THE ANALYSIS OF THE NORWEGIAN AND INDONESIAN MATHEMATICS CURRICULUM MODEL

Trimurtini, Iwan Junaedi
Universitas Negeri Semarang
E-mail: trimurtini3unnes@students.unnes.ac.id

Abstract: This analysis of Norwegian mathematics curriculum development showed that it employed the Taba model consisting of several stages. The researchers focused on the learning process established over a certain period. The subject curriculum is regulated by laws and regulations; and contains accomplishment goals that must be met by students. In all education levels, i.e., elementary school, lower secondary school, and upper secondary or vocational school, the scope of mathematics materials is integrated with the five basic math skills (speaking, writing, reading, numeracy, and digital skills). These entire skills are realized in the competence goals at every level. In addition, the ability to solve mathematical problems, which is accelerated by the use of digital tools, is emphasized as a form of habituation for students to understand and critically assess quantitative information, statistical analysis, and economic forecast. Meanwhile, Indonesia's curriculum development manifested in the Merdeka curriculum; mathematics learning points out five elements of process and materials. The two types of elements are complementary; a flow of understanding through mental activities leads to achieving a flow of understanding of mathematics learning materials in the form of facts, concepts, principles, operations, relations, problems, and specific formal-universal mathematical solutions.

Keywords: mathematics curriculum, Taba model, Norwegian school, Merdeka curriculum

Introduction

Norway is located on the western tip of the Scandinavian Peninsula, bordered by Sweden, Finland, and Russia. It has a strong economic and welfare system and is one of the world's highest spending countries on education. Every child aged 6 to 16 years gets compulsory education at schools. All public schools are free for all students, covering basic (7 years) and secondary (3 years) education, this ensures education for all applies in Norway [1].

The Norwegian curriculum is a government national document explaining the basic values, cultural elements, and learning objectives of primary and secondary education. This curriculum is enshrined in the Education Act, to be relevant to anyone in charge of education planners and providers. The Norwegian national curriculum includes curricula for core subjects, i.e., subjects studied at the elementary, lower secondary, and upper secondary school levels, as well as subject curriculum programs for general and vocational programs at the upper secondary level. The Ministry of Education and Research establishes and revises the curriculum for core subjects at the primary and lower secondary levels. Meanwhile, the Directorate of Education and Training is in charge of regulating or revising the curriculum for subjects at the upper secondary level. Mathematics is one of the core subjects at all stages.

Norway has a favorable mathematics achievement. The 2015 TIMMS showed that four graders' average mathematics achievement was 549 with a 2.5 deviation standard, ranked the eighth around the world. Singapore, on the other hand, placed first with 618 and a 3.8 deviation standard. For students in the eighth grade, the average mathematics achievement was 512 with a 2.3 deviation standard or ranked the fourteenth. Singapore, again, ranked first with 621 and a 3.2 deviation standard. Indonesia has only reached an average of 397 and a standard deviation of 3.7, under the TIMMS average (500).

The current (2013-2021) Norway's mathematics curriculum comprises six components; objectives, main subject area, teaching hours, basic skills, competence goals, and assessment, which are presented systematically. Mathematics, as a part of global cultural heritage, is always used by men in expressing and understanding the relationship between nature and society. Another source of inspiration in the development of mathematics curriculum is the strong math skill needed in other fields like medical, economics, technology, communication, management, energy, and construction.

The aim of developing the Norwegian mathematics curriculum is to provide citizens with the habit of understanding and critically assessing quantitative information, statistical analysis, and economic forecasts. On the other hand, Indonesia's curriculum advanced as time progressed and current conditions. Through the Decree of the Minister of Education, Research, and Technology Number 262/M/2022, the Merdeka Curriculum is implemented at the early, elementary, and secondary education levels whose structure prioritizes intracurricular learning and a project of strengthening Pancasila student profile.

