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SPECIFIC MATHEMATICS COMPETENCES IN LOMLOE. A CHANGE IN THE APPROACH TO TEACHING AND LEARNING IN MATHEMATICS

COMPETENCIAS ESPECÍFICAS DE MATEMÁTICAS EN LA LOMLOE. UN CAMBIO EN EL ENFOQUE DE LA ENSEÑANZA Y EL APRENDIZAJE EN MATEMÁTICAS

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Resumen

El currículo educativo desarrollado tras la publicación de la LOMLOE recoge varios elementos clave, algunos de ellos ya presentes en desarrollos curriculares anteriores, pero otros resultan especialmente novedosos. El objetivo de cualquier reforma educativa es el aprendizaje del alumnado, según se describe en las finalidades y objetivos de cada etapa educativa, y para ello pone a disposición de la comunidad educativa, y del profesorado en particular, como primera referencia, los desarrollos curriculares de las diferentes etapas. Sin embargo, un cambio en el paradigma educativo como el que propone la LOMLOE, que por primera vez pone el centro en las competencias clave y no fija la adquisición de contenidos como un fin en sí mismo, no puede ser incorporado de forma completa en las aulas si el profesorado no lo entiende y no lo integra dentro de su quehacer cotidiano (Alén de la Torre, 2022). Por ello, este artículo pretende contribuir a la formación del profesorado describiendo los elementos curriculares enfocándose, en especial, a los que atañen directamente al área y a las materias y ámbitos de matemáticas en las distintas etapas educativas.

Palabras clave: competencia específica, sentidos matemáticos, Matemáticas.

Abstract

The educational curriculum developed after the publication of the LOMLOE includes several key elements, some of them already present in previous curricular developments, but others are particularly new. The aim of any educational reform is student learning, as described in the aims and objectives of each educational stage, and to this end, the curricular developments of the different stages are made available to the educational community, and to teachers, as a first reference. However, a change in the

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educational paradigm such as that proposed by the LOMLOE, which for the first time focuses on key competences and does not set the acquisition of content as an end, cannot be fully incorporated into the classroom if teachers do not understand it and do not integrate it into their daily work (Alén de la Torre, 2022). Therefore, this article aims to contribute to teacher training by describing the curricular elements focusing on those that directly concern the area and the subjects and areas of mathematics in the different educational stages.

Keywords: specific competence, mathematical senses, Mathematics.

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1. CURRICULAR STRUCTURE. FROM KEY COMPETENCES TO SPECIFIC COMPETENCES

The curricular model proposed by the LOMLOE is based on the current reality and context, which is changing, unpredictable and in constant transformation, so that students must be prepared to develop their personality in all its dimensions and to integrate into the democratic society in an active and responsible way, to face new challenges and respond to those currently posed, as well as to continue learning throughout life.

From this approach, the current educational law develops, as a fundamental axis, the so-called exit competency *profile of students at the end of basic education*. The competency profile is the contextualization in the Spanish educational system of the key competences defined at European level (Council of the EU (Ed.), 2018). It gathers, from different operational descriptors defined for each competence, the linkage of these and the challenges and challenges of the 21st century with the principles and purposes of the educational system defined in the law. The competency profile is unique and common for the whole national territory and must be the reference for teachers from the moment students start schooling and for the evaluation of learning. Since the moment of completion of basic education may be somewhat distant in the infant and primary stages, the profile includes an intermediate milestone, as a guideline, at the end of Primary Education. Likewise, for the Infant Education and Baccalaureate stages, RD 95/2022, of February 1, and RD 243/2022, of April 5, include in their annexes I, respectively, the contextualization of these competences in these educational stages.

Although the curriculum takes the key competences as its main reference, the organization of the educational stages is done by areas (Early Childhood Education and Primary Education), by subjects (Compulsory Secondary

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Education and Baccalaureate) or by fields (Basic Vocational Training and Adult Education). Thus, the curriculum defines specific competences as the main link between the work of teachers in the classroom and the key competences. Specific competences are defined as "performances that students must be able to display in activities or situations whose approach requires basic knowledge of each area, subject or field. The specific competences constitute an element of connection between, on the one hand, the student's exit profile and, on the other hand, the basic knowledge of the areas, subjects or domains and the evaluation criteria". The link between the operational descriptors of the key competences and the specific competences, which the curriculum provides, means that the assessment of the former can be concluded from the assessment of the latter, and therefore from the assessment of the area, subject or field, taking the assessment criteria as a reference.

