renewing the mathematics classroom, and striving for interdisciplinarity.

In terms of ways to develop tools, participating teachers looked for ways to go beyond the mere anecdotal. They mentioned the need for a type of "story line" that could help make connections between various historical developments. They also mentioned the need to sequentially and incrementally explore the history of mathematics by creating different transition situations (such as addition and the subdivision of arguments). In terms of difficulties and reticence, they mentioned that the history of mathematics is not suitable for all students, that testing was not feasible, that they did not have sufficient knowledge, and that their resources were limited. In addition, they pointed out the conflicts between the existing curriculum and the inclusion of the history of mathematics.

#### 6 Conclusion

In this paper, we introduced an ongoing study that seeks to document the epistemological, didactic, and pedagogical reflections of secondary school teachers related to social and political issues in mathematics education, the emerging ways to implement teaching activities along these lines, and the difficulties encountered. We highlighted the need for descriptive and participative approaches to galvanize the relationship between theoretical and empirical research in the field and to examine more finely the ambiguous relationship that teachers seem to have with the history of mathematics. Our study is an attempt in this sense. The preliminary results presented here are limited, but further analysis and research results are forthcoming.

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