Discussion

This study analyzed the development of the Norwegian mathematics curriculum using the Taba model, which focused on the developed learning process at a particular time including six stages (Läänemets & Kalamees-Ruubel, 2013). The importance of curriculum development implicated the construction, adaptation, and redesign of curriculum materials [3]. The first step is needs analysis. As for Norway, several basics of curriculum development shall pay attention to (1) all parties related to education like students, parents, teachers, and schools; (2) values of mathematics as a global heritage depicting the relationship between nature and society; (3) correlation between mathematics and other disciplines like the medical, economy, technology, communication, management, energy, and construction. The needs and upturn of the era have become a point of reference for the next step, which is the formulation of curriculum objectives.

The objectives of the mathematics curriculum are written explicitly to achieve mathematics skills, i.e., problem-solving and modeling. These two skills enable students to analyze and transform a problem into mathematical forms, solve it, and assess the validity of the solution. Other than that, language is emphasized as it plays an essential role in the process of achieving the goals, that is to communicate, speak, and comprehend. This made students aware and practice their language as a tool for advanced thinking processes in solving problems [4]. These aspects are embodied in the five basic competences-that every learner has to master, including oral, writing, reading, numeracy, and digital skills [1].

Mathematics has been fundamental for much of the history of culture and the development of logical thinking. Mathematics subjects contribute to the development of mathematical competences needed by individuals and society. To achieve this, students are allowed to learn both theoretically and practically in creative activities like exploration, problem-solving, and skills training. Every mathematical activity requires props and technology; therefore, it is necessary to know about how its usefulness and to evaluate the benefits and limitations of their use in mathematics learning activities.

Norway's education system comprises elementary school (*Barneskole),* lower secondary school (*Ungdomsskole),* and upper secondary school (*Videregåendeskole)* in which mathematics scope is formulated respectively. In the first to fourth grade, the scope of materials includes numbers, geometry, measurement, and statistics (in 560 lesson hours), the fifth to seventh-grade materials cover numbers, algebra, measurement, statistics, and probability (in 328 lesson hours), and the eighth to tenth-grade materials include numbers and algebra, geometry, measurement, statistics, probability and combinatoric functions (in 313 lesson hours). At the higher level, four types of secondary and vocational schools consist of 1T, 1P, 1T-Y, and 1P-Y. The 1T and 1P have the same scope of numbers, algebra, geometry, probability, and function, yet 1P receives supplementary materials about economics. The 1T-Y's scope of the material is numbers and algebra, geometry and functions, and 1P-Y learns about numbers and algebra, geometry and economics. For the vocational level, the hours of mathematics lessons range from 84 to 140 hours of lessons.

The indicators of numbers and algebra focus on the development of an understanding of numbers and insight into how numbers are processed into systems and patterns. The topics of numbers include integers, fractions, decimals, and percentages. On the other hand, Algebra provides an opportunity to describe and analyze patterns and relationships. Algebra is also useful in geometry and functions.

The geometry lesson discusses the properties of two- and three-dimensional geometry along with its construction and measurement. One should study dynamic processes such as reflection, rotation, and translation which also include describing location and movement within grids, maps, and coordinate systems.

Measurement means comparing and relating a measure to an object or quantity. This process requires the use of measurement units, techniques, tools, and formulas. An essential part of the measurement process is assessing the results and discussing the uncertainty. Meanwhile, the statistics include planning, collecting, organizing, analyzing, and presenting data. In data analysis, it is necessary to describe the data's general condition. Assessing and examining critically the conclusions and data presentation is essential during this process. Moreover, the probability is about the chance that an event will occur. While in combinatoric materials, someone works systematically to compute the possible outcomes to be able to calculate the probability.

A function describes the change or development of one measure that is dependent on another, in a unique way. Functions can be expressed in several ways, for example by formulas, tables, and graphs. The functional analysis involves looking for special traits, such as how quickly development occurs, and when development acquires special value.

The scope of the economics lesson is on calculations and assessments applied to financial matters. Economics is given at the upper secondary level.

