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Analysis of the Integration of Military Themes and Nazi Ideology in the 'Mathematisches Arbeits- Und Lehrbuch' Textbook Series

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ABSTRACT This study explores the integration of military themes and Nazi ideology within the "Mathematisches Arbeits- Und Lehrbuch" textbook series, which was a prominent tool in Nazi Germany for embedding National Socialist principles in mathematics education. Authored by Otto Zoll, a Nazi Party member, these textbooks were strategically designed to support the regime's objectives, aligning mathematical instruction with ideological and military indoctrination. The paper focuses on the revisions made to the textbooks after 1937, under directives from the Reich Ministry of Education, which infused them with exercises that directly related to military science, genetics, and Germanic folklore. Notably, students were introduced to complex military applications, such as ballistic calculations and strategic logistics, from as early as grade 10, illustrating the regime's efforts to prepare the youth for future roles in the military and as bearers of Nazi ideology. Through this analysis, the paper highlights the profound impact of these educational materials on shaping the ideologies and values of students, underscoring the potent role of education in propagating state ideologies. By dissecting the content of these textbooks, this study offers insights into how education under authoritarian regimes can be manipulated to achieve specific political ends, contributing to a broader understanding of the intersection between education, ideology, and political control during the Nazi era.

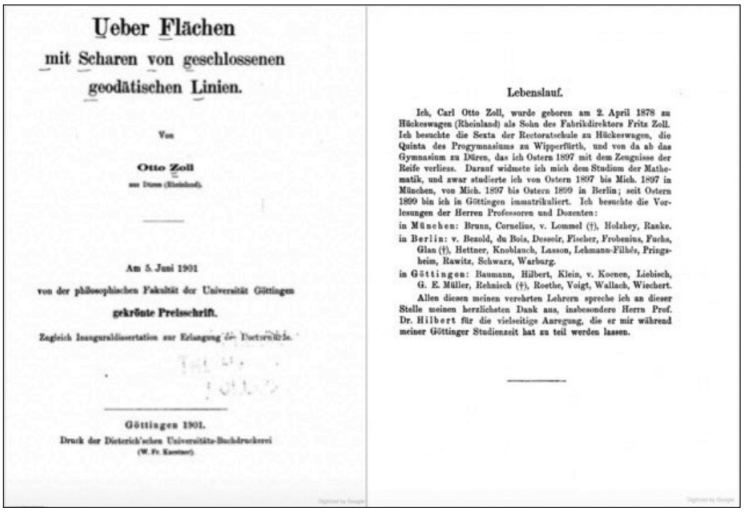
KEYWORDS: *Nazi ideology in mathematics education, mathematics curriculum, military mathematics, National Socialist pedagogy, Otto Zoll*

The goal of this paper is to discuss a series of textbooks used in Nazi Germany, which will help us to understand how mathematics teaching was influenced by Nazi ideology. The literature on the teaching of mathematics under Nazism is relatively limited (especially in English). A useful source for the author was the work of Goebel and Schlensag (2008). However, this paper has been purposefully limited to a review of examples, leaving generalizations for the future.

The analysis will focus on Otto Zoll, a textbook author in a period of Nazism, and a member of the Nazi Party. There were several other textbook series from the Nazi era, but this one was selected because most editions from the collection are readily available on the market, and the sellers were willing to ship to the United States. From 1935 to 1945, Zoll served as a member of the National Socialist Teachers League. Zoll received his PhD from the Georg August University of Göttingen in 1901. His dissertation, titled, "Über Flächen mit Scharen von geschlossenen geodätischen Linien" (On surfaces possessing families of closed geodetic lines), was accepted on June 5, 1901. His defense took place on July 29, 1901, for which he was awarded a prize for addressing the problem in an exceptionally satisfying manner and for his clear, accessible writing style.

Figure 1

Introduction of the author



Ueber Flächen
mit Scharen von geschlossenen
geodätischen Linien.

Von

Otto Zoll

Am 5. Juni 1901
von der philosophischen Fakultät der Universität Göttingen
gekrönte Preisschrift.

Zugleich Inauguraldissertation zur Erlangung der Doctorwürde.

