

Syllabus

Course Description

Course Title	Didactics of Mathematics and Early Childhood Concept Development
Course Code	500004
Course Title Additional	
Scientific-Disciplinary Sector	NN
Language	Italian
Degree Course	5 year master degree in Primary Education - Italian section
Other Degree Courses (Loaned)	LM-85 bis Education Ladin section - 2026
Lecturers	Prof. Federico Corni, Federico.Corni@unibz.it https://www.unibz.it/en/faculties/education/academic-staff/person/800 Prof. Antonella Brighi, Antonella.Brighi@unibz.it https://www.unibz.it/en/faculties/education/academic-staff/person/39352 dr. Sara Bagossi, Sara.Bagossi@unibz.it https://www.unibz.it/en/faculties/education/academic-staff/person/50774 Prof. George Richard Paul Santi, GeorgeRichardPaul.Santi@unibz.it https://www.unibz.it/en/faculties/education/academic-staff/person/39717
Teaching Assistant	
Semester	Second semester
Course Year/s	1
CP	12
Teaching Hours	92
Lab Hours	32

Individual Study Hours	176
Planned Office Hours	36
Contents Summary	This course provides foundational theoretical knowledge and pedagogical skills essential for early childhood and primary education, linking children's cognitive and conceptual development with the teaching of mathematics and physics. On one side (Seminar), the course delves into how categories and scientific/mathematical concepts are structured in early childhood, analyzing Core Knowledge systems, executive functions, embodied cognition, and children's spontaneous generation of scientific explanations anchored in sensory and bodily experiences. On the other side (Lectures and Workshop), the course focuses on the core mathematical domain of "Numbers and Operations" (natural, integer, and rational numbers, mental calculation, early algebra, problem-solving, and mathematical reasoning), combining theoretical frameworks from mathematics education research with the design and critical analysis of laboratory practices using physical and digital artifacts.
Course Topics	- Cognitive and Conceptual Development in Early Childhood: Core Knowledge systems (number, space, objects, causality); conceptual development; Embodied Cognition, gesture, movement, and image schemas in constructing physical and mathematical concepts; phases of understanding; executive functions and self-regulation in inquiry-based science learning; the child as a theory-builder and intuitive explanations of physical/mathematical phenomena. - Numbers and Operations in Mathematics Education: Number sense, counting, enumeration, and calculation processes; natural numbers (operations, properties, number line, multiples/divisors); integers, rational numbers (fractions, decimals, percentages), and introduction to real numbers; mental calculation and standard algorithms; early algebra, pattern recognition, and generalization; exploring, conjecturing, and arguing in numerical contexts. - Theoretical and Pedagogical Frameworks in Mathematics Didactics: Laboratory-based teaching and Activity Theory; mathematical modeling and problem-solving; semiotic registers of representation, multimodality, and mediating tools; didactic transposition, didactic contract, mathematical discussion, and assessment; historical/cultural perspectives on numbers (positional

	systems, ancient cultures, symbol acquisition).
Keywords	Core Knowledge, Embodied Cognition, Imaginative Education, Early Algebra, Problem solving, Semiotic mediation
Recommended Prerequisites	No prerequisites
Propaedeutic Courses	
Teaching Format	The course employs a diverse and highly interactive pedagogical approach, combining lectures (face-to-face and synchronous online) with hands-on workshop sessions. Teaching methods include interactive and expository lectures, laboratory work, micro-teaching design, cooperative learning activities (in small groups and breakout rooms), and plenary mathematical discussions. The methodology also features collaborative analysis of learning scenarios (using video observations of children during play/exploration), direct simulations, embodied activities, the hands-on use of physical artifacts and digital collaborative tools, and the application of Activity Theory principles.
Mandatory Attendance	According to the Academic Regulations
Specific Educational Objectives and Learning Outcomes	1. Knowledge and understanding By the end of the course, students will be able to: - Demonstrate knowledge of key theories regarding cognitive and conceptual development in early childhood, with particular focus on Core Knowledge systems, executive functions, and Embodied Cognition. - Understand how young children build spontaneous explanations and construct physical and mathematical concepts through action, movement, gestures, and sensory experiences. - Master fundamental content within the "Numbers and Operations" conceptual domain (number systems, computation, early algebra, properties, and algorithms). 2. Applying knowledge and understanding By the end of the course, students will be able to: - Design learning units and educational activities for preschool and primary school, integrating mathematics, physics, science education, and developmental psychology. - Utilize physical artifacts, digital tools, and mediating instruments to foster exploration, modeling, and problem-solving in young learners.

