Structure of Primary Mathematics Teacher Education Programs in Spain

María C. Cañadas, mconsu@ugr.es

Pedro Gómez, argeifontes@gmail.com

Luis Rico, lrico@ugr.es

University of Granada

Abstract

Spain is one of the countries involved in TEDS-M 2008. In this paper we explore and describe the structure of Spanish primary mathematics teacher education programs, through syllabi analysis in the 48 sampled institutions. The results show that Spanish teacher education programs are diverse across institutions, but follow a basic structure that emphasizes the teaching of general pedagogy subjects.

Keywords: *education programs, TEDS-M, primary mathematics teacher, syllabi analysis, Spain.*

Introduction

TEDS-M 2008 is an international comparative study of teacher education with a focus on the preparation of teachers of mathematics at the primary and lower secondary levels. It is the first cross-national assessment of learning outcomes in higher education using representative national samples; there were 16 participant countries in TEDS-M (TEDS-M, 2009).

The study focus on three general components (Tatto, Schwille, Senk, Ingvarson, Peck, & Rowley, 2008, p.13):

- Studies of teacher education policy, schooling, and social contexts at the national level.
- Studies of primary and lower secondary mathematics teacher education routes, institutions, programs, standards, and expectations for teacher learning.
- Studies of the mathematics and related teaching knowledge of future primary and lower secondary school mathematics teachers.

Syllabi analysis is part of the second component. This component includes studies of primary and lower secondary teacher education routes, institutions, programs, standards and expectations for teacher learning. TIMMS and PISA studies “revealed extensive insight into the conditions for learning successes and failures of students in elementary and middle school. What is presently lacking is insight into the quality of their teaching" (Schmidt, Tatto, Bankov, Blömeke, Cedillo, Cogan, & et al., 2007, p. 10). In this paper we focus on the quality of training from the perspective of the analysis of the teaching programs.

Understanding and describing course structure is crucial for explaining future teachers' learning outcomes and hence for approaching one of the main questions of TEDS-M 2008: "What are the characteristics of teacher education policies, institutions and programs that lead to high levels of mathematics knowledge and knowledge of mathematics pedagogy in future teachers?" (Tatto et al., 2008, p.14).

The purposes of this paper are to propose a methodological approach for syllabi analysis in TEDS-M and to explore and describe the structure of the Spanish training programs. The analysis of this structure provides information about the Spanish core curriculum of primary mathematics teacher education programs. We consider that core curriculum is constituted by contents that are taught in most of the sampled institutions.

TEDS-M is an original study in Spain and its results are especially relevant given the work that is currently being done for adapting primary teacher degree to the European Higher Education Area.

In what follows, we first present the framework for the syllabi analysis that we performed and the methodological framework of the study. Next, we show the results that emerged from the descriptive and the statistical analyses performed. Finally, we interpret those results.

Syllabi Analysis

The literature on syllabi analysis is scarce (Eberly, Newton & Wiggins, 2001). Some studies have used syllabi for evaluative purposes, comparing them to some standard such as job requirements (Gilbert, 2006; Kousha & Thelwall, 2008) or the norms of a general education committee (Eberly et al., 2001). Other studies have analyzed some particular aspect of syllabi such as course content and assessment techniques (Hrycaj, 2006; Stapleton & Leite, 2005) or the teaching of new concepts (Kerr, Patti, & Chien, 2004). The purposes and expected content of a syllabus have also been described in detail (Johnson, 2006; Parkes & Harris, 2002). The content of these documents usually include references to learning goals, content, teaching methodology and assessment techniques and criteria.

TEDS-M considers three levels for curriculum analysis at primary and secondary education: (a) national/provincial/state, concerning the national, provincial or state requirements, (b) institutional level, and (c) educators' syllabi level. We approach Spain's syllabi analysis by focusing on the established content dimension of curriculum in educators' syllabi.

