BERNT MICHAEL HOLMBOE (1795–1850) AND HIS TEXTBOOKS IN SCHOOL MATHEMATICS

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ABSTRACT

Bernt Michael Holmboe (1795–1850) was the teacher at *Christiania Kathedralskole* that discovered Niels Henrik Abel's (1802–1829) unique skills in mathematics, and who gave him guidance and private tuition. Holmboe was at the *Kathedralskole* from 1818 till 1826, and after that he was professor at the *University of Christiania* until his death in 1850. He published the first edition of Abel's complete works in 1839.

Holmboe wrote several textbooks, two of them in basic mathematics and three in more advanced mathematics, and he was probably one of the most influential persons in the development of school mathematics in the first half of the 19th century in Norway. His presentation of geometry in the books was, however, not without opposition. In 1835, the applied mathematician Christopher Hansteen (1784–1873) wrote a textbook in geometry where he challenged the traditional Euclidean geometry, and he introduced the subject matter in a very «un-Euclidian» way. The controversy that followed in the newspapers has later been called the «dispute about parallelism». The core of it was whether one in mathematics education should – as in the case of Hansteen – let utilitarian considerations overrule logical deduction and theoretical thinking.

1 Introduction

Bernt Michael Holmboe was born on the 23rd of March 1795, and he became a teacher at *Christiania Kathedralskole* in 1818, where he himself had been a student four years earlier.

The kingdom Denmark/Norway introduced a new school reform around year 1800 which in many ways strengthened the position of the discipline of mathematics, and from now on may we talk about proper teaching in mathematics in the higher education (Piene 1937). There was much work done in the last decades of the 18th century to reintroduce mathematics as a subject in school. Søren Rasmusen (1768–1850) was the senior teacher in mathematics at *Christiania Kathedralskole*, and he was later succeeded by Holmboe. Holmboe was a teacher at *Christiania Kathedralskole* from 1818 till 1826, and after that he was professor at the *University of Christiania* until his untimely death in 1850.

The University of Christiania was established in 1811 as *The Royal Frederiks University*[1], and started its function in 1813 with five appointed professors, Søren Rasmussen being one of them. The only use of mathematics the first six years was for the *examen philologico-philosophicum* – a preparatory exam for other subjects. The lectures in mathematics were on trigonometry, stereometry, basic algebra, and later applied mathematics after Hansteen's appointment (Holst 1911).

Holmboe died on the 28th of March 1850, at the age of 55 years and 5 days. His home burnt down shortly after his death, and a great deal of his letters and works were lost, in addition to some of Abel's letters and works (Bjerknes 1925).

2 Professional Career

Bernt Michael Holmboe became a student in 1814, and in 1815 he became Hansteen's assistance in his astronomical observatory. After completing his exams he worked from 1818 till 1826 as teacher at *Christiania Kathedralskole*, where he earned his reputation as Abel's teacher. It was claimed by several that the university made a serious mistake when they appointed Holmboe as teacher at the university in 1826, instead of Abel. Abel himself was abroad at that time, but he wrote a hearty letter to Holmboe congratulating him with the position. After 1826, Holmboe also held a position as teacher in mathematics at the military academy. [2]

Holmboe was a mathematician by heart, and still a young man when he started teaching in 1818. It is said that his teaching was more «lively» and enthusiastic than what his students were used to. He gave them exercises and assignments out of the ordinary, and he caught their attention. At the university, his lecture curriculum was narrow. His printed lecture notes comes to no more than 200 pages quarto, including subjects like analytic geometry, differential- and integral calculus (Holst 1911).