	- Analyze and interpret educational situations and children's outputs (verbal, gestural, and graphical) related to mathematical and physical phenomena. - Implement laboratory-based teaching strategies and cooperative learning to promote hypothesis generation, reasoning, and active concept formation. - Comprehend theoretical and pedagogical frameworks in mathematics education (laboratory-based learning, Activity Theory, didactic transposition, didactic contract, semiotic registers of representation, and multimodality). 3. Making judgements By the end of the course, students will be able to: - Critically evaluate instructional materials, laboratory experiences, and pedagogical proposals concerning early childhood mathematics and science education. - Reflect critically on teaching practices, recognizing the teacher's role, the influence of the didactic contract, and the value of children's intuitive ideas. - Select and adapt mathematical and scientific tasks appropriately based on children's cognitive development levels and classroom needs. 4. Communication skills By the end of the course, students will be able to: - Use appropriate, precise disciplinary terminology across mathematics, science education, and developmental psychology. - Facilitate and orchestrate mathematical and scientific discussions in the classroom, encouraging peer reasoning, debate, and collaborative meaning-making. - Present, justify, and discuss instructional designs clearly with peers and instructors using digital tools and multimodal representations. 5. Learning skills By the end of the course, students will be able to: - Independently access and analyze research literature, bibliographic sources, and educational materials in early childhood mathematics and science education. - Cultivate a reflective attitude toward self-assessment and
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	continuous professional development. - Apply acquired theoretical frameworks to analyze real educational settings and address future teaching challenges.
Specific Educational Objectives and Learning Outcomes (additional info.)	
Assessment	Written exam
Evaluation Criteria	- Content knowledge from an interdisciplinary perspective - Translating theoretical knowledge into learning activities, also with cultural artefacts, consistent with the Learning Unit's objective??? - Language proficiency and clarity of presentation
Required Readings	See the bibliography for each module
Supplementary Readings	
Further Information	
Sustainable Development Goals (SDGs)	Quality education, Affordable and clean energy, Life on land, Climate action, Life below water, Sustainable cities and communities

Course Module

Course Constituent Title	Didactics of Mathematics for Early Childhood Education and Primary School 1: Numbers and Operations
Course Code	500004A
Scientific-Disciplinary Sector	MATH-01/B
Language	Italian
Lecturers	Prof. George Richard Paul Santi, GeorgeRichardPaul.Santi@unibz.it https://www.unibz.it/en/faculties/education/academic-staff/person/39717
Teaching Assistant	
Semester	Second semester
CP	7
Responsible Lecturer	
Teaching Hours	56

Lab Hours	0
Individual Study Hours	119
Planned Office Hours	21
Contents Summary	The course aims to provide students with a solid background in mathematics and mathematics education, which is essential for teaching in kindergarten and primary schools. The course aims to provide students with the tools to: consolidate and acquire mathematical knowledge and skills relating in particular to the 'Numbers' core concept of the National Guidelines, with a focus on problem-solving and problem-formulation processes, exploration, hypothesis formulation, and argumentation; acquire teaching knowledge and skills related to the topics covered; carry out practical activities and engage in critical pedagogical reflection on the topics covered.
Course Topics	Numbers and their meanings; processes of enumeration, counting, and calculation. Natural numbers: operations, meanings, and properties; the number line; the meaning of multiples, divisors, and prime numbers. Integers. Rational numbers: definition, properties, and various forms of representation (decimals, fractions, percentages); an introduction to irrational and real numbers. Mental arithmetic calculation orithwritten ms for the four operations. Early algebra and processes of generalisation. Identifying and describing patterns. Exploring, conjecturing, and reasoning in a numerical context. Theoretical elements from research in mathematics education: laboratory methodology and problem-solving; mathematical modelling; registers of representation and multimodality; didactic transposition, didactic contract, mathematical discussion. Examples of teaching activities related to the topics covered. Assessment in mathematics.
Teaching Format	Laboratory activities and cooperative learning. Class discussions to introduce activities and consolidate learning. Lesson planning
Required Readings	D'Amore, B., & Sbaragli, S. (2011). Principi di base di didattica della matematica. Pitagora. Sabena, C, Ferri, F, Martignone, F., & Robotti E. (2019). Insegnare e apprendere matematica nella scuola dell'infanzia e primaria. Mondadori