Content subjects organize the matter of a syllabus. In a previous smaller study, the MT21, Schmidt, et al. (2007) focused on the subjects that were related to the teaching and learning of mathematics in middle school teacher training programs (p. 3). Adapting this structure to the overall objective of TEDS-M, the conceptual framework of the study structures future teachers' knowledge in different knowledge domains. We consider four knowledge domains: (a) school mathematics, (b) advanced mathematics, (c) general pedagogy, and (d) mathematics pedagogy.

The study MT21 identifies a set of subjects for each domain. The first version of school mathematics subjects was developed for TIMSS in 1995 (Schmidt, Mcknight, Houang, Wang, Wiley, & et al, 2001). TEDS-M adopted the TIMMS 2007 framework (Mullis, Martin, Ruddock, O'Sullivan, Arora, & Erberber, 2007), which has been revised for MT21 and validated for TEDS-M 2008. For instance, school mathematics knowledge domain was hierarchically organized through the following subjects: number, measurement, geometry, functions, relations, and equations (algebra), data representation, probability, and statistics, elementary analysis, validation and structure and other school mathematics. In turn each subject was subdivided into topics. For example, the number subject includes: (a) whole numbers, (b) fractions and decimals, (c) integer, rational and real numbers, (d) other numbers, number concepts and number theory, (e) estimation and number sense concepts, and (f) ratio and proportionality.

Advanced mathematics subjects were developed from the traditional areas of pure mathematics. These subjects were internationally agreed and were not subdivided into topics.

Experts who took part in TEDS-M developed general pedagogy and mathematics pedagogy subjects. These subjects were discussed and revised and the final hierarchically organized list was internationally agreed.

The subjects for general pedagogy were: history of education and educational systems, educational psychology, philosophy of education, sociology of education, introduction to education or theories of schools, principles of instruction, methods of educational research, classroom management, assessment and measurement theory, counseling, advising students, and pastoral care, instructional media and operation, and practical knowledge of teaching. Some of these subjects were divided into topics as well. For example: (a) characteristics of development and international systems (not your country), and (b) historical development of the national system are the topics of history of educational and educational systems.

The subjects for mathematics pedagogy were: theories/models of mathematics ability and thinking, nature and development of mathematics ability and thinking, aspects of mathematical ability and thinking, mathematical problems and solutions, mathematics instruction, developing teaching plans, analyzing/observing/reflecting on mathematics teaching, knowledge of mathematics standards and curriculum, studying and selecting textbooks and instructional materials, methods of presenting main mathematics concepts, foundations of mathematics, context of mathematics pedagogy, and affective issues. For example: (a) analyze problems, (b) problem posing, and (c) solving problems describe the mathematical problems and solutions subject.

A total of 176 subjects and topics of school mathematics, advanced mathematics, general pedagogy and mathematics pedagogy knowledge domains were identified. All the subjects and topics are collected in the appendix with an indicative number that will be used as reference in what follows.

Considering this general framework, in this paper, we search for partial answers to one of the questions considered in TEDS-M Study (Tatto et al., 2008, p. 30): "What knowledge of mathematics, pedagogy and mathematics pedagogy do the participating countries expect their future teachers to acquire?", by considering two specific research questions: (a) What kind of contents is more and less strongly considered by Spanish primary teachers training programs?, and (b) Are there any differences among Spanish institutions? If there are differences, how can they be characterized?

Methodology

Institutions were randomly selected on each of the 16 participant countries for TEDS-M, with a maximum of 50 institutions per country. In Spain, 50 institutions of state and private universities were selected for TEDS-M; 48 of them finally participated.

Following TEDS-M indications, we collected all the required syllabi and the syllabi of non-compulsory courses that were taken by at least 50% of primary future teachers of the knowledge domains considered in TEDS-M. We finally got around 1,800 documents for the Spanish syllabi analysis.

