

*Ysette Weiss*

University of Mainz, Germany

## THE GEOMETRY OF MOTIONS IN THE CONTEXT OF WEST GERMAN AND EAST GERMAN NEW MATH

**Summary:** Reforms in education are particularly interesting moments in the history of education, as educational goals are formulated, educational ideals and pedagogical paradigms are negotiated, and reformers take critical looks at the past to justify their reform efforts. The various developments of the International New Math, or Modern Math, Reform reveal the importance of cultural-historical conditions, underlying economic systems and ideological frames, together with institutional differences that led to numerous variants of the New Math movement in various countries. This paper focuses on differences between East German and West German reform efforts in the post-war period, especially on the introduction of modern ideas of geometric transformations in the teaching of geometry in the 1960s and 1970s. Since West Germany, later the Federal Republic of Germany (FRG)<sup>1</sup>, was formed from the three occupation zones of the victorious powers the USA, the United Kingdom and France, and East Germany, later the German Democratic Republic (GDR), was in the sphere of influence of the Soviet Union, the study of East and West German reform efforts allows us to relate opposing educational ideologies linked to these contexts, albeit only indirectly and implicitly.

**Keywords:** New Math, geometry education, curriculum reform, Federal Republic of Germany (FRG), German Democratic Republic (GDR), Cold War education policy

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<sup>1</sup> Since the term FRG is also the name of the current state, we use the term West Germany for the old federal states of the Federal Republic of Germany to avoid confusion.

## Introduction

Until not long ago, the recent German history of mathematics education, particularly the development of German mathematics education as a scientific discipline, was equated with the history of West German mathematics education, especially in international reports and handbooks. As recently as 2015, Horst Struve addressed only the development of West German mathematics education in his chapter *Zur geschichtlichen Entwicklung der Mathematikdidaktik als wissenschaftlicher Disziplin* in the *Handbuch der Mathematikdidaktik*. In the introductory remarks to the article, he writes:

Since the socio-political framework is a decisive factor in the development of sciences, it would certainly be an interesting topic to examine the development of mathematics didactics during a dictatorship, not only in the Third Reich but also in the GDR. However, these developments were relatively isolated, and with the end of the dictatorships, the influence of the didactic approaches developed at that time also diminished.<sup>2</sup>

The reconstruction of the East German educational system in the context of the German reunification of the two German states at the beginning of the 1990s was achieved by replacing the East German educational system, in particular the *Einheitsschule* system (one-tier school system), with the three-tier West German system. Partly due to this, after the reunification, research questions to examine East and West German educational traditions were aimed mostly at justifying the abolition of East German traditions. This, among other things, led to more deficit-oriented research questions, which implicitly also justified the institutional restructuring<sup>3</sup>. The extremely short-term nature of the reform and the declared lack of alternatives also justified a reunification reform without prior surveys and analysis of existing East German structures and educational traditions. It also played a role that the history of the Federal Republic of Germany, in particular the development of West German mathematics education as a research discipline,

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<sup>2</sup> The author distances himself from the indirect equating of the GDR's state system with Nazi Germany, which can be seen as playing down Nazi Germany's fascist dictatorship. H. Struve, *Zur geschichtlichen Entwicklung der Mathematikdidaktik als wissenschaftlicher Disziplin*, [in:] *Handbuch der Mathematikdidaktik*, ed. by R. Bruder, L. Hefendehl-Hebeker, B. Schmidt-Thieme, H.-G. Weigand, Springer Spektrum, Berlin–Heidelberg 2015, p. 539–566.

<sup>3</sup> Consequently, educational studies focused on humanities subjects rather than mathematics and science education. An exception is the double conference on mathematics education initiated by Hans-Georg Steiner to facilitate to exchange of experiences between East and West Germany in 1996, which will be briefly discussed in the conclusions, *Didaktik der Mathematik in den alten Bundesländern – Methodik des Mathematikunterrichts in der DDR. Bericht über eine Doppeltagung zur gemeinsamen Aufarbeitung einer getrennten Geschichte*, ed. by H. Henning, P. Bender, Otto-von-Guericke-Universität Magdeburg, Universität Paderborn, Magdeburg–Paderborn 2003, <https://www.math.uni-magdeburg.de/private/henning/tagung.pdf> [accessed 8.12.2025].

which was viewed as a success story. From an international perspective, this can be explained, on the one hand, by the activities of West German mathematicians and mathematics education specialists in international commissions and institutions, such as Heinrich Behnke's role as President of the International Commission on Mathematical Instruction (ICMI)<sup>4</sup>.

However, research on the development of the two German educational systems is certainly worthwhile, especially since the history of divided Germany also represents the history of antagonistic ideologies and educational ideals worldwide. In general, international comparative analyses are hardly possible. German history offers the advantage of a shared history and educational tradition, to which both German states drew. Because of these common cultural and historical roots, there is the possibility for common meaningful references when studying the two German histories and at least two narratives of German mathematics education. However, even here, interpretations should be particularly reflective.

In the following, some differences will be highlighted based on selected aspects and a focus on geometry teaching. Since images of humanity, educational goals, and educational policy interests become particularly apparent before and during reforms in mathematics education, the New Math teaching reform will be given priority<sup>5</sup>. Nevertheless, critical reflections on these developments and comparisons are scarce. This paper aims the study common cultural traditions to explore possibilities for socio-cultural and historical perspectives of comparative analyses between the two German histories of mathematics education.

## West Germany

### *History of mathematics education versus history of the scientific discipline Mathematikdidaktik*

The development of geometry teaching in West Germany is often viewed from the perspective of the development of West German mathematics education as a scientific discipline<sup>6</sup>. As a result, the period under consideration often

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<sup>4</sup> West German institutions, such as the Bielefeld Institute for Mathematics Education (IDM), were internationally well connected, it had its own journal (IDM series) and supported numerous personal international contacts of its directors and staff members, as well as of professors in the newly established science *Mathematikdidaktik* (mathematics education). See F. Furinghetti, L. Giacardi, M. Menghini, *Actors in the changes of ICMI: Heinrich Behnke and Hans Freudenthal*, [in:] "Dig where you stand" 6. *Proceedings of the Sixth International Conference on the History of Mathematics Education, September 19–22, 2019, at Luminy, France*, ed. by É. Barbin, K. Bjarnadóttir, F. Furinghetti, A. Karp, G. Moussard, J. Prytz, G. Schubring, WTM-Verlag, Münster 2020, p. 247–260.

<sup>5</sup> This period is viewed in West German historiography as a milestone in the development of mathematics education as a science and its internationalization.

<sup>6</sup> G. Graumann, R. Hölzl, K. Krainer, M. Neubrand, H. Struve, *Tendenzen der Geometriedidaktik der letzten 20 Jahre*, "Journal für Mathematik-Didaktik" 1996, vol. 17, no. 3–4, p. 163–237;

only begins with the establishment of the IDM in Bielefeld, the founding of the “Zeitschrift für Didaktik der Mathematik” [ZDM, Journal for Mathematics Didactics] and the Gesellschaft für Didaktik der Mathematik [GDM, Society for Didactics of Mathematics] in the 1970s, and the associated international visibility. The focus on international visibility and trends can also be seen as a way of avoiding a confrontation with Germany’s own cultural and historical educational tradition, in particular with the educational goals and policy in Nazi Germany, as well as the discussion regarding the involvement and responsibility for the crimes committed in and by Nazi Germany.