Supplementary Readings	Baccaglini-Frank, A., Di Martino, P., Natalini, R., Rolini, G. (2017). Didattica della matematica. Mondadori

Course Module

Course Constituent Title	Didactics of Mathematics for Early Childhood Education and Primary School 1: Numbers and Operations (lab.)
Course Code	500004B
Scientific-Disciplinary Sector	MATH-01/B
Language	Italian
Lecturers	Prof. George Richard Paul Santi, GeorgeRichardPaul.Santi@unibz.it https://www.unibz.it/en/faculties/education/academic-staff/person/39717
Teaching Assistant	
Semester	Second semester
CP	2
Responsible Lecturer	
Teaching Hours	0
Lab Hours	32 Gruppi 1,2,3+4: Prof. George Richard Paul Santi
Individual Study Hours	18
Planned Office Hours	6
Contents Summary	The laboratory aims to provide students with practical experience of mathematics laboratories. The sessions will not only offer ideas and teaching materials, but will also encourage students to reflect on teaching practices, the use of tools, the importance of visual representations, and the role of the teacher.
Course Topics	Working groups will analyze situations, materials, teaching tools, and educational experiences related to key concepts, such as the introduction to the concept of numbers, positional number

	systems, numbers in ancient cultures, teaching models for fractions, and the understanding of symbols.
Teaching Format	Laboratory activities utilizing material and digital artifacts, cooperative learning, and an activity theory approach
Required Readings	Sabena, C, Ferri, F, Martignone, F., & Robotti E. (2019). Insegnare e apprendere matematica nella scuola dell'infanzia e primaria. Mondadori
Supplementary Readings	Course materials provided by the teacher

Course Module

Course Constituent Title	Development of Scientific Concepts in Early Childhood (sem.)
Course Code	500004C
Scientific-Disciplinary Sector	PSIC-02/A
Language	Italian
Lecturers	Prof. Antonella Brighi, Antonella.Brighi@unibz.it https://www.unibz.it/en/faculties/education/academic-staff/person/39352
Teaching Assistant	
Semester	Second semester
CP	1
Responsible Lecturer	
Teaching Hours	12 Gruppo 1+2: Prof. Antonella Brighi
Lab Hours	0
Individual Study Hours	13
Planned Office Hours	3
Contents Summary	This seminar focuses on the structuring of knowledge in early childhood. Central to this are the terms category and concept. The course explores how categories and concepts change throughout the process of cognitive development.
Course Topics	Unit 1 — Early Cognitive Foundations (3 hours) Topics:

	- Early Knowledge Systems (Core Knowledge): Objects, Number, Space, Causality - Conceptual Change as a Theoretical Reorganization, Not Just the Accumulation of Experience - Overcoming the "Pre-logical" View of Infancy: The Child as a Competent Thinker Unit 2 — Body, Action, and Concept: Embodied Cognition Topics: - Embodied Cognition: The Role of Movement and Action in Concept Construction - Gesture and Mathematical Learning: From Concrete Action to Abstract Representation - Physical Action as a Facilitator for Understanding Physical Concepts (e.g., Strength, Balance) Unit 3 — Executive Functions and Scientific Learning (3 hours) Topics: - Executive Functions: Inhibition, Working Memory, Cognitive Flexibility - The Link Between Self-Regulation and the Capacity for Exploration and Inquiry Learning - Implications for Designing Science Activities in Preschool Unit 4 — The Child as a Theory Builder: The Scientific Thinking as a Process (3 hours) Topics: - "Theory-theory": children form and revise intuitive theories like scientists - Causal reasoning, hypothesis formulation, comparison of explanations - Curiosity and emotion as cognitive and motivational variables of learning - Interdisciplinary synthesis and connection with the final integrated design workshop (math, physics, science)
Teaching Format	The module is delivered online in synchronous mode, but is designed to maintain a highly interactive and laboratory-based approach, consistent with the very purpose of the teaching (the active construction of concepts): Lectures conducted via videoconference, with brief moments of theoretical presentation (max 20-25 minutes) alternating with guided discussions