A two valued variable was defined for each of the subjects and topics. Each syllabus was coded for each variable depending on whether the corresponding subject or topic appeared or not in the syllabus. Syllabi coding was performed dividing each syllabus into smaller blocks of information, to which codes were assigned. This coding process allowed us to establish which subjects were included in at least one syllabus of each sampled institution. At this point, we can reformulate the research questions as follows: (a) what are the subjects that appear more frequently in Spanish programs? To which knowledge domains do they belong to? And (b) how can Spain's teacher training programs be characterized in terms of the subjects included in their syllabi?

Data Analysis

In order to use descriptive statistic analysis, we produced a new set of quantitative variables, based on the previous variables emerging from the coding procedure. Each of these new variables represents a subject (e.g., number, philosophy of education, developing teaching plans).

We determined that the quantitative variables for each institution represent the number of topics identified on each of the main subjects that are taught in, at least, one program of such institution. For instance, if in a given institution, for the number subject, there are programs in which (a) whole numbers, and (b) fractions and decimals appear (and there are other four topics that do not appear), then the variable number has value 2 for this institution.

As a first approach to the description of Spanish programs, we established, for each knowledge domain, the percentages of subjects taught in different numbers of institutions and identified the subjects that are taught in few and most institutions. In a second analysis, we looked, for each knowledge domain, at the distributions of the number of institutions teaching different number of subjects. We performed a third analysis based on the variability of subjects in Spanish's training programs across institutions. For this, we compared the coefficients of variation of all the subjects considered, grouped by knowledge domains. Finally, we performed a factor analysis on the quantitative variables mentioned above. Factor analysis was performed using principal components, with Eigen values greater than 1, with a maximum of 30 iterations for convergence, and with a varimax rotation.

Results

In what follows, we present the results of the analyses mentioned above.

Percentage of Topics Taught in a Percentage of Institutions

We show in Figure 1 the percentage of topics taught in a given proportion of institutions, organizing the data by knowledge domains. For instance, we see in Figure 1 that there are about 55% of advanced mathematics topics that are not taught in any of the sampled institutions.

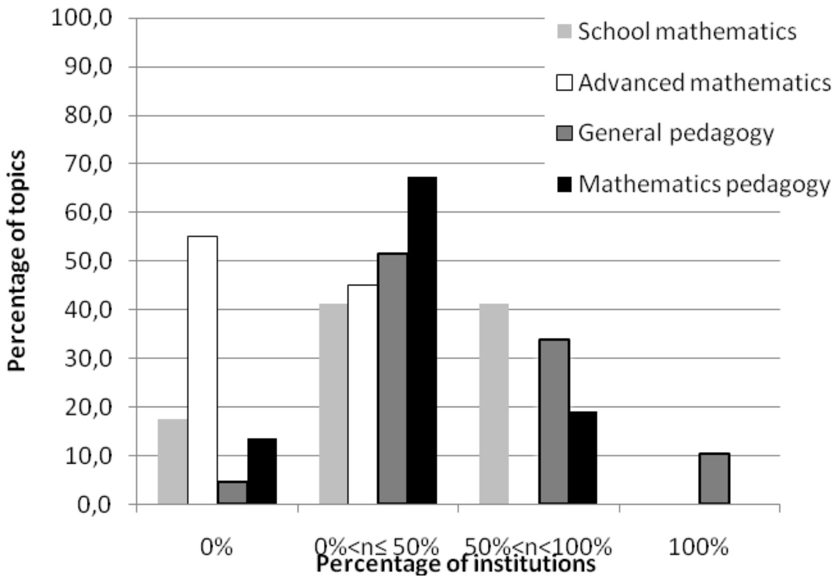

Figure 1: Percentage of topics taught

Results in Figure 1 help us to determine the Spanish core curriculum, which will be constituted by the subjects and topics that are taught in more than 50% of the sampled institutions.

First of all, it is clear that general pedagogy topics are predominant in Spanish's training programs. As we can observe in Figure 1, general pedagogy topics are the most frequent topics taught in more than half of the institutions. They are predominant in all the sampled institutions about 10% of pedagogy topics are taught. This is the only kind of topics taught in 100% of the institutions and 43% of these topics are part of the core curriculum.