In the definition of the competency profile, the European reference frameworks have been one of the fundamental references Bacigalupo et al. (2016); Council of Europe, 2020, for multilingual competence; Carretero et al. (2017), for digital competence; Sala et al. (2020), for personal, social and learning to learn competence; Council of Europe (2016), for citizenship competence). As for STEM competence (mathematical competence and competence in science, technology, and engineering), there is no single reference framework that has been able to become the main reference for defining the operational descriptors of the same. In this regard, the report carried out within the framework of the ATS STEM[1] (Butler *et al.*, 2020) project (Butler *et al.,* 2020) contains a comparative analysis of different frameworks for this competency.

[1] Research project on innovative educational policies with the aim of improving the digital assessment of STEM transversal competences. It is carried out in 8 EU countries and involves a partner network of 12 educational institutions (including the University of Santiago and the Regional Ministry of Education, University and Vocational Training of the Xunta de Galicia)), (https://www.atsstem.eu/)

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True competency work in the classroom must integrate work on the development of the eight key competences, since all areas contribute to progress in all of them. Therefore, mathematics teachers will have, as an immediate reference in their programming, the specific competences, and the evaluation criteria of the stage they are teaching. However, if the links between the specific mathematics competences and the exit profile are analyzed, the STEM competency, as is logical, is the one with the most links to them. There are 16 links with STEM in the primary curriculum and 20 in secondary (followed, in number, by the links with digital competence: 11 and 17 respectively in primary and secondary). It is therefore appropriate to first analyze the operational descriptors of this competency, especially those mainly linked to mathematics, such as STEM1, STEM2 and STEM4, which are shown in Table 1.

Tabla 1. *Descriptores operativos 1, 2 y 4 de la competencia STEM. Primaria y Secundaria Obligatoria.*

Upon completion of primary education, the student will...	**Upon completion of basic education, the student will be able to...**
STEM1. Uses, in a guided way, some inductive and deductive methods of mathematical reasoning in known situations, and selects and uses some strategies to solve problems reflecting on the solutions obtained.	STEM1. Uses inductive and deductive methods of mathematical reasoning in familiar situations, and selects and uses different strategies to solve problems, critically analyzing the solutions and reformulating the procedure, if necessary.
STEM2. Uses scientific thinking to understand and explain some of the phenomena that occur around them, relying on knowledge as a driver of development, using appropriate tools and instruments, asking	STEM2. Uses scientific thinking to understand and explain the phenomena that occur around them, relying on knowledge as an engine of development, posing questions and testing

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questions and performing simple experiments in a guided manner.	hypotheses through experimentation, if necessary.
STEM4. Interpret and transmit the most relevant elements of some scientific, mathematical, and technological methods and results in a clear and truthful way, using the appropriate scientific terminology, in different formats (drawings, diagrams, graphs, symbols...) and taking advantage of the digital culture in a critical, ethical and responsible way to share and build new knowledge.	questions and testing hypotheses through experimentation and inquiry, using appropriate tools and instruments, appreciating the importance of accuracy and truthfulness and showing a critical attitude about the scope and limitations of scientific knowledge.

As can be seen, the descriptors of this key competency already point out the essential elements of what mathematics education should be: the formulation and resolution of problems, reasoning, demonstration and argumentation, and mathematical communication. These descriptors show what all students should achieve at the end of basic education and, together with the operational descriptors of the rest of the competences, show that mathematics, as indicated by Montes, M. *et al.* (in Blanco *et al,* Eds. 2022), "are a birthright for all human beings, regardless of their gender, ethnicity, social group or socioeconomic status, in the same way that language is [...] mathematics is a human activity, indispensable for society, which implies that all citizens have the right to access it".

The following section will describe the specific competences of mathematics, which are derived from the exit profile and, therefore, incorporate to the aforementioned skills processes specific to mathematics, as well as imbricate socio-affective skills, fundamental to support and guide the students in the acquisition of the rest of the specific competences, so

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that it implies a different vision of mathematics, as an important field in human activity and development, which contributes to the progress of society in a committed way with the challenges of the 21st century.

2. SPECIFIC MATHEMATICS COMPETENCES. CONNECTION WITH THE EXIT PROFILE

Before arriving at the new concept of specific competence introduced in the LOMLOE, it is worth stopping to think about the meaning of competence in itself and later on that of mathematical competence. The origin and meaning of the term competence has been widely studied; one possible characterization is provided by (Perrenoud, 2004), competence can be characterized as the set of actions or decisions that a person can take in a specific context. Being competent implies, therefore, knowing a knowledge and having the necessary strategies to apply that knowledge in the resolution of a task. As mentioned above, the eight key competences established in the exit profile are those that should shape the training of all citizens for their integration in the society of the 21st century.