The mathematics curriculum framework emphasizes five basic skills integrated into the objectives. These basic skills have contributed to the development and are part of professional competence. These basic skills are as follows:

1. Mathematics speaking skills, involving the creation of meaning through listening and speaking activities about mathematics, such as asking opinions, and questions and debating in discussions.
2. Mathematics writing skills, consisting of describing and explaining ways of thinking, word choice in expressing discoveries and ideas, and creating pictures, sketches, graphs, and tables. This activity uses symbols and formal mathematical language to solve problems.
3. Mathematics reading skills, including the understanding and using of symbolic language and forms of expression to create meaning in mathematical texts from everyday life as well as professional life. Reading involves the process of sorting information, analyzing, evaluating form and content, and summarizing information from various parts of the text.
4. Numeracy skills, connoting the use of symbolic language, mathematical concepts, varied procedures and strategies to solve issues and explore based on practical everyday situations and mathematical problems.
5. Digital skills, involving the use of digital tools for learning through games, exploration, visualization, and presentation. Being digitally skilled means knowing, using, and evaluating digital tools for calculation, problem-solving, simulation, and modeling. Additionally, mastering such skills means knowing the appropriate digital tools to find information, analyze, process, and present data and be critical of sources, analyses and results.

Furthermore, achievement targets are set in the target competences starting from grade 2, grade 4, grade 7, grade 10, and upper or vocational classes of 1T, 1P, 1T-Y, and 1P-Y. The description of target competences cannot be separated from the scope of mathematics at each level by taking into account the five basic skills. Table 1 describes the competences achieved at the elementary and lower secondary levels.

Table 1. Target Competence of Mathematics for Elementary and Lower Secondary School (https://www.udir.no/kl06/MAT1-04)

Class	Competence
2	**Numbers** Students could: • count to 100, create, and decipher numbers up to >10, breaking down numbers from one to hundreds; • use the number line to perform arithmetic operations and represent specific numbers; • estimate the result of addition, count, compare, and write numbers in various ways; • develop, use, and discuss several arithmetic strategies in addition and subtraction of two-digit numbers and rate the estimated results; • multiply by two and divide by two; • identify, discuss, and continue a simple pattern of numbers. **Geometry** Students could • recognize and describe the properties of plane and solid geometry related to side, angle, and surface; sort and name shapes based on the properties; • identify, use, and discuss symmetrical reflection in practical situations; • create and explore geometry patterns with or without digital tools and describe them orally. **Measurement** Students could: • compute and compare measures implemented through length and area using both standard and non-standard units, describe and discuss the results; • name the day, month, and time in simple terms; • recognize Norwegian coins up to 100 and use them to sell and buy. **Statistics** Students could:

Class	Competence
	• gather, sort, record, and present data with tabulation, table, and bar diagram, and discuss the data processing as well as presentation.
4	**Numbers** Students could: • describe and use values in integers, use positive and negative integers, simple fractions and decimals in a practical context, and present numbers with shapes; • use estimates and determine calculation results, measure materials and write medical records, create estimates and evaluate answers; • develop, use and discuss either written or in-mind calculation methods for addition, and subtraction of numbers consisting of several digits; • develop and adopt several methods of multiplication and division, also use them in a practical situation through multiplication table to solve issues; • discover information in texts or practical contexts, choose the type of calculation based on choices given, use knowledge tables and take advantage of the interrelationship between types of arithmetic operations, evaluate the results of calculations and present the solutions; • recognize, experiment, describe, and continue number patterns; • use mathematical symbols and express the mathematical connection in the problem-solving process. **Geometry** Students could: • recognize and describe the characteristics of circle, polygon, sphere, cylinders, and polyhedra; • draw, make, explore and describe geometric shapes and model them in a practical context including technology and design; • recognize, use, and describe symmetrical reflection and translation in particular situations; • create and explore geometric patterns and describe them orally; • read, place, and describe a position on a grid, map, and coordinate system, with or without digital tools. **Measurement** Students could: • arrange estimates from the measurement results of length, area, volume, temperature, time, and angle, talk about the results and evaluate the results' rationality; • apply non-standard measurement units and explain the measurement purpose with standard units and use conversions between standard units; • compare measures using suitable measuring tools and simple calculations, present results, and evaluate them; • solve practical problems in terms of sales, purchases, and accounts payable. **Statistics** Students could: • gather, sort, record, and present data accurately along with the calculation on tables or bar charts, with or without measurement tools, and discuss the process and results.
7	**Numbers and Algebra** Students could: • describe and use place values in decimals, positive and negative integers, decimal numbers, fractions, and percentages and assign different amounts to numbers;