The latter would have meant not only the dismissal of supporters and propagandists of the Nazi regime among the teaching staff in schools, especially in the Gymnasium (schools for upper secondary education), and universities after the Second World War, but also a critical analysis of the humanistic educational goals of the Weimar Republic, in particular in mathematics and science education.

Almost no such denazification had taken place in West Germany after the Second World War. In the mathematics textbooks, content propagating Nazi ideology was replaced, or school mathematics textbooks from the Weimar Republic were reintroduced. Both in the Weimar Republic and in West Germany, the development and conception of textbooks was the responsibility of private publishers; in the post-war period, the publishers were therefore able to return to their pre-war authors or retain them without political implications.

In the post-war years and in the 1950s, the content of articles in mathematics education journals such as “Der Mathematikunterricht” [Mathematics Education] was of a subject-matter nature<sup>7</sup>. Typical topics were inventive concept developments, new elementary mathematical approaches to and new proofs of traditional topics, elementary introductions to topics of higher mathematics, and didactic suggestions for the teaching in Gymnasium. Following the lack of systematic denazification of the teaching profession, it was not until the 1960s in West Germany that a critical examination of the misuse of humanistic Enlightenment educational goals and the appropriation of secondary school education by racial theories and fascist ideology took place, first only in the educational sciences<sup>8</sup>.

Helge Lenné (1965) provided an interesting and much-cited account of the development of *Mathematikdidaktik* in West Germany. His *Analyse der Mathematikdidaktik in Deutschland* [Development of Mathematics Didactics in

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M. Toepell, A. Vohns, *Zur Gründung und Entwicklung der Gesellschaft für Didaktik der Mathematik*, “Mitteilungen der Gesellschaft für Didaktik der Mathematik” 2016, no. 101, p. 12–17.

<sup>7</sup> Y. Weiss, *West German Neue Mathematik and Some of Its Protagonists*, [in:] *Modern Mathematics: An International Movement?*, ed. by D. De Bock, Springer, Cham 2023, p. 119.

<sup>8</sup> In mathematics education, the work of the Swiss mathematics educator A.I. Wittenberg, *Bildung und Mathematik: Mathematik als exemplarisches Gymnasialfach*, Klett, Stuttgart 1957, being an exception and later a critic of the axiomatic New Math approaches, should be mentioned here.

Germany]<sup>9</sup> is often cited in articles about the history of mathematics education, thereby repeatedly identifying the development of the scientific discipline with the development of social practices related to mathematics education. This can be explained by the close connection between the institutionalization of the scientific discipline of *Mathematikdidaktik* through the establishment of professorships, conferences, and journals, aiming at teacher education and institutional change of school practices<sup>10</sup>. However, Lenné himself distinguished the intended goals of theories in mathematics education, intended institutional and curricular reforms, and the reality of teaching. In many places, he referred to studies that prove the differences.

Since Lenné also dealt with developments in educational goals and methods in and before the Weimar Republic, and his approaches are still formative for the depictions of today's history of German mathematics education and the self-image of *Mathematikdidaktik* today, we would like to discuss his view of German mathematics education briefly.

Lenné's approach is *bildungswissenschaftlich* (from an educational science perspective); his dissertation *Jugend zwischen Tradition und Demokratie. Struktur und politische Bedeutung der Einstellung von Oberschülern zu politischer Autorität* [Youth between Tradition and Democracy: Structure and Political Significance of Upper-Secondary Students' Attitudes toward Political Authority]<sup>11</sup> was an empirical analysis of the attitudes of secondary school students towards political authority. In the spirit of his time and the political situation of the 1960s, this was done among other things by contrasting tradition and democracy. This juxtaposition of 'modern mathematics didactics' and 'traditional mathematics' can also be found in his *Analyse der Mathematikdidaktik in Deutschland*. Possibly due to the educational theory perspective, very different currents in the development of mathematics education, such as reform pedagogical approaches of the 18th, 19th, and 20th c., as well as the development of dual higher education, the teaching reform of Modern Geometry, and the Meraner Reform of mathematics teaching in secondary schools, are subsumed under 'traditional mathematics'. In doing so, he defined different problem-oriented approaches to the conceptual development of 'traditional mathematics' as *Aufgabendidaktik* (task didactics). The latter has in his monograph some negative connotations, which are possibly a result of his studies on the role of political authority for young people's critical faculties. The unified notion of *Aufgabendidaktik* does the problem-oriented

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<sup>9</sup> H. Lenné, *Analyse der Mathematikdidaktik in Deutschland*, Ernst Klett Verlag, Stuttgart 1969.

<sup>10</sup> Ch. Keitel, *Zum Verhältnis der Mathematikdidaktik zur Allgemeinen Didaktik*, "Zeitschrift für Pädagogik" 1983, vol. 29, no. 4, p. 595–603.

<sup>11</sup> H. Lenné, *Jugend zwischen Tradition und Demokratie. Struktur und politische Bedeutung der Einstellung von Oberschülern zu politischer Autorität*, Duncker & Humblot, Berlin 1967.

concept development only partial justice. Different methodological approaches in task design reveal themselves, among other things, in the references, the formulations, the use of different representations, the potential for generalization or transfer of the results, as well as their applications. Lenné's comparison of (traditional) *Aufgabendidaktik* and the teaching methods and learning objectives of the 1960s is therefore not a subject matter-oriented comparison. Nevertheless, his theoretical and political educational approach is also one of the strengths of Lenné's analysis.

### ***Intended, achieved, and implemented goals of the West German New Math reform***

Even though the New Math teaching reform stands for the introduction of set theory and the axiomatic development of concepts, it is worth looking at the geometric content in particular, as changes are more likely to be described in terms of a different approach to the familiar than in terms of new content. We will limit ourselves to looking at mathematics teaching at the second secondary level, as the New Math reform was intended as a modernization of 'backward school mathematics' with the aim of reducing the gap between university and upper secondary school mathematics. Peter Bender in *Abbildungsgeometrie in der didaktischen Diskussion* [Transformation Geometry in the Didactic Discussion]<sup>12</sup> provides an outline of the roots and development of the geometry of motions and the teaching of geometrical transformations in West Germany with numerous references. In addition to the historical outline, Bender clarifies conceptually the meanings with which *Abbildungsgeometrie* was used in geometry teaching at secondary schools in Germany. Thus, a distinction can be made between mapping geometry in the kinematic (physical) understanding, the structural mathematical understanding in the sense of the Erlangen Program(me), the understanding as a relationship and general principle of change and variation in the sense of the Meraner Reform and the axiomatic approach to geometrical transformations either as questions of foundation<sup>13</sup> or in geometrical structural contexts (groups and their generators) or in algebraic settings (vector spaces) or in stochastics settings. Bender's well-chosen references to publications on concept development based on *Abbildungsgeometrie* in the different understandings are rich evidence of a continuous effort to reform classical teaching of geometry, based on the congruence theorems and Euclidean axiomatics. It shows that the German New Math Reform in geometry teaching could draw on the 'Erlangen' tradition of *Abbildungsgeometrie*, which was far removed from application and related to structure and axiomatics, as well

<sup>12</sup> P. Bender, *Abbildungsgeometrie in der didaktischen Diskussion*, "Zentralblatt für Didaktik der Mathematik" 1982, vol. 14, no. 1, p. 9–24.