Göttingen 1901.
Druck der Dieterich'schen Universitäts-Buchdruckerei

Lebenslauf.

Ich, Carl Otto Zoll, wurde geboren am 2. April 1878 zu Hückeswagen (Rheinland) als Sohn des Fabrikdirektors Fritz Zoll. Ich besuchte die Sexta der Rectoratschule zu Hückeswagen, die Quinta des Progymnasiums zu Wipperfürth, und von da ab das Gymnasium zu Düren, das ich Ostern 1897 mit dem Zeugnisse der Reife verliess. Darauf widmete ich mich dem Studium der Mathematik, und zwar studierte ich von Ostern 1897 bis Mich. 1897 in München, von Mich. 1897 bis Ostern 1899 in Berlin; seit Ostern 1899 bin ich in Göttingen immatrikuliert. Ich besuchte die Vorlesungen der Herren Professoren und Dozenten:
in München: Brunn, Cornelius, v. Lommel (†), Holzkey, Ranke.
in Berlin: v. Bezold, du Bois, Dessoir, Fischer, Frobenius, Fuchs, Glan (†), Hettner, Knoblauch, Lasson, Lehmann-Filhés, Pringsheim, Rawitz, Schwarz, Warburg.
in Göttingen: Baumann, Hilbert, Klein, v. Koenen, Liebisch, G. E. Müller, Rehnisch (†), Roethe, Voigt, Wallach, Wiechert.
Allen diesen meinen verehrten Lehrern spreche ich an dieser Stelle meinen herzlichsten Dank aus, insbesondere Herrn Prof. Dr. Hilbert für die vielseitige Anregung, die er mir während meiner Göttinger Studienzeit hat zu teil werden lassen.

Source: Penn State University Mathematics Library

Figure 2

Portrait of the author

Source: Göttinger Digitalisierungszentrum

At the end of his dissertation (Zoll, 1903), there is a short curriculum vitae (Figure 1). It reveals that his full name was Carl Otto Zoll, born on April 2, 1878, in Hückeswagen (a small town located about 30 miles from Cologne). His father, Fritz Zoll, held the position of managing director at a factory. Zoll went to *Sexta* (today's fifth grade) in Hückeswagen and *Quinta* (today's sixth grade) in Wipperfürth. He then attended Gymnasium in Düren and graduated in 1897. From April 18 to September 29, 1897, Zoll studied mathematics in Munich, then in Berlin. He moved to Göttingen on Easter 1899, and completed his doctorate at the University of Götingen. Zoll's PhD thesis served as his only publication in a scientific journal. Zoll's PhD advisor was the renowned mathematician, David Hilbert. Between 1905 and 1947, Zoll held the position of senior teacher at a Düsseldorf high school, attaining the title of professor in 1916, until his retirement. He passed away on January 20, 1952, in Düsseldorf.

The *Göttinger Digitalisierungszentrum* has a picture (Figure 2) of Otto Zoll, dated 1920-1922, which was part of a photo album with portrait shots of mathematicians presented to David Hilbert in January 1922.

Mathematisches Arbeits- und Lehrbuch

From 1931 to 1943, Zoll contributed as the author and one of the editors to the development of *Mathematisches Arbeits- und Lehrbuch* (Mathematical workbook and textbook), a comprehensive mathematics textbook series for secondary education, published by Vieweg in Braunschweig in Germany.

The series of textbooks consists of three volumes: 1) *Unterstufe* (lower level); 2) *Mittelstufe* (middle level); and 3) *Oberstufe* (upper level). Each volume of the textbook was designed using the framework of the modern curriculum of mathematics education. Each chapter contains five to six sections. In each section, Part A contains tasks that are intended to facilitate the development of the lecture; Part B briefly summarizes what has been developed in Part A; Part C further deepens understanding and develops the relationships of mathematics to other fields; and Part D contains a variety of practice problems from which the teacher can make a selection. Some sections may not contain all of A, B, C, and D (Zoll, 1939).