Class	Competence
	• name fractions and present addition, subtraction, and multiplication of fractions; • develop, use, and discuss methods for mental arithmetics, estimate and write arithmetics, and use digital tools in calculation; • describe systems and notations used for formulas and use them, perform calculations and present them; • find out information in texts or practical contexts, organize and explain calculations and procedures, evaluate, present, and discuss the results; • explore and describe structures, transform geometric and number patterns with pictures, words and formulas; • prepare and solve simple equations, complete and calculate addition, subtraction, and multiplication. **Geometry** Students could: • analyze the characteristics of the plane and solid geometry, describe physical objects in everyday life and the use of technology; • construct a solid geometry model, draw perspectives by dots, and discuss either the process or results; • describe and make use of reflection, rotation, and translation; • describe locations and shifts on grids, map, and coordinate systems with or without digital tools, and use coordinates to calculate distances. **Measurements** Students could: • choose the appropriate measurement tools, practice measurements in everyday life, use technology, and evaluate results based on the accuracy and uncertainty of measurements; • use approximate measurements and results of measurements of length, area, mass, volume, angle, and time, use time intervals in simple calculations, discuss results, and evaluate them; • choose the right measurement and convert between standard units of measurement; • explain the structure of measuring length, area, and volume, calculate the circumference, area, surface area, and volume of two-dimensional and three-dimensional shapes; • employ measuring tools to compute distances, create and talk about the map and draw with or without digital tools; • adopt condition on practical contexts, calculate velocity, and convert. **Statistics and Probability** Students could: • plan and collects data concerning observation, survey, and experiment; • present data on tables and diagrams generated with or without digital tools, read, interpret, and evaluate data usage; • determine the median, mode and mean of simple data, evaluate data centers and the relationships between them; • assess and discuss the change in daily life contexts, games, and experiments, and enumerate the probability of the modest situation.
10	**Numbers and Algebra** Students could: • compare and recalculate integers, decimals, fractions, percents, per mile, and standardized numbers, present them in multiple ways, and evaluate the appropriate situation with different

Class	Competence
	representations; • compute fractions, determine the division of fractions, and simplify forms of fractions; • use fractions, powers, square roots, and prime numbers in calculations; • develop, use, and calculate using different computation methods, estimate calculations, and write down four types of calculations; • process, factorize, and simplify algebraic forms, connect formulas in a practical situation, calculate formulas, recognize brackets and fractional forms, and use the power-of-two equation; • complete equations and inequalities to the first power and linear equation systems of two variables and use them to solve practical and theoretical issues; • perform calculations on consumption, income, loans, and savings, use credit cards, manage expenses and accounts using spreadsheets, and present results; • analyze the combination of problems, identify the value of variables, connect the combination of problems to find out methods of finding solutions, and present calculation results appropriately; • use numbers and variables in exploratory, experimental, practical, and theoretical problem solving, and in projects with or without technology and design. **Geometry** Students could: • investigate and describe the properties of plane and solid geometry as well as their relation with construction and calculation; • present, describe, and construct basic geometry using a ruler and dynamic geometry program; • use and give reasons for using Pythagorean equations and theory in calculations; • interpret and create multiple-point image creation and perspective drawings with or without digital tools; • use coordinates to draw plane figures, explore the properties of geometric shapes and deal with geometric conditions that have had a profound influence on technology, art, and architecture. **Measurement** Students could: • estimate and compute length, circumference, angle, area and surface area, volume, time, velocity, mass, and use scale change; • select the appropriate units of measurement, explain the relationship and recalculation between different units, use and evaluate measurement tools and methods in practice, and discuss the accuracy and uncertainty of measurement; • calculate the number of π and use it in measuring the perimeter and area and volume. **Statistics, Probability, and Combinatory** Students could: • perform databased survey to seek for and analyze statistical data, and notice critics towards sources; • organize and classify data, determine and discuss median, mode, mean, and range of variation, presentation of data with or without digital tools and discuss different data presentations and impressions that can be addressed; • find and discuss probability through experiments, simulations,