On the other hand, advanced mathematics topics are not usual in Spanish institutions, as expected for primary teacher education. More than 50% of these topics are not taught in any institution and the rest of them are taught in less than half of the institutions. These results show that there is no agreement among Spanish institutions concerning a core curriculum for advanced mathematics subjects

Topics of school mathematics seem to be irregularly distributed across institutions. There are nearly 20% of the school mathematics topics that are not taught in any of the institutions, a few more than 40% of the topics of this knowledge domain are taught in less than 50% of the institutions, and another 40% are taught in more than half of the institutions. The topics of this knowledge domain can be considered part of Spanish core curriculum.

No institution teaches more than 10% of mathematics pedagogy topics, nearly 70% of them are taught in less than a half of the institutions, and less than 20% of these topics are taught in more than 50% of the institutions.

To summarize, 40% of the school mathematics, 43% of the general pedagogy, and 18% of the mathematics pedagogy topics are included in the syllabi of more than a half of the Spanish sampled institutions. Therefore, these groups of topics from school mathematics, general pedagogy, and mathematics pedagogy knowledge domains will be considered in this paper as the Spanish core curriculum for primary mathematics teacher training.

Frequency of Institutions by Number of Topics Taught

Focusing our attention on the three knowledge domains that are relevant for Spanish core curriculum (school mathematics, general pedagogy and mathematics pedagogy), we now look in more detail at how many institutions teach a given number of topics. This way of observing the data provides us a more detailed and complementary perspective of the structure of the programs by knowledge domains.

In Figure 2 through 4 we show, for each knowledge domain, the number of institutions teaching a range of topics. For instance, Figure 2 shows that there are 8 institutions where 12 school mathematics topics are taught.

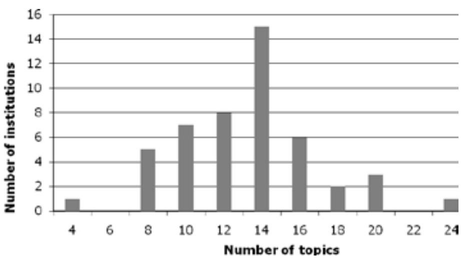

Figure 2: School mathematics

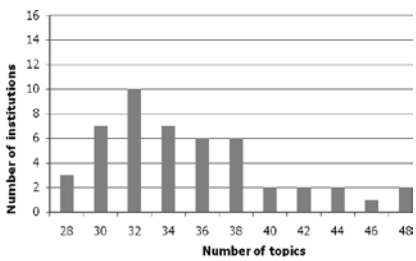

Figure 3: General pedagogy

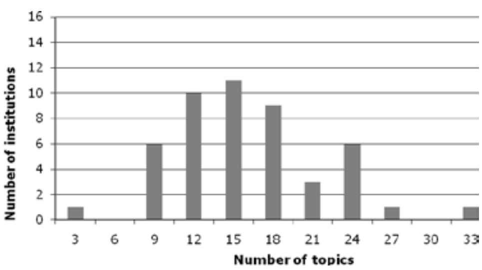

Figure 4: Mathematics pedagogy

These results show that most institutions tend to teach a range of number of topics for each knowledge domain. Figure 2 shows that 85% (41 of 48) of the institutions teach between 8 and 16 school mathematics topics. In the case of general pedagogy topics, Figure 3 shows that 75% (36 of 48) of the institutions teach between 30 and 38 of them. Figure 4 shows that 94% of the institutions teach between 9 and 24 mathematics pedagogy topics.

Even though previous observations indicate that there is some structure in Spanish's programs, there are institutions that teach substantial higher or lower number of subjects. We highlight that the mathematics pedagogy knowledge domain is taught with a wider range of topics than the other two knowledge domains (see Figure 4). We observe a substantial variability in mathematics pedagogy topics across institutions.

These first two descriptive approaches seem to show variability and structure across Spanish institutions, from the knowledge domains perspective. We now focus our statistics analysis on subjects and their topics.