Differentiation Between the Boys' Version and the Girls' Version

There was another system of counting grades at this time (Goebel & Schlensag, 2008). Accordingly, the Grade 6, 7, and 8 studied in this paper are equivalent to today's Grade 10, 11, and 12 respectively. In 1940, the contemporary military applications already reflected in the text as early as Grade 6 (today's Grade 10). Comparing the *Ausgabe A* (Edition A) for boys with *Ausgabe B* (Edition B) for girls in the volume *Oberstufe: Geometrie und Algebra, Ausgabe A* contains extra content in almost every chapter. For example, in the second chapter, Exponential and Logarithm Functions, the girls study the following topics:

1. Graphical representation of exponential and logarithmic functions. Concept of the logarithm
2. Logarithm systems, especially the decimal logarithms
3. The laws of logarithms
4. The arrangement of logarithmic tables
5. Calculating with logarithms

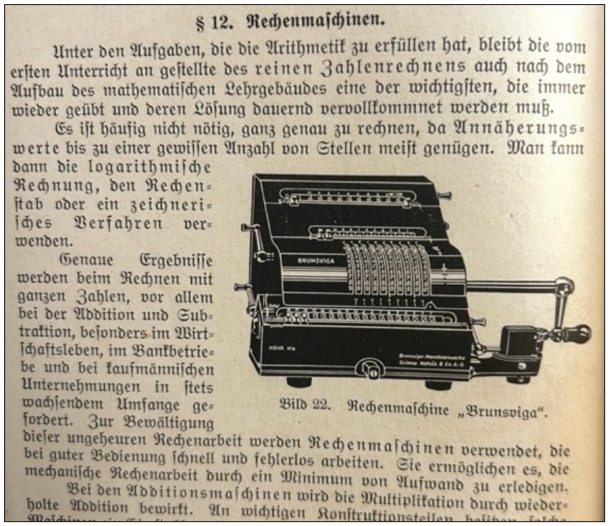
The boys need to study these five topics, plus *6. Rechenmaschinen*, which is a calculating machine named BRUNSVIGA, and can be considered as a very simple version of Enigma, the encryption device Germany had been using during World War II. The *Ausgabe A* provided a detailed picture of BRUNSVIGA (Figure 3).

In terms of practice problems under this topic, the text asks the students to explain the following mechanism as exercises (Figure 4),

In the 1942 version, another two sections were added in *Ausgabe A* of *Oberstufe*, exclusively for boys: *Geometric Relationships In The Conic Sections and Map Projection and The Trigonometry Of The Spherical Surface*, which include topics such as Map Projection, Nautical Triangle, and Astronomical Position Determination at Sea and in Aircraft. Map Projection and Nautical Triangle topics were relatively challenging; they involved a prerequisite knowledge that was neither mentioned elsewhere in the book, nor in any of the previous volumes and editions.

Figure 3

Brunsviga



§ 12. Rechenmaſchinen.

Unter den Aufgaben, die die Arithmetik zu erfüllen hat, bleibt die vom erſten Unterricht an geſtellte des reinen Zahlenrechnens auch nach dem Aufbau des mathematiſchen Lehrgebäudes eine der wichtigſten, die immer wieder geübt und deren Löſung dauernd vervollkommnet werden muß.

Es iſt häufig nicht nötig, ganz genau zu rechnen, da Annäherungswerte bis zu einer gewiſſen Anzahl von Stellen meiſt genügen. Man kann dann die logarithmiſche Rechnung, den Rechenſtab oder ein zeichneriſches Verfahren verwenden.

Genaue Ergebniſſe werden beim Rechnen mit ganzen Zahlen, vor allem bei der Addition und Subtraktion, beſonders im Wirtſchaftsleben, im Bankbetriebe und bei kaufmänniſchen Unternehmungen in ſtets wachſendem Umfange gefordert. Zur Bewältigung dieſer ungeheuren Rechenarbeit werden Rechenmaſchinen verwendet, die bei guter Bedienung ſchnell und fehlerlos arbeiten. Sie ermöglichen es, die mechaniſche Rechenarbeit durch ein Minimum von Aufwand zu erledigen.

Bei den Additionsmaſchinen wird die Multiplikation durch wiederholte Addition bewirkt. An wichtigen Konſtruktionsteilen halten ſolche

Bild 22. Rechenmaſchine „Brunsviga".