Among Holmboe's students we find great mathematicians like Niels Henrik Abel, Ole Jacob Broch and Carl Anton Bjerknes. Holmboe proclaimed that in no other subject did novices complain more than in mathematics (Piene 1937), and his aim was to make the students familiar with mathematical signs *before* a more methodical study. He further stated that unless pupils engaged in «uninterrupted practice»[3] even

[1] Det Kongelige Frederiks Universitet

[2] See (UiO 1862, 1911; Birkeland 1997; Bjerknes 1925; Hansteen 1841)

[3] «idelig øvelse»

persons with several years of education would find that mathematics is «something of a mind consuming and boring matter»[4]. The lecture notes of Carl Anton Bjerknes shows, however, that Holmboe's teaching was characterized by *pre-abelian* times, in spite of his knowledge of Abel and his works (Bjerknes 1925).

After Abel's death in 1829, Holmboe wrote an article about Abel's life and scientific works (Holmboe 1829), where he describes the private tuition he gave Abel. After an overview of the motivation, they studied *Euleri introductio in analysin infinitorum*, *Euleri institutiones calculi differentialis* and *Euleri institutiones calculi integralis*. After that, Abel studied mathematics on his own, in particular the works of Lacroix, Francoeur, Poisson, Gauss, Garnier, and Lagrange. Holmboe wrote once in the school register about Abel, that *«indeed, if he lives, will become the worlds greatest mathematician»*[5].

Holmboe wrote in a letter to the then 24 years old Carl Anton Bjerknes (Holmboe 1849a) that he is inspired by the great French mathematician Joseph-Louis Lagrange (1736–1813). Bjerknes had asked Holmboe to advise him about studies in mathematics, and Holmboe wrote *«The best I have to state in this respect is to inform you about some notes from Lagrange and some rules and remarks by him regarding the study of mathematics, which I found in Lindmanns and Bohnebergers* Zeitschrift für Astronomie *about 30 years ago ... Those who really want, should read Euler, because in his works all is clear, well said, well calculated, because there is an abundance of good examples, and because one should always study the sources»*[6]. Lagrange was autodidact in mathematics, and Holmboe was by his example cautious at selecting suitable ways of learning, he rather communicated good advice. In the mentioned letter to Bjerknes, Holmboe communicates several instances of such good advice from Lagrange. The letter was written only six months before Holmboe died, and may well be regarded as his legacy to students of mathematics.

3 Textbooks in Mathematics

Holmboe wrote several textbooks, two of them in basic mathematics (Holmboe 1825, 1827), and three in higher mathematics (Holmboe 1833, 1834, 1849b), and his textbooks may have been the first textbooks that were published in Norway. They were nearly the only ones used before 1860, and some of them still came in several editions, even after Holmboe's death. The educational establishments in Denmark/Norway in the eighteenth century[7] clearly distinguished between *arithmetics* and *mathematics*. The former was characterized by *calculations*, and the latter by Euclid*'s Elements*. Piene (1937) writes that it is unknown whether textbooks were used in the learned schools in Norway before Holmboe's time.

[4] «noget åndsfortærende og kjedsommelig tøi»

[5] «vistnok, om han lever, vil blive Verdens største Mathematiker» (Seip 1971)

[6] «Som det bedste jeg her i denne Henseende veed at anføre, vil jeg meddelle nogle Notiser om Lagrange og en Deel Regler og Bemærkninger av ham angaaende Mathematikens Studium, hvilke jeg for omtrent 30 Aar siden fandt i Lindmann's og Bohnebergers *Zeitschrift für Astronomie* ... De som virkelig vil, bør lese Euler, fordi i hans skrifter alt er klart, godt sagt, godt regnet, fordi de vrimler av gode eksempler og fordi man altid bør studere kildene.»

[7] The development of mathematics and mathematics education in Denmark/Norway in the eighteenth, and early nineteenth, century is thoroughly described by Christensen (1895), Frøyland (1965), Piene (1937, 1938) and Solvang (2001).

The following table shows an overview over HOLMBOE's textbooks, their Norwegian titles and their various editions.