<sup>13</sup> F. Bachmann, *Aufbau der Geometrie aus dem Spiegelungsbegriff*, Springer, Berlin–Heidelberg 1959.

as Meran-style functional thinking in dynamic geometric contexts and applications, and on Newer Non-Euclidean Geometry.

***Intended curriculum – perspectives  
from university mathematicians***

The international visibility of the newly emerging German scientific discipline of *Mathematikdidaktik* was supported, among others, by the activities of Heinrich Behnke, Günter Pickert, Heinz Kunle, and Behnke's former assistant Hans-Georg Steiner, later one of the directors of the IDM<sup>14</sup>. Heinrich Behnke was a member of the ICMI Executive Committee from 1952 – the year the ICMI was re-established – until 1966 and served as President (ICMI) from 1955 to 1958. It is not only in this function that he is often placed in the tradition of Felix Klein.

Assessing the role of geometry in the New Math teaching reform is difficult: on the one hand, because various traditions of geometric concept development have existed in Germany since the end of the 19th c.; and on the other hand, because of implicit international influences and trends.

The 1959 Royaumont Seminar, organized by the OEEC, is regarded internationally as the starting point for an international discussion on understanding and agreement on curricula reforms and a global view of national curricula, in particular of modernizing school geometry in the spirit of Bourbakism. Each participating country was able to send three delegates: one outstanding mathematician, one official from the Ministry of Mathematics Education, and a distinguished secondary school mathematics teacher and textbook author<sup>15</sup>. Neither Behnke nor any other university mathematician from Germany took part in the Royaumont Seminar, the conference that was to shape the modernization movement as an international project<sup>16</sup>. Heinrich Behnke took part in the ICMI seminar in Aarhus, where renowned mathematicians presented their ideas for a Bourbakist-inspired development of the concept of geometry. In his opening lecture, he attempted to place the planned reform movement in the tradition of Klein's ideas by quoting Klein:

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<sup>14</sup> See also U. Hartmann, *Heinrich Behnke (1898–1979): zwischen Mathematik und deren Didaktik*, Peter Lang, Frankfurt am Main u.a. 2009; Y. Weiss, *West German Neue Mathematik and Some of Its Protagonists*.

<sup>15</sup> Although the teachers were not prepared for set-theoretical, axiomatic geometry lessons, what was known to university teachers (see e.g. H.-J. Vollrath, *Betrachtungen zur Entwicklung der Algebra in der Lehre*, "Mathematische Semesterberichte" 1991, vol. 38, p. 58–98; D. Laugwitz, *Zur sogenannten Modernisierung des mathematischen Schulunterrichts*, "Jahresbericht der Deutschen Mathematiker-Vereinigung" 1965, vol. 67, Beilage "Mitteilungen der DMV", p. 31–34) and the axiomatic-deductive method also contradicted established reform pedagogical principles, the 'modernization' began with the 'modernization' of the curricula of the upper secondary schools, including the teaching of geometry.

<sup>16</sup> See also Y. Weiss, *West German Neue Mathematik and Some of Its Protagonists*.

My [Klein's] interest from my time in Bonn [...] was to understand the mutual relationships of the opposing mathematical schools and to encompass their contradictions through a unified overall conception. How much he could have won over today's Bourbakism from this perspective! For it was precisely this unified conception of mathematics, which the French have been striving for with such great success for about two decades, that was always Klein's main goal.<sup>17</sup>

And on the next page, Behnke continued somewhat contradictorily:

Klein believes that axiomatic representation necessarily leads to "purism", to the isolation of one part of mathematics from the other. But here he was radically wrong. The Bourbakism of our day is axiomatic, but it reconnects the individual parts. Yes, that is his initial motive. The whole of mathematics is based on a few basic structures, namely: 1. algebraic structures, 2. order structures, 3. topological structures.<sup>18</sup>

This simultaneous distancing from Klein's ideas in order to emphasize the fascination of the new and modern and the claim to stand in Klein's tradition can also be found, for example, in Kuno Fladt, a school practitioner, to whom we will turn in the next paragraph. Despite critical resistance from teachers, axiomatic set theory was integrated into the curricula by the Standing Conference of the Ministers of Education and Cultural Affairs of the Länder in the Federal Republic of Germany (KMK)<sup>19</sup>.

### ***Intended curriculum – perspectives of school practitioners***

In West Germany and now in the FRG, education policy was and is a matter for the federal states. Due to the low level of centralization and state control, as well as the federal structures, the achieved and taught curriculum after the New Math Reform is difficult to assess. The variety of textbooks, the publishers' efforts to make a name for themselves, and the teachers' freedom of method in the 1960s and 1970s complicate, in addition, a uniform assessment. Also, the described historical ambiguity of the term *Abbildungsgeometrie* hinders the interpretation of intended educational goals.

From the German side, two experienced textbook authors, Hermann Athen and Otto Botsch, took part in the Royaumont Seminar, with Botsch giving a lecture on the modernization of geometry teaching (OEEC, 1961). Athen was co-editor of a traditional textbook series edited by Georg Wolff, who was an exemplary representative of traditional mathematics in the sense of Lenné and later an oppo-

<sup>17</sup> *Grundzüge der Mathematik*, ed. by H. Behnke, F. Bachmann, K. Fladt, W. Süß, Vandenhoeck & Ruprecht, Göttingen 1958, p. 15.

<sup>18</sup> *Ibidem*, p. 16.

<sup>19</sup> Y. Weiss, *West German Neue Mathematik and Some of Its Protagonists*, p. 117–120.

ment of the New Math teaching reform<sup>20</sup>. Otto Botsch was a representative of the *Bewegungsgeometrie*<sup>21</sup>. The principles explained in the guidelines to his textbook express the spirit of the Meraner Reform, of *Verwandtschaften* (affinities) and variabilities, coupled with careful considerations of systematization, ordering, and structuring. Botsch's ideas of a modernization of secondary school geometry thus differ fundamentally from the algebraization proposals and the replacement of geometry by an axiomatically derived linear algebra, as presented by Choquet and Dieudonné<sup>22</sup>. In his analysis of (West-) German *Mathematikdidaktik*, Lenné makes a distinction between two main directions of the New Mathematics, the rigorous and the moderate. Lenné categorized Jean Dieudonné, Emil Artin, Georges Papy, Hans Hahn, Jürgen Dzewas, and also Herbert Meschkowski as the rigorous representatives. In his view, Hans Freudenthal and Hermann Athen, among others, belonged to the moderate direction<sup>23</sup>. Otto Botsch could probably be assigned to a very moderate direction that used slogans of the New Math Reform for further development of the Meraner ideas. Hans-Georg Steiner is cited as an example of a didactician who was initially more strongly oriented towards axiomatics and rigor, but later took a more moderate position by adding pedagogical perspectives.