Source: *Mathematisches Arbeits- und Lehrbuch, Oberstufe: Geometrie und Algebra, Ausgabe A* (Zoll, 1940, p. 26)

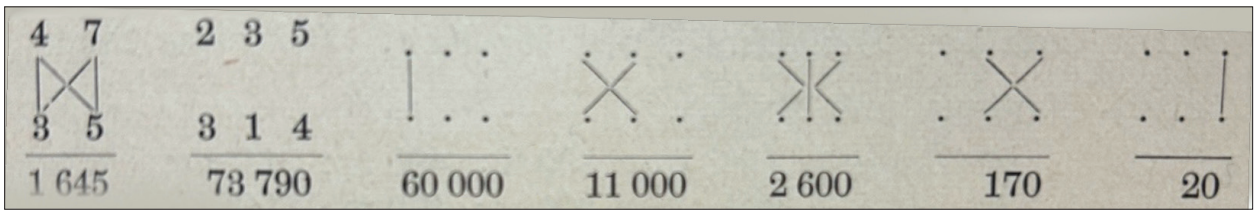
Major Revisions with 'National Socialist Thought and the German Spirit'

Under the order of the Reich Ministry of Education, the series' structure and content were periodically revised to reflect changes in the education system. Numerous exercises directly related to National Socialist ideology, and military applications were included in the textbooks with the revisions of 1937 and 1939, initially in the form of supplementary booklets, and later in the body of the textbook (Goebel & Schlensag, 2008). Such ideology and military topics did not exist in the first edition published in 1931 (Zoll, 1931).

The following are quoted directly from the preface of the volume of the 1937 revised version, "Nationalpolitische Anwendungen der Mathematik" of *Mathematisches Arbeits- und Lehrbuch* (Zoll, 1937). All translations of German text from the textbooks analyzed in this study were performed by the author of this article. This

Figure 4

Practice problems to Brunsviga



Source: *Mathematisches Arbeits- und Lehrbuch, Oberstufe: Geometrie und Algebra, Ausgabe A (Zoll, 1940, p. 27)*

edition contains several tasks with the main goal to indoctrinate students in the spirit of Nazi ideology:

> The National Socialist movement has given all German schools a unified goal, namely to educate students to be politically minded German individuals. To achieve this goal, it is necessary to familiarize students with National Socialist thought and imbue them with the German spirit. The present treatises aim to contribute to this task: They discuss a series of life-relevant, significant questions for the German people, in which mathematics plays a role (Zoll, 1937, p. 1).

Ideological issues were presented not just in the preface, but again in the final pages of each edition of the textbooks.

The following was quoted from "Historical Fact" at the end of the *Oberstufe* volume, revised in 1942:

> All people and races of the earth, in their attempt to interact with their environment, have developed some degree of mathematical knowledge and skill, even if sometimes modest. Even the Bushmen and Australian Aborigines possess a numeracy system structured according to their needs; in terms of spatial understanding, they exhibit orientation skills and sometimes an extraordinarily developed capacity for imagination and estimation. However, a vast gulf exists between these mathematical abilities and the mathematical fields discussed in this volume, which are essential to the economic and technical culture developed over the last five centuries. These skills are almost exclusively the result of the intellectual efforts of European Indo-Germanic peoples; among them, the Germanic peoples, and particularly the Germans, have contributed significantly. Compared to these, the mathematical achievements of all other ethnic groups lag considerably behind in the "race of achievement" and remain far behind the European Indo-Europeans, including the most advanced among them, such as the Indians, the inhabitants of the Euphrates and Tigris valleys, the Chinese, the Japanese, and the people of the American continents. (Zoll, 1942, p. 275)

This ideology was reflected not only in the boys' version of the text but also in the girls' version:

> From our Germanic ancestors of more than 2000 years ago, we know practically nothing about their scientific pursuits relevant to our interests here, as well as many other scientific matters. The rise of the sciences has simply brushed aside much of prehistoric Germanic knowledge. However, from the geometric patterns on the pottery of the Neolithic period or the Bronze Age, and from the pleasing geometric shapes of some of these items, we can infer that the Germanic women of that time certainly did not lack an appreciation for the beauty of geometric forms. (Zoll, 1940, p. VII)