Particularly in mathematical competence, a good definition is "Mathematical competence means the ability to understand, judge, do and use mathematics in a variety of intra and extra-mathematical contexts and situations in which mathematics plays or could play a role" (Niss, 2003).

From this perspective, mathematical competence is understood as that which allows us to make functional use of mathematical knowledge in diverse situations with deep understanding.

However, this definition of mathematical competence, introduced since the original wording of the LOE of 2006, can be difficult to handle when it comes to transferring it to the classroom. For this reason, in the new regulation,

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specific mathematical competences are established, which describe the performances that students must be able to display in activities or situations whose approach requires basic mathematical knowledge.

But what are these specific mathematics competences? The National Council of Teachers of Mathematics (2020) establishes five process standards (problem solving, reasoning and proof, communication, connections, and representation) that all students should develop from Early Childhood Education to Baccalaureate.

Taking as a globalizing idea for the whole curriculum the work of these process standards and to be able to develop these processes in all non-university educational stages, the current regulations specify the specific mathematics competences. In addition, in accordance with research on the affective domain of mathematics (Mcleod, 1992; Gómez-Chacón, 2000), the so-called socio-affective competences are also included, whose purpose is for students to understand and manage emotions, establish, and achieve goals and make decisions aimed at improving their performance in mathematics.

Thus, 8 specific competences have been defined for Primary Education, 10 in Compulsory Secondary Education and 9 in Baccalaureate.

Although the regulations do not explicitly divide the specific competences into blocks, as previously indicated, it can be deduced that they are structured in 5 axes:

1. Troubleshooting

Problem-solving is a key element of mathematics teaching and learning and is essential for the development of solid mathematical skills and deep

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understanding of mathematical concepts, as it forces students to think about how to apply what they have learned to new and different situations, encourages logical reasoning and critical thinking, skills that are essential for success in mathematics and other areas.

Analyzing the processes involved in problem solving (Polya, 2021), the new curriculum includes two specific competences grouped under problem solving, as shown in table 2 below.

Tabla 2. *Specific competences of the problem-solving axis.*

Elementary School		**Secondary School**
1. Interpret situations of everyday life, providing a mathematical representation of them through concepts, tools and strategies, to analyze the most relevant information.		1. Interpret, model and solve problems of everyday life and mathematical problems, applying different strategies and ways of reasoning, to explore different ways of proceeding and to obtain possible solutions.
2. Solve problematic situations, applying different techniques, strategies and ways of reasoning, to explore different ways of proceeding, obtain solutions and ensure their validity from a formal point of view and in relation to the context raised.		2. Analyze the solutions to a problem using different techniques and tools, evaluating the answers obtained, to verify their validity and suitability from a mathematical point of view and their overall impact.
	Baccalaureate	
Mathematics I and II	**Mathematics CCSS**	**General Mathematics**
1. Model and solve problems of everyday life and science and technology by applying different strategies and forms of reasoning to obtain possible solutions.	1. Model and solve problems of everyday life and social sciences applying different strategies and forms of reasoning to obtain possible solutions.	1. Model and solve problems of everyday life and social sciences applying different strategies and forms of reasoning to obtain possible solutions.
2. Verify the validity of possible solutions to a problem using reasoning and	2. Verify the validity of possible solutions to a problem using reasoning and	2. Verify the validity of possible solutions to a problem using reasoning and

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argumentation to contrast their suitability.	argumentation to contrast their suitability.	argumentation to contrast their suitability.

2. Reasoning and demonstration

El Mathematical reasoning refers to the ability to think in a logical and reasoned manner to understand and solve mathematical problems. Demonstration, on the other hand, is the process of presenting a logical and coherent argument to show that a mathematical statement is true. Both processes provide a powerful tool for developing ideas, exploring phenomena, justifying results, and establishing conjectures. The specific competences are shown in Table 3.

Table 3. *Specific competences of the reasoning and demonstration axis.*

Elementary School	**Secondary School**
3. Explore, formulate, and check simple conjectures or pose problems of mathematical type in situations based on everyday life, in a guided way, recognizing the value of reasoning and argumentation, to contrast their validity, acquire and integrate new knowledge.	3. Formulate and test simple conjectures or pose problems autonomously, recognizing the value of reasoning and argumentation, to generate new knowledge.
4. Use computational thinking, organizing data, decomposing into parts, recognizing patterns, generalizing and interpreting, modifying and creating algorithms in a guided way, to model and automate situations of everyday life.	4. Use the principles of computational thinking by organizing data, decomposing into parts, recognizing patterns, interpreting, modifying, and creating algorithms, to model situations and solve problems effectively.