Teachers such as Georg Wolff, Walther Lietzmann, and Kuno Fladt were of great importance for the development of practical school didactics in Germany. They worked as teachers and principals mostly in *Realgymnasien*, *Oberrealschulen*, and *Reformschulen*, which, in contrast to the classical humanistic gymnasium, emphasized mathematics, sciences, and modern languages. They wrote maths textbooks and methodologies, published in school practical journals, had themselves worked in mathematics, and promoted mathematically gifted students in upper secondary education. Both reforms, the Newer Geometry and the Meraner Reform of geometry teaching, had long-term goals, among others, the opening up and dynamizing of existing concept developments. These goals were not com-

<sup>20</sup> For a more detailed placement of Athen's and Wolff's role in the New Math reform see Y. Weiss, *West German Neue Mathematik and Some of Its Protagonists*; Y. Weiss, *GEORG WOLFF im Wandel der Geschichtsschreibung*, "Der Mathematikunterricht" 2024, no. 3, p. 36–45.

<sup>21</sup> O. Botsch, *Die Bewegung als methodisches Prinzip im Geometrie-Unterricht der Mittelstufe*, Diesterweg, Frankfurt 1955.

<sup>22</sup> See e.g. D. De Bock, G. Vanpaemel, *Modern mathematics at the 1959 OEEC Seminar at Royaumont*, [in:] "Dig where you stand" 3. *Proceedings of the Third International Conference on the History of Mathematics Education*, ed. by K. Bjarnadóttir, F. Furinghetti, J. Prytz, G. Schubring, Uppsala universitet, Uppsala 2015, p. 151–168; W. Goemans, D. De Bock, *Debates on axiom systems for school geometry during the 1960s: Relating the proposals by Artin, Choquet, Dieudonné and Papy*, [in:] "Dig where you stand" 7. *Proceedings of the seventh International Conference on the History of Mathematics Education*, ed. by K. Bjarnadóttir, F. Furinghetti, A. Karp, J. Prytz, G. Schubring, Y. Weiss, J. Zender, WTM-Verlag, Münster 2023, p. 99–113.

<sup>23</sup> Y. Weiss, *West German Neue Mathematik and Some of Its Protagonists*, p. 112.

pleted at the start of the New Math movement; kinematic and motion-geometric tasks, consideration of affinities and physical applications were common in textbooks but thought to be ambitious. ‘Meraner geometry’ did not contradict ‘Newer geometry’. The latter was very broad-based; the basic idea was to develop alternatives to the strictly deductive conceptual developments structured according to the books of Euclid. Partial fixations on analytical geometry in the context of the Meraner Reform were viewed critically and discussed; both reforms had arisen from concrete problems in school practice, had been pushed forward by committed teachers over decades, and had been smoothed over in school practice. The major methodological differences between the former reforms and the New Math reform become particularly visible when comparing the Bourbaki *Grundzüge der Mathematik* [Foundation of Mathematics], edited by Behnke, Bachmann, Fladt, and Süß, with the seven-volume compendium *Handbuch der Schulmathematik* [Handbook of School Mathematics] published by the critic of the New Math, Georg Wolff<sup>24</sup>. The contributions in the *Grundzüge der Mathematik*, in particular in the geometry volume, were ‘written by university teachers and only checked for comprehensibility by a school teacher’<sup>25</sup>. The articles in every *Handbuch der Schulmathematik* were written by teachers and school practitioners in the spirit of the reform Newer Geometry and the Meraner Reform. The New Math Reform was primarily conceived from the top down and under increased international influence<sup>26</sup>. The latter can be seen, for example, in Steiner’s role and activities in the ‘golden years of the Steiner era’<sup>27</sup>. In Weiss’s paper *West German Neue Mathematik and Some of Its Protagonists*, we looked at the activities of Hermann Athen as a New Math-supporting school practitioner, and we also studied the New Math critic Georg Wolff<sup>28</sup>. To provide another perspective, we now turn to Behnke’s co-author and school practitioner, Kuno Fladt.

One of the special features of Fladt’s activities was that since the *Weimarer Republik* he was very well connected in the teacher community, being an active teacher, principal and textbook author as well as a leading official in teachers’ associations, but was also very well networked with university mathematicians. He

<sup>24</sup> See e.g. G. Wolff, *Handbuch der Schulmathematik: Geometrie der Oberstufe*, H. Schroedel, Hannover 1960.

<sup>25</sup> K. Strubecker, Behnke, Bachmann, Fladt: *Grundzüge der Mathematik. Buchbesprechung*, “Physikalische Blätter” 1960, vol. 16, no. 9, p. 487.

<sup>26</sup> Y. Weiss, *Globalization through the Lens of History of Mathematics Education*, [in:] *International Study Group on the Relations between History and Pedagogy of Mathematics, Proceedings of the 2024, ICME Satellite Meeting, HPM 2024 Sydney, 1–5 July*, ed. by S. Lawrence, É. Barbin, L. Puig, 2025, to appear.

<sup>27</sup> U. Hartmann, *Heinrich Behnke (1898–1979): zwischen Mathematik und deren Didaktik*, Peter Lang, Frankfurt am Main u.a. 2009, p. 232.

<sup>28</sup> Y. Weiss, *West German Neue Mathematik and Some of Its Protagonists*.

retained these leading roles even during the Nazi dictatorship<sup>29</sup>. Fladt's continuing influence in the networks of university mathematicians after the Second World War becomes evident not only in his co-editing of the compendium but also in his organization of one-week conferences on mathematics teaching at secondary schools from 1962 to 1969 at the Mathematical Research Institute in Oberwolfach and his honorary professorship after his retirement<sup>30</sup>. From the 1920s onwards, Fladt had made numerous contributions in the form of articles in journals and as author of a textbook and a methodology aiming at the modernization of geometry teaching, both in the sense of modern geometry through the inclusion of projective perspectives, as well as alternative conceptual developments in geometry in the sense of the Meraner Reform with an emphasis on *Verwandtschaften* and functional dependencies. But also, axiomatic foundations of geometry based on the concept of mirroring (axioms of inversion) play a role in Fladt's geometry textbooks starting at the end of the 1920s<sup>31</sup>.

Fladt demonstrated his understanding of different meanings and the use of mapping geometric approaches in his study of German textbooks<sup>32</sup>. He differentiated between textbooks, (1) in which the idea of mapping is dealt with in some cases, but without it becoming the basic organizing scheme of the whole subject matter, and without the concept of groups being discussed. (2) in which the idea of mapping is carried out to such an extent that all or at least the majority of the mappings possible in school geometry, i.e. those of the similarity group, those of the affine group and those of the collineation group, are treated individually in this order, and that large parts of the subject matter are subordinated to the idea of mapping without the concept of groups being dealt with, and (3) in which the idea of mapping is carried out to such an extent that, in addition to the usual mappings in school geometry, their compositions are also dealt with, and the concept of groups is discussed using the available examples. As an advocate of the Meraner goals, Fladt still in 1955 complained about the lack of a true implementation: 'I still can't get my head around the fact that Klein's reform did not succeed in its very own field – for Klein was a Geometer and is seen as such before the whole world'<sup>33</sup>. Toepell notes concerning

<sup>29</sup> H. Heske, *Mathematikunterricht im Nationalsozialismus: Die Positionen und Konzeptionen von Walther Lietzmann, Bruno Kerst und Kuno Fladt*, "Mathematische Semesterberichte" 2021, vol. 68, no. 1, p. 119–142.