Class	Competence
	and calculations on daily life context and game; • describe results and present probability as fractions, percentages, and decimals; • discuss and complete simple combinatory problems. **Function** Students could: • create functions depicting the numerical relationships and practical situations with or without digital tools, describe, interpret, and translate between the different functions of representation like graphs, tables, functions, and texts; • identify and make use of properties of the proportional, inverse, linear function, and square, and give examples of practical conditions describing the functions.

In addition to the scope of the materials that have been organized at each grade and school level, curriculum development continues with the selection of learning activities. However, the Norwegian curriculum document of mathematics learning activities is not an exceptional section, yet presented in the curriculum objectives. Mathematics learning activities allow students to learn both theoretically and practically through exploring, creative playing, problem-solving activities, and honing skills. Every mathematical activity requires props and technology. Several studies showed that technology has a positive impact on learning mathematics, especially in elementary schools, if used with a constructivist approach [5]. The use of mathematical manipulatives can link representational and abstract ideas in mathematics to help students deeply understand the mathematics they are learning and the need to apply it to daily lives [6].

In terms of the learning activities management, students are expected to be challenged to communicate mathematics in writing, verbally, and digitally. Arrangements are made for girls and boys to gain a rich experience in mathematics, which can create positive attitudes and solid subject competences. In this way, the foundation is laid for lifelong learning.

The final stage of curriculum development is an assessment that contains the final assessment guide. The final evaluation is not carried out at every school level but is only performed at the end of grade 10 (elementary and lower secondary school) and grade 13 (upper secondary or vocational school). This final form of assessment comprises two forms; a written exam and an oral exam. Following the laws and regulations that apply, the exam can be prepared centrally or locally. Everything is regulated in laws and regulations named the Education Law.

Mathematics, in Indonesia, is defined as knowledge about logical learning or thinking needed by humans to live with the development of modern technology. In the Merdeka Curriculum document, mathematics is seen as a material and a conceptual tool to construct and reconstruct the materials to hone and train the thinking skills needed to solve problems. Mathematics subject for students is about ways of thinking, reasoning, and logic through particular mental activities that form a plot to think about it. The end is the formation of a mathematical understanding in the form of concepts, principles, operations, relations, and specific formal-universal mathematical solutions. This mental process can strengthen the position of students to sense the meaning and benefits of mathematics and moral values in studying it. Furthermore, its relevance to the Pancasila student profile points out at development of independence, critical reasoning abilities, and creativity.

Mathematics materials at every level of education are packaged into several fields of study, including numbers, algebra, measurement, geometry, data analysis, and probability. At the same time, calculus is added to class XI and XII only. According to the Merdeka curriculum, mathematics comprises content and process element. The content element consists of learning materials that students must understand and are related to the formation of a flow of understanding in the form of facts, concepts, principles, operations, and formal-universal relations. The description of the content is explained in table 2 (from the curriculum document on page 134; Description of Elements).