Variability of Spanish' Training Programs

In order to measure the variability of subjects across institutions, we calculated their coefficients of variation. For this, we had to exclude two mathematics pedagogy subjects that had the value 0 in all the institutions: (a) teories/models of mathematics ability and thinking (Mogens Niss, Van Hiele, Kruteskii, Skemp, etc.), and (b) developing teaching plans (mathematics). These subjects obviously had no variability across institutions.

Figure 5 shows the coefficients of variation of the subjects, grouped by knowledge domains. We represent these coefficients in Y axis and the number that identify the subjects on X axis[1].

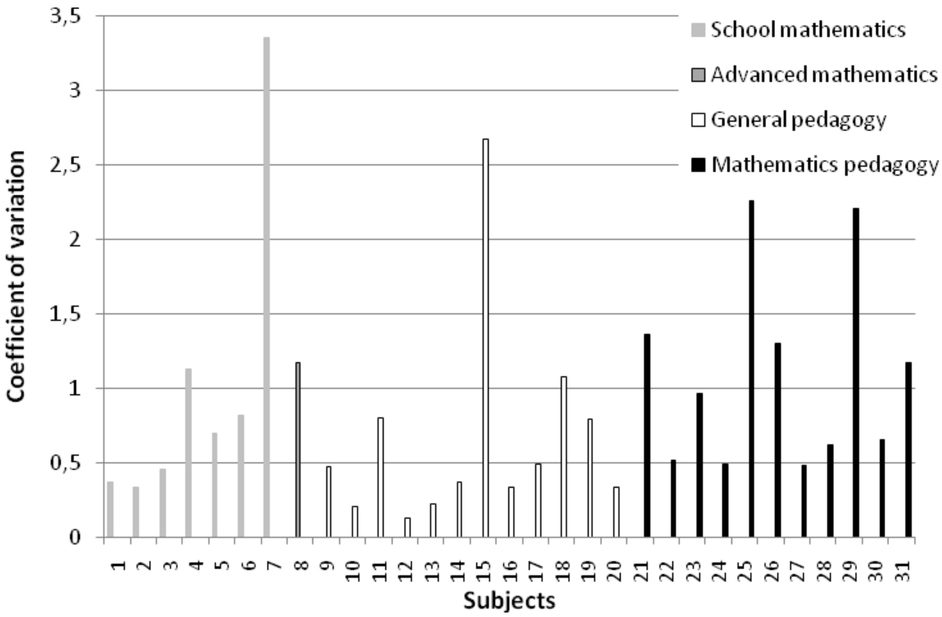

Figure 5: Coefficients of variation of the subjects grouped by knowledge domains

[1] As we mentioned before, we present subjects corresponding to these numbers in the appendix.

As we can observe in Figure 5, subjects 7 (validation & structure), 15 (methods of educational research), 25 (analyzing/observing/reflecting on mathematics teaching), and 29 (foundations of mathematics) have the highest coefficients of variation (higher than 2), so they are the less homogeneous subjects across institutions. These variables belong to three different knowledge domains. The rest of the subjects have coefficients of variation lower than 1.5. We highlight that the 70.1% of the subjects have coefficients of variation lower that 1, which means that they are quite homogeneous across institutions.

We observe in Figure 5 that the coefficients of variation of subjects 7 and subject 15 are outliers in their corresponding knowledge domains. The rest of the subjects for those domains (school mathematics and general pedagogy) are quite similar among them, whereas there is more variation in the coefficients of mathematics pedagogy subjects.

In Figure 5 we observe that the lowest coefficients of variation belong to general pedagogy subjects. On the other extreme, we can observe that a bigger number of subjects have higher coefficients of variation in the mathematics pedagogy knowledge domain. This fact seems to indicate that subjects of general pedagogy are more homogeneous than subject of the other three knowledge domains (school mathematics, advanced mathematics, and mathematics pedagogy) across institutions. The means of the coefficients of variation of subjects by knowledge domains (1.02 in school mathematics, 0.66 in general pedagogy, and 1.09 in mathematics pedagogy) confirm that subjects of general pedagogy are, in general, more homogeneous and indicate that subjects of mathematics pedagogy are the less homogeneous ones across institutions.