<sup>30</sup> Ibidem, p. 138.

<sup>31</sup> K. Fladt, *Elementargeometrie, 2. Teil: Der Stoff bis zur Untersekunda (Planimetrie und Stereometrie)*, B.G. Teubner, Leipzig-Berlin 1928; K. Fladt, *Elementargeometrie, 3. Teil: Der Stoff der Obersekunda und Prima (Darstellende Geometrie, Trigonometrie und Analytische Geometrie)*, B.G. Teubner, Leipzig-Berlin 1931.

<sup>32</sup> K. Fladt, *Die Auswirkung des Abbildungsgedankens in den heutigen Schulbüchern*, "Unterrichtsblätter" 1932, vol. 39, p. 155–158.

<sup>33</sup> See K. Fladt, *Strenge und Systematik im geometrischen Unterricht der höheren Schulen*, "Der mathematische und naturwissenschaftliche Unterricht" 1954/1955, vol. 7, p. 68.

Klein's reform that, although it removed Euclid's 'braking blocks' from geometry teaching, it could not – according to Fladt – have been completely effective because the scientific foundations of the newer geometric ideas remained unclear<sup>34</sup>. The latter shows the great importance Fladt attributed to the axiomatic foundations of school mathematics. His activities and efforts to make mapping geometry the basis of New Mathematics were not restricted to upper secondary education, but included all school types. In German historiography of mathematics education, Fladt is attributed a significant role in the implementation of 'Modern Mathematics' in schools; his papers and activities are frequently mentioned in Lenné's *Analyse der Mathematikdidaktik in Deutschland*<sup>35</sup>.

### ***Institutional reforms and educational politics***

Due to the several simultaneous institutional reforms in Germany in the 1960s, like the conversion of *Volksschulen* (elementary schools) into *Hauptschulen* (secondary elementary schools) and the associated intention to transform arithmetic lessons into modern mathematics lessons, as well as the unification of secondary education implying the abolition of *Oberrealschulen* and *Realgymnasien*, educational politicians and administrators were open to new guidelines and changes in curricula. The extent to which the contents related to *Bewegungsgeometrie* and *Abbildungsgeometrie* in the textbooks of the 1960s can be interpreted as a result of the New Math reform is difficult to assess.

In Germany, the development of textbooks with implicit or explicit involvement of *Bewegungsgeometrie* and geometrical transformations had already begun in the 19th c.<sup>36</sup>, and was continued in the Meraner Reform<sup>37</sup>. By the mid-20th c., the geometrical transformations as the basis for the geometrical concept development had received new impetus and had been partly implemented in teaching materials for all types of schools. At the same time, however, textbooks based on congruence geometry and propaedeutic preparations and treatments of Euclid's elements were also used and developed.

Although the various ministries of education in the federal states made recommendations for mathematics textbooks, there were also differences between the federal states and the control of curriculum specifications, the 'willingness to

<sup>34</sup> M. Toepell, *Rückbezüge des Mathematikunterrichts und der Mathematikdidaktik in der BRD auf historische Voraussetzungen*, "Zentralblatt für Didaktik der Mathematik" 2003, vol. 35, no. 4, p. 179.

<sup>35</sup> See also P. Bender, *Abbildungsgeometrie in der didaktischen Diskussion*.

<sup>36</sup> S. Kitz, "*Neuere Geometrie*" als Unterrichtsgegenstand der höheren Lehranstalten. Ein Reformvorschlag und seine Umsetzung zwischen 1870 und 1920, PhD dissertation, Bergische Universität Wuppertal, Wuppertal 2015, <https://elekpub.bib.uni-wuppertal.de/ubwhsmig/content/zoom/4150855> [accessed 8.12.2025].

<sup>37</sup> K. Krüger, *Kinematisch-funktionales Denken als Ziel des höheren Mathematikunterrichts – das Scheitern der Meraner Reform*, "Mathematische Semesterberichte" 2000, vol. 47, p. 221–241.

experiment' of the relevant administrations, and the influence of publishers on the recommendations. It is therefore not surprising that the history of the West German New Mathematics teaching reform is primarily characterized by the narratives of the mathematics didacticists, textbook authors, and university mathematicians involved, who pursued very different objectives. The more radical representatives of the axiomatic derivation of linear algebra based on set-theoretical approaches in the sense of Bourbaki and algebraic structural mathematics were mainly found among university mathematicians, their doctoral students and co-authors at the beginning of the reform. In contrast to the Meraner Reform, despite the university-mathematics perspective, it did not begin with teacher education and teacher training, but with didactic drafts and the struggle for international visibility. In 1969, Lenné<sup>38</sup> analysed 11 then-current curriculum proposals from various federal states from a curricular perspective<sup>39</sup>.

The development of mapping geometry in the context of the New Mathematics reform through the efforts of school practitioners interested in the reform, most of whom can be counted among the moderate reformers, is complicated even for those who reflected on their efforts. The critical attitude from Gymnasium teachers to both the new content and the restructuring of the curriculum became evident in the discussions of the Nuremberg curricula<sup>40</sup>. The formulation and implementation of the new curricula took place through educational policy measures such as the restructuring of the upper secondary school courses, support for the publication of New Math textbooks, and the establishment of corresponding *Abitur* tasks<sup>41</sup>. Until the 1960s, the development of mapping geometry in West Germany was largely independent of foreign influences. From the mid-1960s, the New Mathematics received international impetus through numerous publications and the intensive propagation of the new guiding concepts of 'quantity, structure, transformation'<sup>42</sup>,

<sup>38</sup> H. Lenné, *Analyse der Mathematikdidaktik in Deutschland*.

<sup>39</sup> See also E. Schuberth, *Die Modernisierung des mathematischen Unterrichts: ihre Geschichte und Probleme unter besonderer Berücksichtigung von Felix Klein, Martin Wagenschein und Alexander Israel Wittenberg*, Verlag Freies Geistesleben, Stuttgart 1971 (Erziehung vor dem Forum der Zeit, vol. 8); P. Damerow, *Die Reform des Mathematikunterrichts in der Sekundarstufe I: Reformziele, Reform der Lehrpläne*, Max-Planck-Institut für Bildungsforschung, Klett-Cotta, Stuttgart 1977; Y. Weiss, *West German Neue Mathematik and Some of Its Protagonists*.

<sup>40</sup> See K. Wigand, *Fördervereinstagung in Nürnberg. Die 56. Hauptversammlung des Deutschen Vereins zur Förderung des mathematischen und naturwissenschaftlichen Unterrichts vom 11. bis 15. April in Nürnberg*, "Praxis der Mathematik" 1965, vol. 7, no. 5, p. 127–130.

<sup>41</sup> Passing the final exams (*Abiturprüfung*) in German upper secondary education enables access to university studies. Traditionally, mathematics exam questions were often set by the corresponding maths teacher.