TITLE	EDITION	YEAR	EDITED BY	PUBLISHER
Lærebog i Mathematiken Første Deel, Inneholdende Indledning til Mathematiken samt Begyndelses-grundene til Arithmetiken (Holmboe 1825)	1st 2nd 3rd 4th 5th	1825 1844 1850 1856 1860	Holmboe	Jacob Lehman
Lærebog i Mathematiken Anden Deel, Inneholdende Begyndelsesgrundene til Geometrien (Holmboe 1827)	1st 2nd 3rd 4th	1827 1833 1851 1857	 Jens Odén	Jacob Lehman J. W. Cappelen
Stereometrie (Holmboe 1833)	1st 2nd	1833 1859	 C. A. Bjerknes	C. L. Rosbaum
Plan- og sphærisk Trigonometrie (Holmboe 1834)	1st	1834		C. L. Rosbaum
Lærebog i den høiere Mathematik Første Deel (Holmboe 1849b)	1st	1849		Chr. Grøndahl

Table 1: AN OVERVIEW OVER HOLMBOE'S TEXTBOOKS

3.1 Arithmetic

The third edition of his textbook in mathematics, part one (Holmboe 1825), was published in 1850, and HOLMBOE wrote in the preface that «*The first edition of this textbook has now in almost 19 years been used in the teaching in arithmetics in Christiania learned school, and with one exception, as far as he knows, also in the other learned schools in Norway. This he takes as an evidence that the book meets its requirements. It has also been used at the lectures in elementary algebra for almost 18 years*»[8].

There is also reason to believe that HOLMBOE was influenced by the Norwegian philosopher and politician NIELS TRESCHOW (1751–1833). He was the first headmaster at the university in Oslo. TRESCHOW published a textbook in logic (Treschow 1813) where one finds the conceptualization that HOLMBOE uses.

The introduction to HOLMBOE (1825) is divided into eight sections. In section

[8]Denne Lærebogs første Oplag har nu i henved 19 Aar været brugt ved den aritmetiske Undervisning i Christiania lærde Skole og med een Undtagelse i næsten ligesaa lang Tid, saavidt jeg ved, i de øvrige lærde Skoler her i Landet. Dette antager jeg som Beviis for, at man har fundet Bogen svarende til sin Hensigt. Den har også i 18 Aar været lagt til Grund ved de elemtæralgebraiske Forelærninger ved Universitetet.

one he introduces *fundamental concepts* that cannot be «disintegrated». A *statement*[9] is when two or more concepts are connected in an expression, and they are classified in *direct*[10] and *indirect*[11] statements. A statement is *direct* if one understands the correctness *without* having to consider other statements, and a statement is *indirect* if you need other statements to understand it. The statements were also classified in *synthetic* or *practical* statements, and *analytic* or *theoretic* statements[12]. HOLMBOE is then introducing four different types of statements:

1. Direct synthetic statements which he calls *Postulates*[13]
2. Direct analytic statements which he calls *Axioms*[14]
3. Indirect synthetic statements which he calls *Problems*[15]
4. Indirect analytical statements which he calls *Theorems*[16]

In section two he describes a *magnitude* as something that may be made larger og smaller, or may be composed of parts. The notion of the set of several homogeneous magnitudes is a *distinct magnitude* or a *number*, and opposed to this we have *coherent magnitudes* [17]. *Mathematics* is then defined in section three as the science about magnitudes and their connections. Mathematics may be divided into two separate parts since magnitudes are divided into two parts[18]:

1. *Arithmetic*, which is the science about the distinct magnitudes or numbers.
2. *Geometry*, which is the science about the coherent magnitudes.

Section four gives a general description of the mathematical signs =, > and <, and the last three sections describes some basic concepts and statements.

3.2 Geometry and Stereometry

The textbook in basic geometry (Holmboe 1827) starts with several definitions of basic concepts. The very first definition describes *geometry* as a science about the *coherent magnitudes*. Coherent magnitudes are the space with all available dimensions and time. According to Solvang (2001), HOLMBOE's way of organizing the subject matter was influenced by ADRIEN-MARIE LEGENDRE's (1752–1833) introduction to geometry (Legendre 1819). The geometry of LEGENDRE is constructed mainly the same way

[9] setning

[10] umiddelbar

[11] middelbar

[12] TRESCHOW and HOLMBOE uses the concepts *synthetic* and *analytic* different from the way the German philosopher IMMANUEL KANT (1724–1804) used them.