Table 2. The Element of Content in Mathematics Subject (*Keputusan Kepala Badan Standar, Kurikulum, dan Asesmen Pendidikan kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi Nomor 033/H/KR/2022*)

Element	Description
Numbers	This element discusses numbers as symbols, concepts, operations, and the relationship between various number operations in sub-elements of visual representation, the nature

	of sequences, and operations.
Algebra	Algebra discusses non-formal (image symbols) to formal algebra (letter symbols) representing specific numbers in the sub-elements of equations and inequalities, relations and number patterns, and ratios and proportions.
Measurement	Measurement discusses measurement quantities, how to measure specific quantities, and proving principles or theorems related to particular quantities in geometric and non-geometric measurement sub-elements.
Geometry	Geometry studies various forms of flat and spatial shapes in both Euclidean and Non-Euclidean, as well as their characteristics in the sub-elements of flat geometry and spatial geometry.
Data analysis and probability	Data Analysis and Probability discuss the notion of data, types of data, data processing in various forms of representation, and quantitative data analysis related to the centralization and distribution as well as the probability for the emergence of specific data or events in sub-elements of data and their representations, uncertainties, and probability.
Calculus (optional for grade XI and XII)	Calculus deals with the instantaneous rate of change of a continuous function and cover the topics of limits, differentials, and integrals and their uses.

The achievement of learning mathematics is divided into several phases, from phase A for grade I and grade II elementary schools, phase B for grades III and IV, and phase C for grades V and VI. As for junior high school, grades VII, VIII, and IX are in phase D, grade X in phase E, and phase F in grade XI and XII.

In addition to the content element in the Merdeka Curriculum, the process element is also elucidated. It relates to mental activities that form the flow of thinking and understanding to develop skills. The element of process includes mathematical imitation and proof, mathematical problem-solving, communication, mathematical representation, and mathematical connections.

Conclusion

Considering the development background and development process with the Taba model in Norwegian mathematics, this type of curriculum development refers to a problem-centered design where students obtain experience in solving everyday problems or in a professional context. In addition, the basic skills established in mathematics lessons (oral skills, writing, reading, numeracy, and digital skills) allow students to earn skills useful in their real-life context to face the challenges of the times. Indonesia's curriculum development manifested in the Merdeka curriculum; mathematics learning points out five elements of process and materials. The two types of elements are complementary; a flow of understanding through mental activities leads to achieving a flow of understanding of mathematics learning materials in the form of facts, concepts, principles, operations, relations, problems, and specific formal-universal mathematical solutions.

References

1. A Guide to Curriculum Development https://www.udir.no/in-english/a-guide-to-curriculum-development/
2. H. J. Braathe and A. M. Otterstad, “Education for All in Norway : Unpacking Quality and Equity,” *Procedia - Soc. Behav. Sci.*, vol. 116, no. 1877, pp. 1193–1200, 2014, doi: 10.1016/j.sbspro.2014.01.368.
3. U. LÄÄNEMETS and K. KALAMEES-RUUBEL, “The Taba-Tyler Rationales,” *J. Am. Assoc. Advacement Curric. Stud.*, vol. 9, pp. 1–12, 2013.
4. E. Tronsmo and M. Nerland, “Local curriculum development as object construction : A sociomaterial analysis,” *Teach. Teach. Educ.*, vol. 72, pp. 33–43, 2018, doi: 10.1016/j.tate.2018.02.008.
5. A. Hansen, “Basic conceptual systems (BCSs) – tools for analytic coding , thinking and learning : A concept teaching curriculum in Norway ☪,” *Think. Ski. Creat.*, vol. 4, pp. 160–169, 2009, doi: 10.1016/j.tsc.2009.09.001.
6. J. Hardman, “Towards a pedagogical model of teaching with ICTs for mathematics attainment in primary school: A review of studies 2008–2018,” *Heliyon*, vol. 5, no. 5, p. e01726, 2019,

doi: 10.1016/j.heliyon.2019.e01726.
7. J. M. Furner and N. L. Worrell, "The Importance of Using Manipulatives in Teaching Math Today," *Transformations*, vol. 3, no. 1, 2017.