	Baccalaureate	
Mathematics I and II	**Mathematics CCSS**	**General Mathematics**
3. Formulate or investigate conjectures or problems, using reasoning, argumentation, creativity, and the use of technological tools,	3. Formulate or investigate conjectures or problems, using reasoning, argumentation, creativity and the use of technological tools,	3. Generate mathematical questions by applying known knowledge and strategies to answer problematic situations of everyday life.

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to generate new mathematical knowledge.	to generate new mathematical knowledge.	
4. Use computational thinking effectively, modifying, creating and generalizing algorithms that solve problems through the use of mathematics, to model and solve situations of everyday life and the field of science and technology.	4. Use computational thinking effectively, modifying, creating and generalizing algorithms that solve problems through the use of mathematics, to model and solve situations of everyday life and the field of social sciences.	4. Use computational thinking effectively, modifying and creating algorithms that solve problems using mathematics, to model and solve situations of everyday life and various fields.

3. Connections

Mathematics is not a collection of isolated contents; on the contrary, it is an integrated whole in which everything is interconnected. This view of mathematics makes it necessary to study the internal connections between mathematical ideas, how they are interconnected and how they build on each other. In addition, it is also important to see mathematics in non-mathematical contexts thus establishing extra-mathematical connections. The specific competences are listed in Table 4.

Table 4. *Specific competences of the axis connections.*

Elementary School	Secondary School
5. Recognize and use connections between different mathematical ideas, as well as identify mathematics involved in other areas or in everyday life, interrelating concepts, and procedures, to interpret diverse situations and contexts.	5. Recognize and use connections between different mathematical elements, interconnecting concepts and procedures, to develop a view of mathematics as an integrated whole.
	6. Identify mathematics involved in other subjects and in real situations that can be approached in

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		mathematical terms, interrelating concepts, and procedures, to apply them in diverse situations.
	Baccalaureate	
Mathematics I and II	**Mathematics CCSS**	**General Mathematics**
5. Establish, investigate, and use connections between different mathematical ideas by making links between concepts, procedures, arguments, and models to give meaning and structure mathematical learning.	5. Establish, investigate, and use connections between different mathematical ideas by making links between concepts, procedures, arguments, and models to give meaning and structure mathematical learning.	5. Establish, investigate, and use connections between different mathematical ideas by making links between concepts, procedures, arguments, and models to give meaning and structure mathematical learning.
6. Discover the links of mathematics with other areas of knowledge and deepen their connections, interrelating concepts, and procedures, to model, solve problems and develop critical, creative, and innovative capacity in diverse situations.	6. Discover the links of mathematics with other areas of knowledge and deepen their connections, interrelating concepts, and procedures, to model, solve problems and develop critical, creative, and innovative capacity in diverse situations.	6. Discover the links of mathematics with other areas of knowledge and deepen their connections, interrelating concepts, and procedures, to model, solve problems and develop critical, creative, and innovative capacity in diverse situations.

4. Representation and communication

How mathematical ideas are represented is very important to understanding and using them effectively. When students access forms of mathematical representations and the ideas they represent, their ability to think mathematically is enhanced. Creating, using, selecting, applying, and translating into mathematical representations helps to solve problems and consolidate mathematical thinking.

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Communication is an essential part of mathematics; it is important to be able to express mathematical ideas clearly, accurately, and coherently, both orally and in writing, as well as to be able to analyze and evaluate other people's mathematical thinking. In addition, it allows organizing and consolidating mathematical thinking. The specific competences are shown in Table 5.

Table 5. *Specific competences of the representation and communication axis.*

Elementary School		**Secondary School**
6. Communicate and represent, individually and collectively, mathematical concepts, procedures, and results, using appropriate oral, written, graphic, multimodal language and terminology, to give meaning and permanence to mathematical ideas.		7. Represent, individually and collectively, concepts, procedures, information, and mathematical results, using different technologies, to visualize ideas and structure mathematical processes.
		8. Communicate, individually and collectively, mathematical concepts, procedures, and arguments, using oral, written, or graphic language, using the appropriate mathematical terminology, to give meaning and coherence to mathematical ideas.
	Baccalaureate	
Mathematics I and II	**Mathematics CCSS**	**General Mathematics**
7. Represent mathematical concepts, procedures, and information by selecting different technologies, to visualize ideas and structure mathematical reasoning.	7. Represent mathematical concepts, procedures, and information by selecting different technologies, to visualize ideas and structure mathematical reasoning.	7. Represent mathematical concepts, procedures, and information by selecting different technologies, to visualize ideas and structure mathematical reasoning.
8. Communicate mathematical ideas, individually and collectively, using the appropriate support,	8. Communicate mathematical ideas, individually and collectively, using the appropriate support,	8. Communicate mathematical ideas, individually and collectively, using the appropriate support,

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terminology, and rigor, to organize and consolidate mathematical thinking.	terminology, and rigor, to organize and consolidate mathematical thinking.	terminology, and rigor, to organize and consolidate mathematical thinking.