	Work in small groups in a breakout room, with plenary feedback at the end of each activity Collaborative analysis of videos of children in exploration, play, and scientific activities Use of collaborative digital tools (shared whiteboards, real-time documents) for micro-planning of teaching Remote simulations and embodied activities: students experience firsthand activities that they will then design for preschool (e.g., the walked number line, performed individually and then compared in groups) Critical discussion of cases and readings, with a request for motivated personal placement Concluding feedback in Unit 4, in conjunction with the final interdisciplinary workshop of the Seminar Supporting materials: pre-assigned readings, summary slides, shared video repository, and sample teaching activities
Required Readings	- Carey, S. (2009). The Origin of Concepts. Oxford University Press. - Diamond, A. (2013). Executive functions. Annual Review of Psychology, 64, 135–168. - Gopnik, A., & Schulz, L. (2004). Mechanisms of theory formation in young children. Trends in Cognitive Sciences, 8(8), 371–377.
Supplementary Readings	further references will be communicated during the seminar

Course Module

Course Constituent Title	Development of Scientific Concepts in Early Childhood (sem.)
Course Code	500004D
Scientific-Disciplinary Sector	MATH-01/B
Language	Italian
Lecturers	Prof. George Richard Paul Santi, GeorgeRichardPaul.Santi@unibz.it https://www.unibz.it/en/faculties/education/academic-staff/person/39717 dr. Sara Bagossi, Sara.Bagossi@unibz.it https://www.unibz.it/en/faculties/education/academic-staff/person/39717

	staff/person/50774
Teaching Assistant	
Semester	Second semester
CP	1
Responsible Lecturer	
Teaching Hours	12 Gruppo 1: Dr. Sara Bagossi 12 Gruppo 2: Prof. George Richard Paul Santi
Lab Hours	0
Individual Study Hours	13
Planned Office Hours	3
Contents Summary	The seminar aims to provide future kindergarten teachers with an opportunity to link the theoretical knowledge acquired in the "Developmental and Educational Psychology" course with the observation and practical understanding of how pre-school children think and reason about their experiences with physical phenomena and mathematical concepts. Building on basic knowledge of cognitive development processes in early childhood, the course will explore the ways in which children construct spontaneous explanations of the world around them. Through examples, discussion of educational situations, and analysis of teaching activities, children's intuitive ideas will be explored. Particular attention will be paid to the ways in which children formulate hypotheses through experimentation and action, use language and expressive gestures to explain what they observe and feel, and progressively construct representations of phenomena, always deeply rooted in bodily and sensory experience.
Course Topics	Phases of understanding in early childhood. Basic image schemas for interpreting experience. Development of key concepts according to the theory of the embodied mind.
Teaching Format	Laboratory-based teaching with material and digital artifacts, cooperative learning, and whole-group discussions.
Required Readings	Bartolini Bussi, M. G. (2008). <i>Matematica. I numeri e lo spazio</i> . Edizioni Junior.
Supplementary Readings	

Course Module

Course Constituent Title	Development of Scientific Concepts in Early Childhood (sem.)
Course Code	500004E
Scientific-Disciplinary Sector	PHYS-06/B
Language	Italian
Lecturers	Prof. Federico Corni, Federico.Corni@unibz.it https://www.unibz.it/en/faculties/education/academic-staff/person/800
Teaching Assistant	
Semester	Second semester
CP	1
Responsible Lecturer	
Teaching Hours	12 Gruppo 1+2: Prof. Federico Corni
Lab Hours	0
Individual Study Hours	13
Planned Office Hours	3
Contents Summary	The seminar aims to provide future kindergarten teachers with an opportunity to link the theoretical knowledge acquired in the "Developmental and Educational Psychology" course with the observation and practical understanding of how pre-school children think and reason about their experiences with physical phenomena and mathematical concepts. Building on basic knowledge of cognitive development processes in early childhood, the course will explore the ways in which children construct spontaneous explanations of the world around them. Through examples, discussion of educational situations, and analysis of teaching activities, children's intuitive ideas will be explored. Particular attention will be paid to the ways in which children formulate hypotheses through experimentation and action, use language and expressive gestures to explain what they observe and feel, and progressively construct representations of phenomena, always deeply rooted in bodily and sensory experience.
Course Topics	Phases of understanding in early childhood. Basic image schemas

	for interpreting experience. Development of key concepts according to the theory of the embodied mind.
Teaching Format	Online classes with assignments for small groups
Required Readings	Handouts and bibliography provided by the lecturer
Supplementary Readings	Handouts and bibliography provided by the lecturer