<sup>42</sup> P. Bender, *Abbildungsgeometrie in der didaktischen Diskussion*, p. 15. See also H. Griesel, *Die Leitlinie Menge-Struktur im gegenwärtigen Mathematikunterricht*, "Der Mathematikunterricht" 1965, vol. 11, no. 1, p. 40–53.

as well as translations and distribution of foreign textbooks and materials<sup>43</sup>. Based on Piaget, it was assumed that ‘the same mechanisms decisive in the genesis of knowledge in the sciences and in the individual’<sup>44</sup>.

From the point of view of upper secondary school practice, there were no new problems at the end of the 1950s that needed to be solved by the reform. The discussions that have been going on for decades regarding an overburdening amount of material were not addressed by the new contents ‘sets’, ‘structures’, and ‘transformations’, but rather intensified. The alignment of mathematics didactics with international trends and buzzwords and the increasing preoccupation of the mathematics didactics community with itself, its own international visibility, and the scientific nature of mathematics didactics methods was leading to a split in traditional practical mathematics education and the scientific discipline *Mathematikdidaktik*. The latter was supported by the numerous appointments to mathematics of professorships in *Mathematikdidaktik*<sup>45</sup> at *Pädagogischen Hochschulen* (pedagogical colleges), the foundation of the IDM<sup>46</sup> and the GDM<sup>47</sup>, and the Center for Didactics of Mathematics at the University of Karlsruhe and the Third International Congress on Mathematical Education (ICME) in Karlsruhe in 1976<sup>48</sup>. The work of teachers, *Fachleiter* (teacher trainer), school principals, and textbook authors, which included conceptualizing and structuring of the existing local social practices, as well as understanding what worked and continuing it in an adapted form, was rarely seen as a creative scientific achievement.

In contrast to East German mathematics didactics, to which we will turn in the next section, West German mathematics didactics was judged to a much greater extent by the international standing of its representatives in professional associations and by their contributions to, and influence in, national and international journals. The focus here was on the modern scientific nature of the methods, transferability, and their generalizability to culturally and historically different conditions.

<sup>43</sup> For example: G. Papy, *Elemente der modernen Geometrie*, Klett, Stuttgart 1967; F. Papy, G. Papy, *Die ersten Elemente der Neuen Mathematik*, Otto Salle Verlag, Halle 1968.

<sup>44</sup> E.C. Wittmann, *Grundfragen des Mathematikunterrichts*, Springer-Verlag, Berlin–Heidelberg–New York 1974, p. 53.

<sup>45</sup> Ch. Keitel, *Zum Verhältnis der Mathematikdidaktik zur Allgemeinen Didaktik*, “Zeitschrift für Pädagogik” 1983, vol. 29, no. 4, p. 595–603.

<sup>46</sup> G. Schubring, *Die Geschichte des IDM Bielefeld als Lehrstück*, Shaker Verlag, Aachen 2018.

<sup>47</sup> M. Toepell, A. Vohns, *Zur Gründung und Entwicklung der Gesellschaft für Didaktik der Mathematik*, “Mitteilungen der Gesellschaft für Didaktik der Mathematik” 2016, no. 101, p. 12–17.

<sup>48</sup> See M. Toepell, *Rückbezüge des Mathematikunterrichts und der Mathematikdidaktik in der BRD auf historische Vorausentwicklungen*; G. Schubring, *Die Entwicklung der Mathematikdidaktik in Deutschland*, “Mathematische Semesterberichte” 2016, vol. 63, no. 1, p. 3–18; H. Griesel, H.-G. Steiner, *The Organisation of didactics of mathematics as a professional field*, “ZDM” 1992, vol. 24, no. 7, p. 287–295.

## East Germany

### *Cultural historical roots of the East German New Math*

The comparison of the goals and implementation of New Math in West and East Germany is particularly interesting from several perspectives. The fact that a comparison is possible at all is due to the same roots, similar cultural-historical conditions, and thus possible references between the two very different social systems. However, the different economic situations, ideologies, and associated value systems of the occupying powers also led to major differences between the education system in West Germany and the education system in the GDR. Although all four occupying powers (France, UK, USA, and USSR) had agreed that the tripartite school system of the Weimar Republic had supported the appropriation and racist indoctrination of young people, a new school system, the *Einheitsschule*, was only introduced in East Germany. This type of school consisted of an 8-year, later 10-year polytechnic elementary school and a 4-year upper secondary school<sup>49</sup>. The unified school was also the predominant type of school in the Soviet Union. Therefore, translations of Soviet methodologies and teaching materials could be used to some extent in East Germany, although the education systems in the member states of the Soviet Union, in particular in Russia, differed from the educational traditions of Germany.

As a result of the war and the denazification carried out in the Soviet occupation zone after the Second World War, there was a shortage of 40,000 teachers<sup>50</sup>. One of the responses to this was the training of ‘new teachers’ in short accompanying courses. The first curricula up to 1951 were geared more towards the requirements of further education, especially secondary school. From 1951, a uniform educational policy concept formed the basis of a central curriculum that was binding in all schools in the GDR<sup>51</sup>. The aims of the introduction of a central mathematics curriculum were to provide a high level of general education for all children, to raise both accessible and academic standards, and to prevent the division of society through different offerings (e.g., boys/girls, urban/rural, educated middle class/working class). In this context, the curricula for all grades were conceived from the perspective of uniform subject complexes and

<sup>49</sup> R. Sträßer, R. Bruder, A. Büchter, *Zur Etablierung der Mathematikdidaktik nach dem zweiten Weltkrieg – unter Berücksichtigung von Entwicklungen in der DDR*, [in:] *Handbuch der Mathematikdidaktik*, ed. by R. Bruder, A. Büchter, H. Gasteiger, B. Schmidt-Thieme, H.-G. Weigand, Springer, Heidelberg 2023, p. 679–715.

<sup>50</sup> P. Grüner, “Nun dachte ich, jetzt fängt’s neu an, nun soll’s sozial werden...”. *Zur Kritik des Neulehrermythos*, “*Zeitschrift für Pädagogik*” 1995, vol. 41, no. 6, p. 943.

<sup>51</sup> See H. Wuschke, *Curriculare Entwicklungen in der SBZ und DDR bis 1962*, [in:] *Fallstudien zur Geschichte der Mathematikdidaktik. Beiträge eines Minisymposiums während der GDM-Tagung Universität Duisburg–Essen, März 2024*, ed. by R. Bruder, A. Büchter, R. Sträßer, WTM – Verlag für wissenschaftliche Texte und Medien, Münster 2024, p. 87–108.

a clear structure<sup>52</sup>. Methodologically, reform pedagogically inspired approaches from the pre-war period were used. Initially, these also included approaches focused on the individual. However, the school practice of the unified school and the orientation towards socialist principles pushed these back and placed the emphasis on *Arbeitsschulpädagogik* approaches. Great attention was paid to practice through accompanying instruction (scaffolding) with systematic, task-guided concept development and repetition, systematization, practice, and application to consolidate and reflect on what had been practiced. The latter approach was further strengthened and substantiated by studying translations of Soviet methodological principles for learning and teaching mathematics.