[13] Fordringssætninger

[14] Grundsætninger

[15] Opgaver

[16] Læresetninger

[17] Enhver Ting kaldes en Størrelse med Hensyn til, at den kan blive større eller mindre, eller tænkes bestaaende af Dele. Begrebet om Mængden af flere eensartede Størrelser kaldes en *adskilt Størrelse* eller et *Tal*. I Motsætning heraf, I Motsætning heraf, det er uden Hensyn til Mængden af en Størrelses eensartede Dele, kaldes den en *sammenhengende Størrelse*.

[18] *Mathematik* er en Videnskab om Størrelser og deres Forbindelse. Paa Grund af Størrelsers Inddeling i adskilte og sammenhengende inddeles Mathematiken i to Dele. (1) *Arithmetik*, som er en Videnskab om de adskilte Størrelsene eller Tallene. (2) *Geometrie*, som er en Videnskab om de sammensatte Størrelser.

as EUCLID, and starts with a long list of what he calls *explanations*, similar to what EUCLID calls *definitions* (Euclid 1956).

The first definition in LEGENDRE (1819) defines *geometry* as *a science which has for its objects the measure of extension. Extension has three dimensions, length, breadth, and thickness.* With reference to classification of coherent magnitudes in space and time, HOLMBOE classifies geometry in two parts:

1. *The real geometry* defined by the relations between the various magnitudes in space, without considering their changes in time.
2. *Mechanics*, defined by the changes the magnitudes goes through in time. All changes on a magnitude through time is called *motion*, and it is conditioned by *force*.

It is postulated that the space stretches indefinitely[19].

HOLMBOE advises the teacher to show moderation in the review of proofs, and to show examples using *numbers* before the examination of the proof. This practical advice contradicts the structure of his textbooks, which is strictly Euclidean. There are few exercises and numerical examples, and the notion of *construction* means to *elucidate* the concept, and not to use compass and ruler. HOLMBOE does *not* give any detailed instructions on how to use ruler and compass in this book, nor does he mention geometric locus, but writes about *elucidative*[20] objects, magnitudes and concepts. His idea may be that the mathematics teaching shall educate the students with respect to formal logic, by encouraging them to *think* and *conclude*. There was a present debate about the use of Euclidean ideas in textbooks in geometry, and when CHRISTOPHER HANSTEEN published his textbook in geometry (Hansteen 1835), it was evidently a controversial issue, and an attack on the Euclidean textbooks (Piene 1937; Solvang 2001).

The textbook in stereometry (Holmboe 1833) starts with some basic definitions without any introductory remarks. The subject *stereometry* is defined as the part of geometry that is not only restricted to one plane[21].

3.3 Trigonometry

The textbook in trigonometry (Holmboe 1834) is divided into two separate parts – *plane trigonometry* and *spherical trigonometry* – the first part is 21 pages long, and the latter is 19. *Plane trigonometry* is defined as the part of geometry that includes the problem of finding the remaining sides and angles of a triangle, when sufficient sides and angles are known[22]. The trigonometric functions of a circular arc, or its central angle, are then defined as follows:

[19]Geometri er en Videnskab om de *sammenhængende Størrelser*. Sammenhengende Størrelser er ere Rummet med enhver deri forekommende Udstrækning og Tiden. Med Hensyn til de sammenhængende Størrelsers Inddeling i Rum og Tid, inddeles Geometrien i 2 Dele. (1) *Den egentlige Geometri*, der bestemmer de i Rummet forekommende Størrelsers Forhold til hinanden uden Hensyn til deres Forandring i Tiden. (2) *Mekanik*, der bestemmer de Forandringer, som Størrelserne undergaae i Tiden. Anm. Enhver Forandring, som en Størrelse i Tiden undergaaer, kalles *Bevægelse*, hvis betingelse kaldes *Kraft*. *Fordringssætning*. Rummet maa tænkes udstrakt i det Uendelige.