To summarize, results concerning the coefficients of variations are consistent with the previous analyses. First, the Spanish core curriculum is mainly constituted by general pedagogy subjects: they are the most frequent subjects in more than half of the Spanish institutions (see Figure 1) and they have lower coefficient of variation. Second, the coefficients of variation of mathematics pedagogy topics indicate that they are the less homogeneous topics, as we suspected from Figures 2 to 4.

The analyses performed show some programs' variability but some structure as well. We explore and characterize the programs' structure through factor analysis.

Factor Analysis

We performed a varimax rotated factor analysis on the quantitative variables mentioned above. The results show that all variables have a high communality (>0.553). We collect the first 11 components, which explain 74% of the variance, and the cumulative percentage of the variance in Table 1.

Table 1: Components

Component	Varimax rotated	Cumulative % of variance
1	Number (school mathematics)	14.9
	Measurement (school mathematics)	
	Geometry (school mathematics)	
	Sociology of education (pedagogy)	
	Aspects of mathematical ability and thinking (mathematics pedagogy)	
	Mathematical problems and solutions (mathematics pedagogy)	
	Mathematics instruction (mathematics pedagogy)	
	Practical knowledge of teaching (pedagogy)	
2	Data representation, probability, and statistics (school mathematics)	24.6
	Elementary analysis (school mathematics)	
	Educational psychology (pedagogy)	
3	Functions, relations, and equations-Algebra (school mathematics)	32.6
	Validation and structure (school mathematics)	
	Advanced mathematics (advanced mathematics)	
4	Methods of presenting main mathematics concepts (mathematics pedagogy)	39.8
	Analyzing/observing/reflecting on mathematics teaching (mathematics pedagogy)	
5	History of education and educational systems (pedagogy)	46.2
	Nature and development of mathematics ability and thinking (Piaget) (mathematics pedagogy)	
	Foundations of mathematics (mathematics pedagogy)	
6	Context of Mathematics Education (mathematics pedagogy)	52.1
	Affective issues (mathematics pedagogy)	
	Practical knowledge of teaching (pedagogy)	
7	Introduction to Education or theories of schools (pedagogy)	57.7
	Principles of instruction (pedagogy)	
8	Assessment and measurement theory (pedagogy)	62.6
	Counseling, advising students, and pastoral care (pedagogy)	
	Analyzing/observing/reflecting on mathematics teaching (mathematics pedagogy)	
9	Methods of educational research (pedagogy)	66.7

Component	Varimax rotated	Cumulative % of variance
10	Studying and selecting textbooks and instructional materials (mathematics education) Knowledge of mathematics standards and curriculum (pedagogy) Instructional media and operation (pedagogy)	70.7
11	Knowledge of mathematics standards and curriculum (pedagogy)	74.2

As we expected, most of the components have, as least, one pedagogy subject, which are the predominant and the more homogeneous subjects in Spanish programs across institutions. But there are some exceptions as well, as we will see in what follows.

We focus our comments on the first five components, which explain 46% of the variance. These five components provide information about different groups of subjects that allow us to characterize different patterns in the Spanish institutions. The first component is related to school mathematics subjects: mathematics instruction, and practical knowledge of teaching. These subjects are part of the traditional Spanish curriculum. The subjects that are shared by the second group are related to statistics, calculus and educational psychology. On the contrary to the previous components, the third one does not contain any subject related to pedagogical sociological or psychological aspects. This component share school mathematics and advanced mathematics subjects, which characterize a group of institutions that emphasize mathematics. Methodology subjects characterize the fourth component, concerning teaching and teaching analysis methodology, with subjects related to the representation of school mathematics concepts, the connections between mathematical areas and the developing of mathematical ability and thinking; and different processes associated to mathematics teaching. The subjects of the fifth component are mainly related to foundation subjects like history of education, nature and development of mathematics ability and thinking and foundations of mathematics from a mathematics pedagogy viewpoint.