5. Socio-affective

Mathematics performance can be improved by challenging biases and developing positive emotions towards mathematics. The development of social-affective skills makes it possible to decrease negative attitudes toward mathematics, promote active learning, eradicate preconceived ideas related to gender or the myth of innate talent, build resilience, and maintain motivation in learning mathematics. The specific competences are shown in Table 6.

Table 6. *Specific competences of the socio-affective axis*.

Elementary School	**Secondary School**	
7. To develop personal skills that help to identify and manage emotions when facing mathematical challenges, fostering confidence in one's own possibilities, accepting mistakes as part of the learning process and adapting to situations of uncertainty, to improve perseverance and enjoyment in learning mathematics.	9. Develop personal skills, identifying and managing emotions, putting into practice strategies for accepting mistakes as part of the learning process and adapting to situations of uncertainty, to improve perseverance in achieving goals and enjoyment in learning mathematics.	
8. Develop social skills, recognizing and respecting the emotions, experiences of others and the value of diversity and actively participating in heterogeneous work teams with assigned roles, to build a positive identity as a mathematics student, foster personal well-being and create healthy relationships.	10. Develop social skills by recognizing and respecting the emotions and experiences of others, participating actively and reflectively in projects in heterogeneous teams with assigned roles, to build a positive identity as a student of mathematics, promote personal and group well-being and create healthy relationships.	
	Baccalaureate	
Mathematics I and II	**Mathematics CCSS**	**General Mathematics**

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9. Use personal and social skills, identifying and managing their own emotions, respecting those of others and actively organizing work in heterogeneous teams, learning from mistakes as part of the learning process and facing situations of uncertainty, to persevere in the achievement of objectives in the learning of mathematics.	9. Use personal and social skills, identifying and managing their own emotions, respecting those of others and actively organizing work in heterogeneous teams, learning from mistakes as part of the learning process and facing situations of uncertainty, to persevere in the achievement of objectives in the learning of mathematics.	9. Use personal and social skills, identifying and managing their own emotions, respecting those of others and actively organizing work in heterogeneous teams, learning from mistakes as part of the learning process and facing situations of uncertainty, to persevere in the achievement of objectives in the learning of mathematics.

Below, Sankey diagrams are presented showing the connections between the specific Mathematics competences and the operative descriptors of the key competences in basic education, as stated in the corresponding royal decrees of minimum education.

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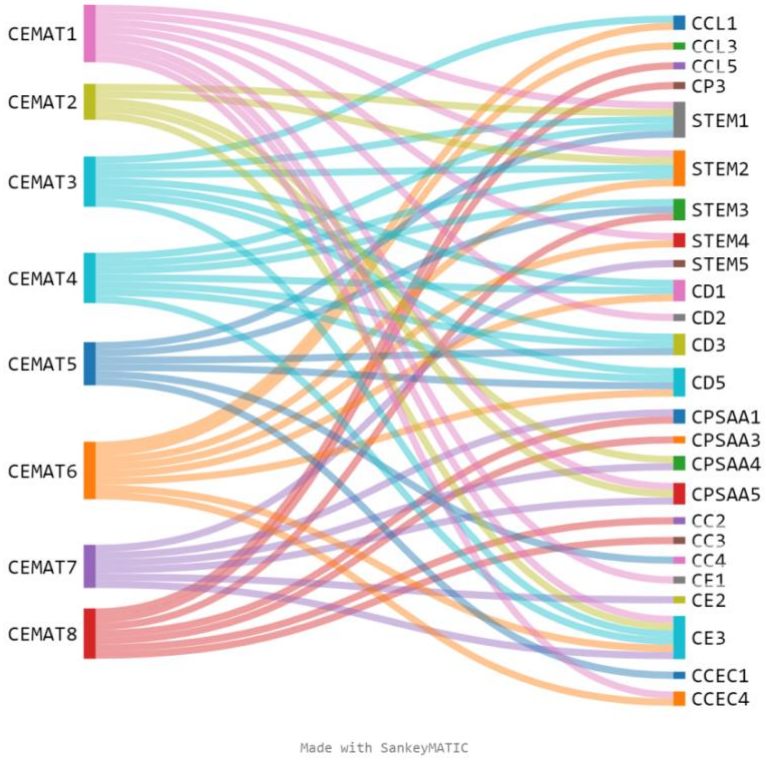

Figure1. Connections in Primary Education.