[20]anskueliggjørende

[21]*Stereometrie* kaldes den Deel af Geometrien, der handler om Udstrækninger, som ikke indeholdes i et eneste Plan.

[22]Plan Trigonometrie kaldes den Deel af Geometrien, som indeholder Opløsningen af følgende Opgave: naar blandt de 6 i et Triangel forekommende Størrelser, 3 Sider og 3 Vinkler, saamange, som ere nødvendige og tilstrekkelige til at bestemme Trianglet, ere givne, at finde hver af de øvrige.

Sine is described by using the unit circle, and illustrated by a figure. *Sine* of a circular arc is also defined half the chord of the arc that is twice as large.

Cosine is only defined as *sine* to the complementary angle.

Tangent is defined using the unit circle.

Cotangent is defined as *tangent* to the complementary angle.

Secant is defined using the rectangular triangle used to define the *tangent*.

Cosecant is defined as *secant* to the complementary angle.

Spherical trigonometry has the same definition as *plane trigonometry*, with the only difference that the triangle is *spherical*[23]. There are no further initial definitions in this part of the book.

HOLMBOE is very clear in the first four textbooks to indicate when there is a conclusion or deduction. There is a horizontal line across the page, the width of the text, and the first word on the next line is normally «*consequently*»[24]. There are in addition often references to the sections describing or defining the arguments used for the conclusion.

3.4 Higher Mathematics

Finally, HOLMBOE's textbook in higher mathematics (Holmboe 1849b) was published much later than the other four textbooks, and only a year before HOLMBOE died, and it is many ways different from its predecessor. This book was printed in Roman letters, while the other four were printed in German type. There are also no horizontal lines across the text to indicate conclusions or deductions, as was common in the other four books. HOLMBOE writes in the preface that CAUCHY and ABEL are the mathematicians that he has used most in the preparation of his book, and he highly recommends their works for further studies.

HOLMBOE's textbooks were eventually succeed by the textbooks written by OLE JACOB BROCH (1818–1889) (1855; 1860).

4 The Controversy with Hansteen

In 1835, CHRISTOPHER HANSTEEN published a textbook in basic geometry (Hansteen 1835), which in many ways challenged HOLMBOE's textbooks, and was the cause of a bitter controversy between the two professors in mathematics. A newspaper polemic between HOLMBOE and HANSTEEN about HANSTEEN's textbook in geometry took place in *Morgenbladet* from December 1835 till January 1836, and in *Den Constitutionelle* from June till September 1836[25].

[23]Sphærisk Trigonometrie kaldes den Deel af Geometrien, som indeholder Opløsningen af følgende Opgave: naar blandt de 6 i et sphærisk Triangel forekommende Størrelser, 3 Sider og 3 Vinkler, saamange, som ere nødvendige og tilstrekkelige til at bestemme Trianglet, ere givne, at finde hver af de øvrige.

[24]«*altsaa*» or «*saa er*»

[25]See Morgenbladet (1835) and Den Constitutionelle (1836).
The newspaper *Morgenbladet* was established in 1819, and was until 1857 a substantial voice for the opposition against the establishment, both literary and political. It was also the first daily newspaper in Norway, and it exists now as a weekly newspaper with a liberal, radical and intellectual profile. *Den Constitutionelle* existed as a daily newspaper in Norway between 1836 and 1847. The idea was to establish a newspaper on a considerably higher intellectual level than *Morgenbladet*. *Den Constitutionelle* made high demands on the journalistic content, and it introduced daily editorials (Kunnskapsforlaget 2006).