Conclusion and Implications

The results show a diversity of institutional approaches to teacher education within a given structure. Primary teacher training institutions make their own interpretation of the official curriculum generating diverse teacher training programs. This fact is particularly observed in mathematics education subjects.

Spanish core curriculum for primary mathematics teacher education can be characterized by (a) no advanced mathematics topics, (b) 40% of school mathematics topics, (c) 43% of general pedagogy topics, and (d) 18% mathematics pedagogy topìcs.

We observe that general pedagogy subjects tend to be more homogeneous across institutions. In general, Spanish programs emphasize the teaching of pedagogy and mathematics school subjects, mainly the first ones. Mathematics pedagogy is treated with less emphasis and show great diversity across institutions. Validation and structure is the subject with the highest coefficient of variation. It is related to the set theory, which was traditionally included in programs some decades ago. Nowadays this subject has been removed from syllabi of some mathematics pedagogy departments, but not from others. This fact could be the reason of this high coefficient of variation.

Even though there is an official national curriculum, determining 120 credits of the 190 credits established to get Spain's primary teacher certificate, the specific subjects taught in each institution varies greatly. The way of developing syllabi documents in Spain, where three levels of curricular responsibility coexist, can explain this fact. Even for courses established at national level, there exist differences among documents established at institutional level because each institution has competence to adapt national curriculum to its specific needs and interests, maintaining the national requirements. These differences usually increase at educators' syllabi level because educators can develop their own programs. Even if different educators teach the same course in the same institution, differences can be observed in terms of subjects and topics considered for TEDS-M. Although this fact could imply a lot of variability in terms of subjects, we have noticed from factor analysis that there are some components that allow us to describe patterns in the Spanish institutions.

Even though syllabi for the European Higher Education Area have already been designed and will be implemented soon, the results of this study suggest the need for more emphasis in mathematics pedagogy subjects and a better coverage of the school mathematics subjects.

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Appendix. Subjects and topics grouped by knowledge domains

School Mathematics Subjects

1. **Number**: a) whole numbers, b) fractions & decimals, c) integer, rational & real numbers, d) other numbers & number concepts & number theory, e) estimation & number sense concepts, and f) ratio and proportionality.
2. **Measurement**: a) measurement units, b) computations & properties of length, perimeter, area & volume, and c) estimation & error.
3. **Geometry**: a) 1-D & 2-D coordinate geometry, b) Euclidean geometry, c) transformational geometry, d) congruence and similarity, e) constructions with straightedge and compass, f) 3-D geometry, g) vector geometry, and h) simple topology.
4. **Functions, Relations, & Equations (Algebra)**: a) patterns, relations & functions, b) equations & formulas, and c) trigonometry & analytic geometry.
5. **Data Representation, Probability, & Statistics**: a) data representation & analysis (including sampling, inferences from data, correlations), and b) uncertainty & probability.
6. **Elementary Analysis**: a) infinite processes, and b) change (including differentiation, integration, differential equations).
7. **Validation & Structure**: a) validation & justification (i.e. Boolean algebra, mathematical induction, logical connectives), and b) structuring and abstracting (i.e. sets, groups, fields linear space, isomorphism, homomorphism).
8. **Advanced Mathematics.**