### ***Relatedness of East German mathematics education reforms to Soviet reforms in mathematics education***

A possible distinction, which Lenné also makes for other reasons with the notion *Aufgabendidaktik*, is the order in which mathematical concepts appear as tools and as objects of study. In the first case, concept development starts with activities aimed at the acquisition of skills and methods as tools for the solution of mathematical problems. The understanding of the tool is mostly related to the understanding of how it functions, e.g., in which situations and on which objects it can be used, and counterexamples, where the tool does not work. The conceptual understanding, for example, why the method works, proofs, conceptualisations, and formalisation, and where it comes from, is taught to the skilled problem solver. In the second case, in particular, deductive concept development, theory, and conceptual understanding come first, and the mathematical method itself is the subject of study. The skills are obtained by applying the ‘understood’ method. The first approach, task-led, problem-oriented concept development, has a long tradition in the Soviet Union, e.g., in the form of the so-called task collections (*Sbornik Zadach*), which also had a high status in the German didactic tradition. In the post-war years, for example, Lietzmann’s *Aufgabensammlungen* were republished in both East and West Germany. In the GDR, also due to the great heterogeneity of the *Einheitsschule*, the first approach prevailed, and the GDR textbook series was structured accordingly. Soviet collections of geometrical problems were also used and translated<sup>53</sup>.

A look at psychological models and principles of general didactics is also useful for understanding the development of geometry teaching in the GDR. As Regina Bruder points out, both implicit and explicit activity theory approaches had an influence on mathematical concept development. Activity theory also of-

<sup>52</sup> Ibidem, p. 91.

<sup>53</sup> For example: E.F. Danilowa, *Wege zur Lösung geometrischer Aufgaben*, VEB Verlag Volk und Wissen, Berlin 1964.

ferred ideological connections to the educational concepts of the GDR through its foundation in dialectical historical materialism (Bruder, 2024).

As we saw from the example of New Math in West Germany, it is also worth looking at reforms that preceded the New Math reform. In contrast to Germany, where the Meraner Reform had led to content such as differential and integral calculus and analytical geometry in upper secondary schools, the situation in the USSR was different. In the 1930s, there were efforts by mathematicians, such as Pavel S. Alexandroff, Alexander Y. Chinchin, and Aleksei I. Markushevich, the students of the mathematician Nikolai N. Lusin, one of the fathers of set theory, to the modernization of the teaching of calculus, as was the case in Germany with the Meraner Reform. However, they are considered unsuccessful. A brief look at reform efforts in the USSR, the so-called Kolmogorov reform, is also useful when discussing the New Math teaching reform in East Germany<sup>54</sup>.

The USSR was not a member of the first International Mathematical Union (IMU) and the International Commission on Mathematical Instruction (ICMI), which was due to the political positions of the founding states. Nevertheless, there were numerous contacts and intensive exchanges on a personal level, in particular with the Göttingen mathematical school. After the war, efforts to modernize school mathematics and bring mathematics closer to science were continued by mathematicians like I.V. Arnold, V.L. Goncharov, Ya.S. Dubnov, A.I. Markushevich, N.F. Chetverukhin<sup>55</sup>.

The development of new curricula and textbooks in the USSR was guided by the work of commissions; there were competitions and awards for textbooks, but there was usually a trial phase before they were introduced into everyday school life and mass use:

Since the early 1960s, active attempts have been made to modernize the system of teaching mathematics in schools. Some experimental textbooks had appeared. For example, the textbook of arithmetic for grades 5–6 by I.K. Andronov and V.M. Bradis (built on a set-theoretical basis), the textbooks of R.S. Cherkasov, A.I. Markushevich, and others on algebra for senior grades (in which there was an attempt to introduce elements of higher mathematics into school), the geometry textbook of V.G.G. Boltvansky and I.M. Yaglom (built on the idea of geometric transformations), etc. And if the first two of the named textbooks were tested experimentally, then the third textbook

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<sup>54</sup> See also A. Borovik, *The Kolmogorov Reform of Mathematics Education in the USSR*, [in:] *Modern Mathematics: An International Movement?*, ed. by D. De Bock, Springer, Cham 2023, p. 319–336.

<sup>55</sup> Y.M. Kolyagin, *Russkaya shkola i matematicheskoe obrazovanie: nasha gordost' i nasha bol'*, Prosveshchenie, Moscow 2001, p. 194. See also A.N. Kolmogorov, A.I. Markushevich, I.M. Yaglom, *Proekt programmy srednei shkoly po matematike*, "Matematika v shkole" 1967, no. 1, p. 4–23.

was immediately introduced into mass schools in 1958 (a year later, it was canceled by order of the Ministry of Education as unsuitable for mass schools).<sup>56</sup>

The *Entsiklopediya elementarnoy matematiki* [Encyclopedia of Elementary Mathematics], edited in the 1950s by P.S. Alexandroff, A.I. Markushevich, and Y.M. Khinchin, and translated into German by the East German publishing house VEB Verlag der Wissenschaften in 1954, and also praised by Behnke<sup>57</sup>, demonstrates ‘pre-Kolmogorovian’ ideas of conceptual developments. The first volume of the encyclopedia also contains a chapter by the methodologist W.M. Bradis<sup>58</sup>. His methodology, an example of *Aufgabendidaktik*, was translated into German and used in the GDR. During and after the Kolmogorov reform, it was also reprinted in the USSR.

The idea of evaluating and editing teaching materials by corresponding interdisciplinary commissions was also adopted in the GDR. Central institutions such as the Academy of Sciences of the GDR and the German Central Pedagogical Institute (DPZI) began their work immediately after the Second World War. Differentiation in the heterogeneous classes of the *Einheitsschule* and performance-relatedness were implemented in the USSR and the GDR, partly through extracurricular opportunities to promote talent, like mathematical competitions and specialised schools. The development of structures and materials for the promotion of mathematical talent is of particular importance in the context of teaching transformation geometry, as two of the leading reformers of geometry teaching in the USSR, Kolmogorov and Yaglom, were heavily involved in the promotion of mathematical talent: Kolmogorov is considered the initiator of mathematical science boarding schools and Yaglom is the author of numerous popular introductions into higher mathematics, especially geometry, some of which were also translated and accessible in the GDR. Kolmogorov, as well as Yaglom, developed Soviet textbooks that followed modern approaches, especially those based on transformation geometry<sup>59</sup>.

The models for the support of mathematical gifted children that had been tested, disseminated, and perceived as successful in the Soviet Union were established in a very similar form in the GDR. Since the special schools, in addition to

<sup>56</sup> Y.M. Kolyagin, *Russkaya shkola i matematicheskoe obrazovanie: nasha gordost' i nasha bol'*, p. 196.

<sup>57</sup> H. Behnke, R.J.K. Stowasser, *Der gymnasiale Mathematikunterricht im Lichte der Wolffschen Unternehmungen*, “Mathematisch-physikalische Semesterberichte” 1979, vol. 26, no. 2, p. 145–153.

<sup>58</sup> V.M. Bradis, *Ustnyi i pis'mennyi schet. Vspomogatel'nye sredstva vychislenii*, [in:] *Entsiklopediya elementarnoy matematiki*, vol. 1. *Arifmetika*, ed. by A.P. Sergeevich, A.I. Markushevich, Y.M. Khinchin, Gostekhizdat, Moscow–Leningrad 1951, p. 357–441.