Military Applications

With the 1937 revision, the textbook heavily emphasized military applications; the textbook consisted of nine chapters, which were later mixed into the body of different volumes of the textbook series. These chapters are completely independent of one another. The covered fields involved military science, biology (population policy, genetics), and prehistory:

i From the Theory of Flight
ii Aircraft Localization
iii From the Theory of Conclusion (talking about Ballistics)
iv Perspective (talking about photometry)
v Image Measurement
vi Combinatorics along with Applications from the Theory of Inheritance
vii Fundamentals of Probability Theory along with Problems from the Theory of Inheritance
viii Fundamentals of Statistics with Consideration of Biological Processes and Population Policy
ix Problems in Germanic Folklore and Prehistory

Here is an example of the practice problems under the section Aircraft Localization:

> A bomber aircraft B flies at a ground speed of V_b = 360 km/h in an east-west horizontal direction and is attacked by a fighter aircraft K, which also flies in an east-west direction at a speed of V_k = 480 km/h, in the same vertical plane as the bomber but with a 30° inclination to the horizontal. At the moment of the attack, the distance KB = 400 m and the inclination of KB to the horizontal a = 50°. The projectile trajectory can be assumed to be straight and aligned with the sighting direction for this short distance; furthermore, the average projectile speed on this path is c = 800 m/s, and air resistance is not considered. What is the lead angle in the assumed position? How must the bomber's defensive fire be directed against the fighter? How does the solution change if the bomber flies in a west-east direction, but all other numerical data remains the same? (Zoll, 1937, p. 28)

Under the section on Ballistics, the text introduced External Ballistics by presenting an image of a mortar (Figure 5), which is a type of artillery weapon that fires explosive shells in a high-arching trajectory, making it effective for targeting entrenched positions or enemies behind cover.

Then, as a practice problem, the text asks students to calculate a projectile's flight from the moment it leaves the barrel until it reaches the target.

Here is an example:

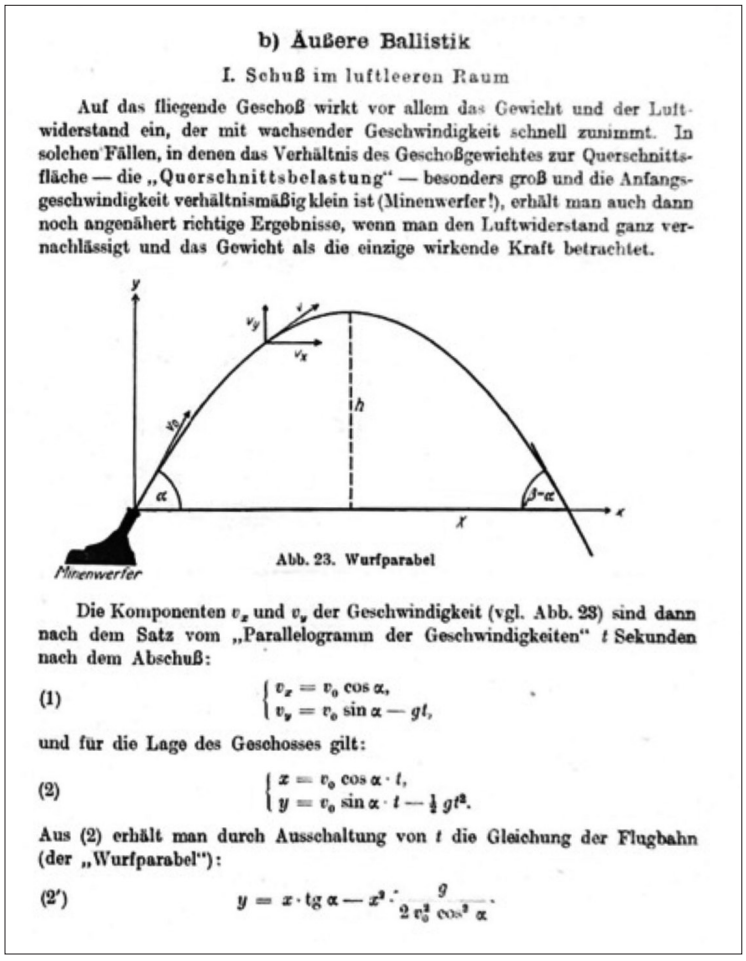
> A hand grenade was thrown from a trench with an initial speed of 26 m/s at an angle of 28°. What is the maximum height it reaches, where, and when does it land? How large must the elevation angle be if one (again with $v_0 = 26$) wants to hit an enemy trench 62 meters away? (Zoll, 1937, p. 41)