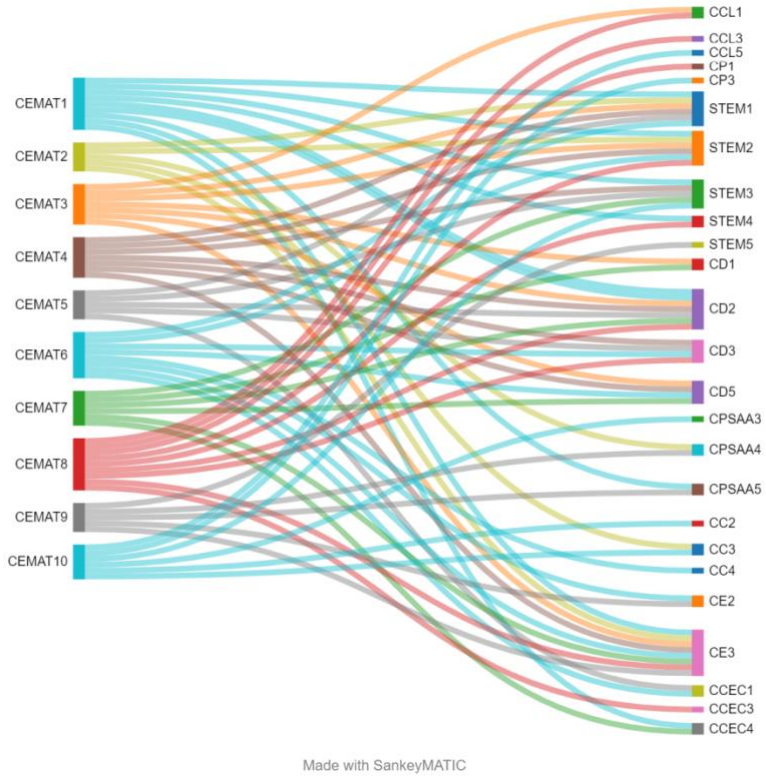

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Figure 2. Connections in Compulsory Secondary Education.

3. SPECIFIC MATHEMATICS COMPETENCES. CONNECTION WITH BASIC KNOWLEDGE

In addition to constituting an element of connection with the students' exit profile, the specific competences also constitute a connection with basic knowledge. Following the recommendations of the Spanish Mathematics Committee (CEMAT[2]), the knowledge has been structured around the concept of "mathematical sense" and organized into two dimensions: cognitive and affective.

The senses are understood as the set of skills related to the mastery in context of numerical, metric, geometric, algebraic, stochastic and socio-affective contents. These senses allow the use of basic knowledge in a functional way, providing the necessary flexibility to establish connections between them. Therefore, the connection of specific competences with basic knowledge is established based on the activities or tasks proposed and their management in the classroom.

The following figure shows the six senses that make up the basic knowledge: algebraic, spatial, stochastic, measurement, numerical and socio-affective.

[2] Bases for the development of a Mathematics curriculum in non-university education. May 2021.

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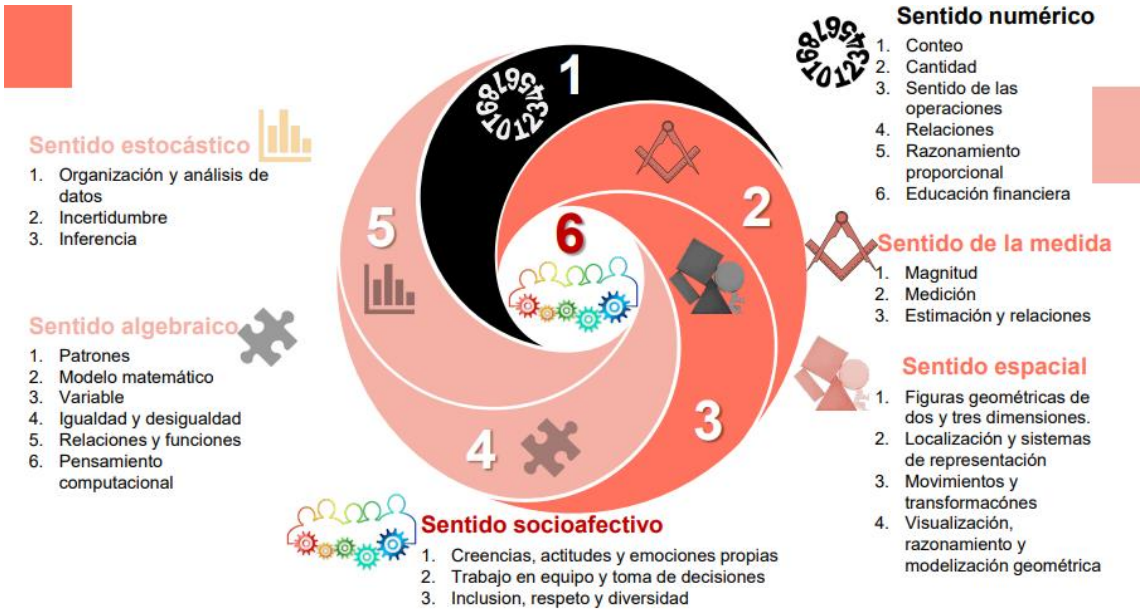