<sup>59</sup> I.M. Yaglom, *Geometricheskie preobrazovaniya*, vol. 2. *Lineinye i krugovye preobrazovaniya*, GITTL, Moscow 1956 (Biblioteka matematicheskogo kruzhka, vol. 8).

the central curricula, also developed their own curricula, ideas for modernizing mathematics teaching could be tried out without mass use. The *Mathematische Schülerbücherei*<sup>60</sup> published from 1965 extracurricular subjects for further education of interested teachers and the support of mathematically gifted children<sup>61</sup>.

As indicated, developments in New Math in West Germany were primarily driven by the activities of internationally well-connected and influential protagonists in Germany and, above all, Anglo-Saxon trends, and less by the specific problems and local conditions in the individual federal states. The GDR was also not an official member of the ICMI due to political divisions during the Cold War<sup>62</sup>.

The philosophical basis of pedagogical principles, lesson design, and educational policy in the GDR was historical and dialectical materialism. The principles of the Meraner Reform were compatible with these teaching principles; work-based teaching, a paradigmatic inductive development of concepts, and a close integration of mathematics teaching with the natural sciences, especially physics, were the guiding principles of the Meraner Reform on which to build. Due to the initial lack of well-trained teachers, the heterogeneity of teachers and of pupils' social backgrounds within the *Einheitsschule*, the focus was on practicing and understanding examples that were paradigmatic for the subjects. Research on mathematics didactics was state-controlled and institutionalized and, like teacher training, was strongly oriented towards school practice. In part due to the traditional proximity to the ideas of the Meraner Reform, efforts to modernize geometry teaching focused on linking the concept of geometrical elementary transformations with the concept of function, aiming at a more uniform presentation of the areas of geometry, algebra, and analysis. The initially planned, consistent foundation of geometry on the concept of *Abbildungsgeometrie* proved to be impractical and was only implemented as a possible background theory. The concept of geometrical transformations found its way into the curriculum primarily through the construction of congruence mappings and their compositions, as well as their use in geometric proofs of triangle geometry. However, a consistent connection between the geometric concept of transformation and the concept of function could not be demonstrated in the students' understanding. A detailed study of didactic discussions related to the introduction of *Abbildungsgeometrie*

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<sup>60</sup> See [https://de.wikipedia.org/wiki/Mathematische\\_Sch%C3%BClerb%C3%BCcherei](https://de.wikipedia.org/wiki/Mathematische_Sch%C3%BClerb%C3%BCcherei) [accessed 8.12.2025].

<sup>61</sup> The situation in the 1960s in West Germany differed greatly; there was a negative attitude towards the promotion of gifted children, as it was seen as supporting already privileged children and fostering future elites from bourgeois circles.

<sup>62</sup> F. Furinghetti, L. Giacardi, *ICMI in the 1950s and 1960s: Reconstruction, Settlement, and "Revisiting Mathematics Education"*, [in:] *The International Commission on Mathematical Instruction, 1908–2008: People, Events, and Challenges in Mathematics Education*, ed. by F. Furinghetti, L. Giacardi, Springer, Cham 2023, p. 43–94.

in the GDR is given by Andreas Filler<sup>63</sup>. In mathematical and physical contexts, however, this was partially successful. Although the education system in East Germany was centrally organized, the New Math movement did not lead to any drastic reorientations or breaks with cultural-historical traditions, perhaps thanks to its strong orientation towards school practice. Some of the concepts introduced in set theory have been retained, especially in the context of inequalities, transformations, and functions.

### Conclusions

The present study is only a beginning. The presentation of West German developments of the New Math reform took up more space; this reform was shaped primarily by the influences of West German and international networks, as well as various ideas for the modernization of mathematics teaching, predominantly from the perspective of university mathematicians and university didacticians. Their actions were far less transparent than was the case in the centrally structured institutions of the GDR. In West Germany, in curricula and textbooks, the concepts of an axiomatic foundation of geometry teaching on transformations disappeared again and were replaced by the algebraization of geometry in upper secondary school and by concepts of linear algebra. A characteristic of the development of mathematics didactics in the context of the New Math reform in West Germany was the increasing separation between instructors and teacher educators, who dealt with school practical problems, and the research-based, internationally and methodologically oriented didacticians. In contrast, in East Germany, New Math ideas were primarily adopted, which were compatible with the teaching of mathematics in geometrical and physics contexts and the structuring of concept development along the concept of function. Since the fusion of the concepts of geometrical transformation and of a function could not be successfully implemented in school experiments, this did not lead to fundamental curricular reforms. The strong, somewhat pragmatic orientation of East German mathematics methodology and the concentration of resources to address existing problems in school practice also proved to be a hindrance to visionary teaching programs in East Germany. At a double conference organized by Steiner in 1996, at which mathematics educators from the old and new federal states met to present their research topics to each other, Gert Schubring wrote in a discourse with Hans Wußing<sup>64</sup>:

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<sup>63</sup> A. Filler, *Weg von Euklid... und wieder zurück? Kongruenz- vs. Abbildungsgeometrie in der didaktischen Diskussion in der DDR*, "Mathematische Semesterberichte" 2016, vol. 63, no. 1, p. 93–134.

<sup>64</sup> The role of the history of mathematics in teacher education and mathematics teaching in East Germany was presented by Hans Wußing and in West Germany by Gert Schubring; the proceedings of the conference were published only in 2003: *Didaktik der Mathematik in den alten Bundesländern – Methodik des Mathematikunterrichts in der DDR. Bericht über eine Doppeltagung*

I think one can say that Marxism adopted historicism, which had been the fundamental attitude of the bourgeois era, and systematically developed it further. Therefore, it is not surprising that historical concepts were well received in the GDR. [...] In this respect, the contrast between the GDR and the FRG appears not so much to be one between “socialism” and a “free” society, but rather between a still largely traditional society with a system of fixed norms and values on the one hand, and an increasingly dissociated, “postmodern” society on the other.<sup>65</sup>

Schubring thus places the relationship between East and West Germany in the 1960s and 1970s in a broader context that still needs to be examined.

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zur gemeinsamen Aufarbeitung einer getrennten Geschichte, <https://www.math.uni-magdeburg.de/private/henning/tagung.pdf> [accessed 8.12.2025].

<sup>65</sup> G. Schubring, *Mathematik-Geschichte im Mathematik-Unterricht und in der Mathematik-lehrer-Ausbildung*, [in:] *Didaktik der Mathematik in den alten Bundesländern – Methodik des Mathematikunterrichts in der DDR. Bericht über eine Doppeltagung zur gemeinsamen Aufarbeitung einer getrennten Geschichte*, ed. by H. Henning, P. Bender, Otto-von-Guericke-Universität Magdeburg, Universität Paderborn, Magdeburg–Paderborn 2003, p. 103.

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**Ysette Weiss** is a professor of mathematics education at Johannes Gutenberg University Mainz in Germany. Since 2012, she has been the spokeswoman of the Study Group for History of Mathematics and Education of the German Society of Didactics of Mathematics. She works and publishes on the history of mathematics education as a resource in mathematics teacher education to foster awareness of the tradition in which teachers work.

e-mail: [yweiss@uni-mainz.de](mailto:yweiss@uni-mainz.de)