HANSTEEN's book was 278 pages, which is a lot more than what is expected of a textbook in elementary geometry. The author is intentionally trying to tear down the walls that existed between the classical geometry and the newer analytical geometry and the infinitesimal geometry. The basis of the textbook is *real life*, with references to artifacts like corkscrews, stove pipes and hourglasses. The presentation of the subject matter is very unlike EUCLID*'s Elements*. The style is narrative, sometimes very lengthy, and there are many numerical examples (Piene 1937). HANSTEEN tried to expand EUCLID's definition of straight lines and of parallel lines, and EUCLID's fifth postulate (Euclid 1956). HOLMBOE, however, was firmly in agreement with LEGENDRE's understanding of parallelism, and he believed that he could prove EUCLID's fifth postulate. The core of the debate that followed was whether one in mathematics education should let utilitarian considerations overrule logical deduction and theoretical thinking. HANSTEEN declared that *proofs* should not be used in the elementary teaching before it was necessary for the students. This, he said, invited the students to memorizing without understanding. To this, HOLMBOE replied that you either have to prove all or nothing, as half a proof is worse than no proof. None of them probably knew the correct understanding of the theory of parallels, as it recently had been presented by LOBATSCHEWSKY and BOLYAI, strongly influenced by GAUSS (Holst 1911). The polemics has later been called the «dispute about parallelism».

HANSTEEN's textbook was published in one edition only, but one reason may be that it contained much subject matter outside the school curriculum.

HANSTEEN wrote a booklet (Hansteen 1836) titled «*Enlightenment of Mr. Professor B. Holmboe's review of my plane geometry, Morgenbladet no. 339, 5th of Dec. 1835*»[26], and it is dated 26th of December 1835. It is, in other words, written towards the end of the period the polemics was active in *Morgenbladet*. HOLMBOE's name appears only in the title, later he is only referred to as *the reviewer*. In addition to defending his own textbook, HANSTEEN also criticises HOLMBOE's arguments in the review, and he attacks HOLMBOE's textbook in geometry (Holmboe 1827).

HOLMBOE responded by writing a booklet titled «*Reflection provoked by Mr. Professor Hansteen's enlightenment of my review of his textbook in geometry, containing: 1) Defence of the review containing proofs collected by a continued review of his textbook. 2) Refutation of his attack on my textbook in mathematics*»[27], and this was dated the 8th of March 1836 (Holmboe 1836). It was written in the period between the two polemics in *Morgenbladet* and *Den Constitutionelle*. Throughout the booklet, HANSTEEN is referred to as *the author*. The better part of HOLMBOE's booklet is a defence against the attacks made by HANSTEEN on his textbooks, and HOLMBOE is constantly referring to LEGENDRE and his definitions.

5 Some concluding remarks

The first half of the 19th century was in many ways a breaking point for the higher education in mathematics in Norway. The position of mathematics as a school subject was strengthened through school reforms at the turn of the century, and the first uni-

[26]Belysning af Hr. Professor B. Holmboes Anmeldelse af min Plangeometrie, Morgenbladet No. 339, 5 Dec. 1835 .

[27]Gjenmæle fremkaldt ved Hr. Professor Hansteens Belysning af min Anmeldelse af hans Lærebog i Geometrien, indeholdende: 1) Forsvar for anmeldelsen med Beviser hentede ved en fortsat Recention over hans Lærebog. 2) Gjendrivelse af hans Angreb paa min Lærebog i Mathematiken.

versity was established in Norway in 1811. Bernt Michael Holmboe's textbooks in mathematics were the ones that were predominantly used in the learned schools at that time. His textbooks were, however, not without opposition. The core of this opposition was the use of *proofs* in elementary mathematics, and whether the introduction of geometry should be in a traditional Euclidean way using logical deductions and theoretical thinking – as in the case of Holmboe – versus a more «informal» way using everyday language and terms.

I hope that an analysis of these books, and the responses they caused, may help to give an understanding of the development of mathematics education and the didactical debate in this period.

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