General Pedagogy Subjects

9. **History of Education and Educational Systems**: a) characteristics of development and international systems (not your country), and b) historical development of the national system.
10. **Educational Psychology**: a) motivational theory, b) theories of psychological development, cognitive development, and intelligences, c) learning theory, and d) teaching and learning with the framework of multiple intelligence.
11. Philosophy of Education: a) philosophy of education and general philosophy, b) knowledge and appreciation of educational theory (including meaning of educational goals), c) educational ethics and moral education, d) education and epistemology, and e) education and humanism.
12. **Sociology of Education**: a) social status of teachers, b) purpose and function of education in society, c) organization of current educational systems, d) organization and culture of schooling and school, e) social conditions, social change, social development, social resources and school education, f) diversity (indigenous people, cultural, language, gender and special needs), g) educational policies, reform, and current educational issues, h) comparative education, and i) relation of education and other topics (including culture, economy, society, politics, etc.).
13. **Introduction to Education or Theories of Schools**: a) goals of schooling (institution of schooling), b) purpose and function of education, c) role of teacher, d) curriculum theory and theory of curriculum development, e) teacher-student relations, f) school administration and leadership (including personnel management, school finance, etc.), g) education and legal issues, and h) teacher professional development.
14. **Principles of Instruction**: a) didactic/teaching methods and models, and b) instructional theory and instructional design.
15. **Methods of Educational Research.**
16. **Classroom management**: a) theory of classroom management, b) management of classroom community and learning environment, and c) classroom rules and handling of improper behavior.

17. **Assessment and Measurement Theory**: a) types and functions of assessment, b) purposes, reliability and validity of assessment, and c) analysis and design of examinations.

18. **Counseling, Advising Students, and Pastoral Care**: a) basic theories and models in counseling, b) professional ethics of counseling, and c) training for skills and ability of counseling.

19 **Instructional Media and Operation**: a) theories of media design, b) developing skills and abilities for media design, and c) use of ICT and other media to support instruction.

20. **Practical Knowledge of Teaching**: a) knowing how to deal with students of different abilities, b) knowing how to deal with students with different linguistic, cultural and economic backgrounds and special needs, c) moral responsibility toward diverse pupils, d) how to communicate and/or engage parents, e) use of data in making decisions regarding students, f) general cooperation among teachers (e.g., marshalling resources at school), g) strategies to deal with behavior problems (ex: aggression), h) how to motivate students, i) learning styles, j) develop lesson plans, k) classroom assessment, l) how to structure content, m) how to manage classroom discourse, and n) general teaching (none of the above).

Mathematics Pedagogy Subjects

Theories/Models of Mathematics Ability and Thinking (Mogens Niss, Van Hiele, Krutetskii, Skemp, etc.).

21. **Nature and Development of Mathematics Ability and Thinking (e.g. Piaget).**

22. **Aspects of Mathematical Ability and Thinking**: a) developing mathematical concepts, b) reasoning, argumentation, proving, c) abstracting, generalizing, d) carrying out procedures (algorithms), e) application, f) modeling, and g) other.

23. **Mathematical Problems and Solutions**: a) analyze problems, b) problem posing, and c) solving problems.

24. **Mathematics Instruction**: a) representation of mathematics content (e.g. Bruner), b) selection and sequencing the mathematics content, c) teaching methods (e.g. discovery learning, etc.), d) student difficulties (misconceptions), e) using calculations, f) using computers, g) using other manipulations (physical models, blocks, etc.), h) use of mathematics language and symbols, i) managing classroom communication, j) diagnosing and assessing student achievement, and k) homework.

Developing Teaching Plans (Mathematics).

25. **Analyzing/Observing/Reflecting on Mathematics Teaching.**

26. **Knowledge of Mathematics Standards and Curriculum.**

27. **Studying and Selecting Textbooks and Instructional Materials.**

28. **Methods of Presenting Main Mathematics Concepts**: a) numbers, b) geometry (including analytic geometry), c) algebra (equations, functions, linear algebra, etc.), d) analysis (calculus), e) trigonometry, f) probability and statistics, g) connections between mathematical areas, and h) developing mathematical ability and thinking.

29. **Foundations of Mathematics**: a) mathematics and philosophy, b) mathematics epistemology, and c) history of mathematics and mathematics education.

30. **Context of Mathematics Education**: a) role of mathematics in society, b) international approaches in mathematics education, c) gender/ethnic aspects of mathematics achievement, d) cooperate with colleagues on content and teaching, and e) special needs (mathematically gifted students, students with special needs, etc.).

31. **Affective Issues**: a) beliefs and attitudes, and b) mathematics anxiety.