In another problem under the Ballistic section, technical parameters of a heavy mortar are given and students are asked to calculate which area of the terrain can be covered. By what value must a certain technical parameter be increased (or decreased) so that the next area seamlessly connects? (Zoll, 1937, p. 41)

Under the section of Image Measurement, military applications such as the determination of the location of a shell's burst by photographic capture, altitude measurement, evaluation of aerial, and sequential aerial photographs are included (Zoll, 1937, p. 78)

Figure 5

Ballistics



b) Äußere Ballistik

I. Schuß im luftleeren Raum

Auf das fliegende Geschoß wirkt vor allem das Gewicht und der Luftwiderstand ein, der mit wachsender Geschwindigkeit schnell zunimmt. In solchen Fällen, in denen das Verhältnis des Geschoßgewichtes zur Querschnittsfläche — die „Querschnittsbelastung" — besonders groß und die Anfangsgeschwindigkeit verhältnismäßig klein ist (Minenwerfer!), erhält man auch dann noch angenähert richtige Ergebnisse, wenn man den Luftwiderstand ganz vernachlässigt und das Gewicht als die einzige wirkende Kraft betrachtet.

Abb. 23. Wurfparabel

Die Komponenten v_x und v_y der Geschwindigkeit (vgl. Abb. 23) sind dann nach dem Satz vom „Parallelogramm der Geschwindigkeiten" t Sekunden nach dem Abschuß:

(1) $$\begin{cases} v_x = v_0 \cos\alpha, \\ v_y = v_0 \sin\alpha - gt, \end{cases}$$

und für die Lage des Geschosses gilt:

(2) $$\begin{cases} x = v_0 \cos\alpha \cdot t, \\ y = v_0 \sin\alpha \cdot t - \frac{1}{2} gt^2. \end{cases}$$

Aus (2) erhält man durch Ausschaltung von t die Gleichung der Flugbahn (der „Wurfparabel"):

(2') $$y = x \cdot \operatorname{tg}\alpha - x^2 \cdot \frac{g}{2 v_0^2 \cos^2\alpha}.$$

Source: Nationalpolitische Anwendungen der Mathematik, p. 39

Post WWII

Zoll attempted to resume his career as a textbook author after 1945 (Krömer & Nickel, 2023). His affiliations with the Nazi party caused him troubles in the Allied-occupied Germany. The Vieweg publisher tried to revise his textbook, along with authors and editors, to remove all disagreeable content. Due to objections from the education division of the British military government, the publisher eventually replaced Zoll in the fall of 1947 as editor with his former co-author, Hans Brandes (Goebel & Schlensag, 2008).

In a letter dated October 2, 1945 (archived at the TU Braunschweig library) to the publisher, Vieweg, Zoll raised the question of whether it was even possible for him to remain as an editor, since he had been a member of the National Socialist German Workers' Party (NSDAP):

> […] with the new book, it might be questionable whether an education counselor, who was a Parteignosse (although no longer active), can be an editor. Should you have any concerns, I suggest assigning a colleague who was not Parteignosse as the editor. (Zoll, 1945)

In a letter dated May 5, 1947, the education branch of the British Military Government responded to Vieweg: "In reply to your letter of 27th March, would it not be preferable to concentrate on books by Bauer-Hanxleden than on the work of a man known to everyone to contain pernicious material from the Nazi era? We suggest a new edition under a different editor's name" (Goebel & Schlensag, 2008). Without further publications, Zoll died on January 20, 1952, in Düsseldorf, Germany.

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