Figure 3. *Mathematical senses* (© Copyright Showeet.com – Creative & Free PowerPoint Templates)

4. SPECIFIC MATHEMATICS COMPETENCES. CONNECTION WITH THE EVALUATION

The approach to these specific competences turns students into the protagonists of their learning, so it is advisable to opt for methodologies that allow them to build them in contextualized situations. Furthermore, to develop these specific competences, it is best to propose a sequence of rich, authentic, relevant, and meaningful tasks for the students. In this way, they will acquire those competences that will allow them to transfer to real life what they have learned in the classroom.

For the above connections to be viable, it is important to point out how the specific competences have been constructed and what the syntactic structure of formulation is:

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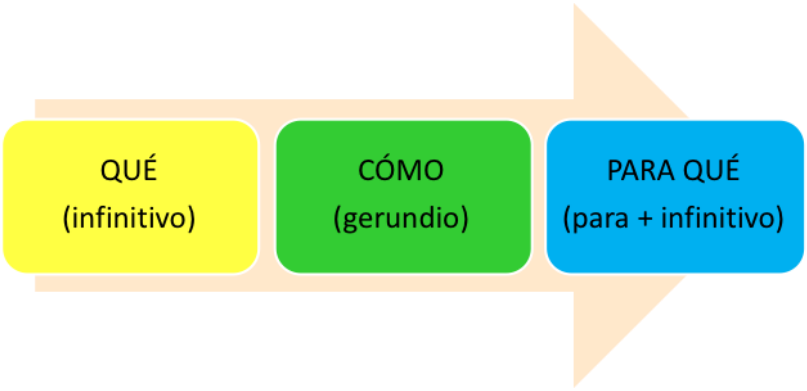

Figura 4. *Syntactic structure of specific competences.*

For example, we can see that the specific competence 1 of 1st ESO follows this structure: "Interpret, model and solve problems of everyday life and mathematical problems by applying different strategies and forms of reasoning to explore different ways of proceeding and obtaining possible solutions".

In other words, what (*qué*) the students are expected to acquire, how (*cómo*) they are expected to achieve it and for what (*para qué*) purpose they want to acquire it. In addition, the connection is established with the evaluation criteria that are formulated from what for (*para qué*) and that put the focus on what (qué) and how *(cómo)*. These evaluation criteria are drafted by cycles in the royal decrees, and it is the educational administrations or the centers, in its the case, who determine the criteria corresponding to each competency.

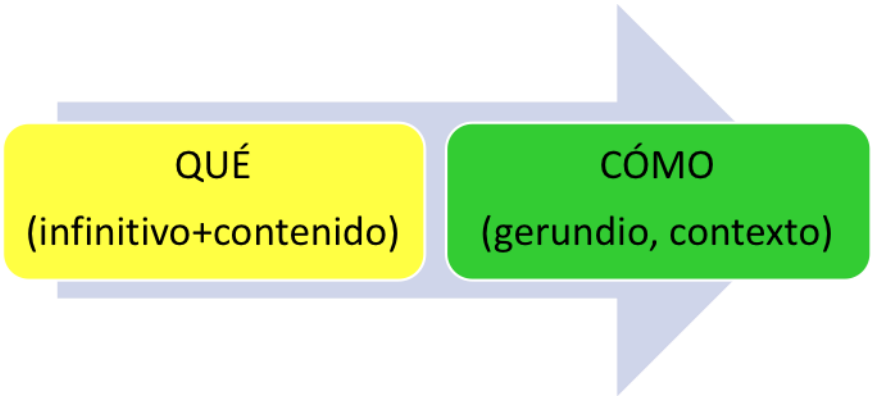

Figure 5. *Syntactic structure of the evaluation criteria*.

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Following the previous example, the evaluation criterion 1.1. corresponding to competence 1 for the cycle from 1st to 3rd ESO starts from "to explore different ways of proceeding and obtaining possible solutions" and is specified as "1.1 Interpret mathematical problems by organizing the data, establishing the relationships between them and understanding the questions asked".

The content "mathematical problems" is addressed in each programming unit with the corresponding basic knowledge. Therefore, it can be observed that, in Mathematics, the specific competences and evaluation criteria are not biunivocally linked to specific basic knowledge but are worked on in an integrated manner with the processes. As indicated in the previous section, the same knowledge, depending on the task with which it is worked, will contribute to the acquisition of one specific competence or another. This fact facilitates its implementation and shows that the relevant learning processes are marked by the specific competences that will be evaluated through the evaluation criteria. Therefore, the selection of exercises, activities or tasks must allow to obtain evidence of the learning acquired, as indicated by Javier Cortes de las Heras[3] (2022) in the following figure.

[3] Evaluation in the LOMLOE. National conference on the curricular, competency-based, and inclusive model. Ministry of Education and Vocational Training. Cuenca (2022).

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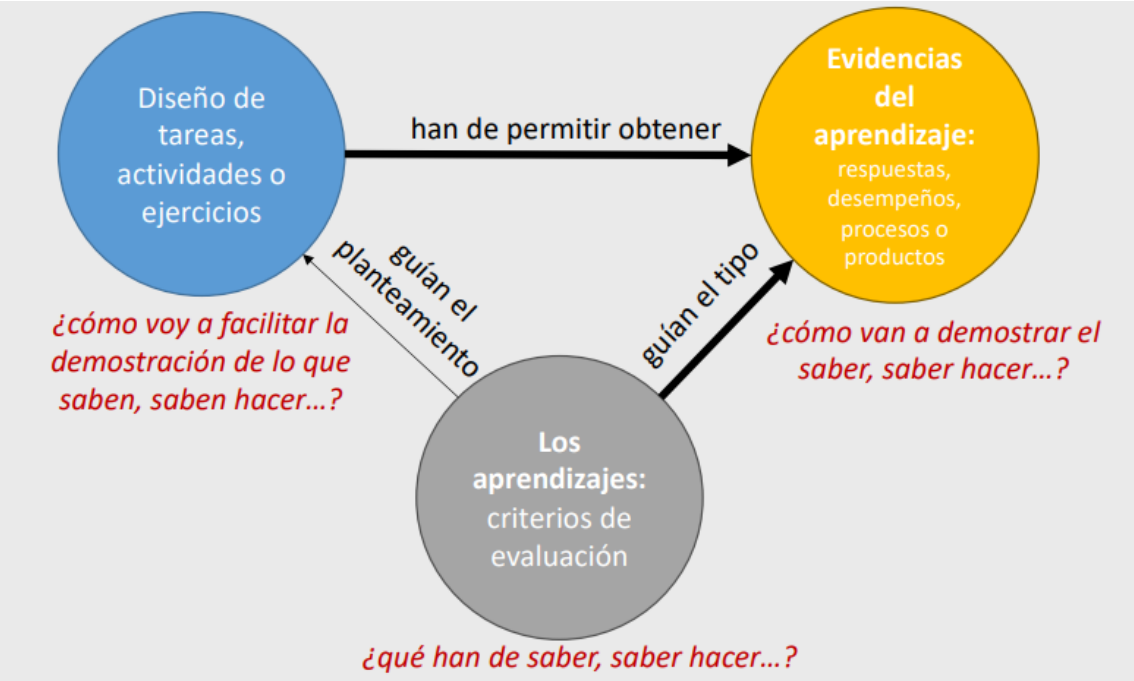

Figure 6. *Competency assessment.*

Thus, using the specific competences and their criteria together with the basic knowledge required, it will be possible to design tasks and/or learning situations whose evaluation will therefore be carried out through the evaluation or grading of the corresponding criteria.

5. CONCLUSION

This way of working implies a change in the approach to teaching and learning in Mathematics, facilitating the use of diverse methodologies, and placing the student as the main protagonist. For these changes to become real in the classroom, it is necessary the involvement of teachers and the necessary time to allow their implementation. Only after a prolonged time will it be possible to evaluate their effect.

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