EMPOWER NATIONAL REPORT ON THE USE OF MODELLING-BASED LEARNING IN CURRICULA - CYPRUS

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EMPOWER

Empowering Teachers for Science Learning Through Modelling-Based Approaches

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EMPOWERING TEACHERS FOR SCIENCE LEARNING THROUGH MODELLING-BASED APPROACHES

Project-Team of the Workpackage (alphabetical order)
Kyriaki Vakkou, Marios Papaevripidou, University of Cyprus (UCY)

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1 Introduction

This report examines how modelling-based learning (MbL) is integrated into the national curriculum for Natural Sciences in primary education in Cyprus. The analysis is based on the teachers' handbooks developed by the Ministry of Education, which outline the core learning objectives, content areas, and recommended instructional approaches for each unit. Particular attention is given to how models and modelling practices are represented in the curriculum materials, including the use, construction, evaluation, and revision of models. The report aims to identify the extent to which MbL is explicitly promoted as part of science teaching and learning.

Modelling-based learning is particularly relevant in science education because many scientific phenomena cannot be directly observed by students. Models can make abstract, invisible, complex, large-scale, or microscopic processes more accessible and understandable. In primary education, modelling can also support students' inquiry skills, reasoning, communication, and ability to connect scientific explanations with observable phenomena. For this reason, examining how modelling is represented in curriculum materials can provide insight into the opportunities students are given to engage with scientific thinking from an early age.

2 Methodology

A qualitative content analysis was conducted on the official Natural Sciences curriculum materials for primary education in Cyprus, covering Grades 1-6 and students aged approximately 6-12.

The analysis aimed to identify all references to modelling (such as models, modelling competence, modelling processes, or other model-related practices) across the curriculum texts. To ensure consistency, the identified instances were coded using a common coding scheme that had been developed and agreed upon by the consortium.

Each identified reference was treated as one coding unit. Each coding unit was examined across all categories of the coding scheme, meaning that a single reference could receive multiple codes, for example a type of model, a modelling practice, a context of use, and an indication of whether the passage was addressed to teachers or students. When the text referred to modelling but did not provide enough information to assign a specific code within a category, the code "not specified" was used. In addition to the predefined codes, supplemental codes were introduced under the category "other" to capture cases that were not fully captured by the initial framework. A summary of the coding scheme and the identified instances is presented in Table 1.

Category	Sub-category
Definitions of modelling competence	Specified
	Not specified
Significance of models	Significance of models in the natural sciences
	Significance of models in the educational process
	Significance of models in the modelling process in Science
	Not specified
Types of models	Physical
	Conceptual
	3D model
	Diagrams
	Digital
	Multiple
	Mental
	2D
	Role-play
	Not specified
Contexts of model use	
Modelling practices	Model creation
	Model use/selection of models
	Model evaluation
	Model revision
	Not specified
Meta-modelling knowledge	Knowledge about the properties and functions of models
	Knowledge of the modelling process
	Not specified
Other	Significance of Modelling-Based Reasoning
	Use of models to understand the concept of a Physical System
	Other
	Not specified
Aim of text	For the teacher
	For the student
Ways/strategies of using MbL	Ready-made models
	Ready-made models by other students
	Develop models from scratch

	Not specified

Table 1. Coding categories used to analyse references to modelling in the Natural Sciences curriculum materials

The coding scheme was designed to capture the multidimensional representation of modelling within the curricular texts through a comprehensive set of interrelated categories and subcategories. Initially, the framework identifies (1) definitions of modelling competence, distinguishing between specified and not specified instances. The second component of the scheme involves (2) the significance of models, categorizing whether the text mentions the importance of models in the natural sciences, the educational process, or the modelling process in science, thereby capturing their conceptual role within the curriculum. Furthermore, (3) the scheme identifies various types of models, such as physical, conceptual, 3D models, diagrams, and mental, while a fourth component records (4) the contextual area in which models are used across natural science thematic areas, such as earth and sky, electricity, human body and health, and energy. MbL practices are also examined by (5) coding the actions required from students during teaching and learning with models – specifically model creation, use/selection, evaluation, and revision – whereas (6) meta-modelling knowledge codes distinguish between knowledge about the properties and functions of models and knowledge of the modelling process itself. Supplemental categories were introduced under "other" (7) to capture instances such as the discussion of the significance of modelling-based reasoning or the use of models to understand physical systems. Finally, the framework records (8) the aim of the text, whether directed at the teacher or the student, and (9) the specific ways or strategies of using MbL, such as using ready-made models or developing models from scratch, while consistently coding cases lacking explicit information as "not specified" to maintain analytical transparency.

A total of 114 references to modelling were identified across the analysed curriculum materials for primary education. Specifically, 1 reference (1%) was identified in Grade 1, 7 references (6%) in Grade 2, 44 references (39%) in Grade 3, 13 references (11%) in Grade 4, 30 references (26%) in Grade 5, and 19 references (17%) in Grade 6. The highest number of references was found in Grade 3, followed by Grade 5, indicating that modelling is more strongly represented in these grade levels.

3 Background

The curriculum materials in Cyprus are organised around Success and Competence Indicators for learning, which define the expected student learning outcomes and specify the knowledge, skills, and concepts to be addressed in each unit. In addition, the Ministry of Education has developed teachers' handbooks for each Natural Sciences unit in primary education. These handbooks are intended to support teachers in translating the curriculum into classroom practice by providing suggested lesson structures, learning objectives, content areas, classroom activities, materials, worksheets, and assessment opportunities.

As a result, the teachers' handbooks are not only curriculum documents but also practical pedagogical resources. Their analysis can therefore show both what is expected at the curriculum level and how these expectations are operationalised through classroom activities. Overall, the curriculum emphasises the development of students' scientific understanding through observation, inquiry, experimentation, discussion, and the use of representations and models. Within this context, models are used to support students in understanding scientific phenomena that may be abstract, complex, too large, too small, or difficult to observe directly. Therefore, these materials provide a useful basis for examining how modelling-based learning is represented in primary science education in Cyprus. The analysis was based on the latest versions of the materials identified in March 2026. The links to all identified materials are provided in the References section at the end of the report.

4 Findings

4.1 Strategies for using MbL

In terms of the ways/strategies of using MbL, 83 references (73%) out of the total 114 references explicitly specified a modelling strategy, while 31 references (27%) were coded as not specified. The most frequent strategy was the use of ready-made models, with 46 references (40% of all references; 55% of the specified references). This indicates that students are most often expected to work with models that are already provided to them. Developing models from scratch appeared in 36 references (32% of all references; 43% of the specified references), showing that students are also frequently given opportunities to construct or develop their own models. Only one reference (1%) involved the use of ready-made models by other students. These results suggest that although ready-made models are the dominant strategy overall, the curriculum also includes substantial opportunities for students to create their own models, particularly in Grade 3. The results are presented in the following figures (Figures 1-6). Grade 1 is not presented in a separate graph, as only one reference to MbL was identified at this level; this reference involved the use of a ready-made model.

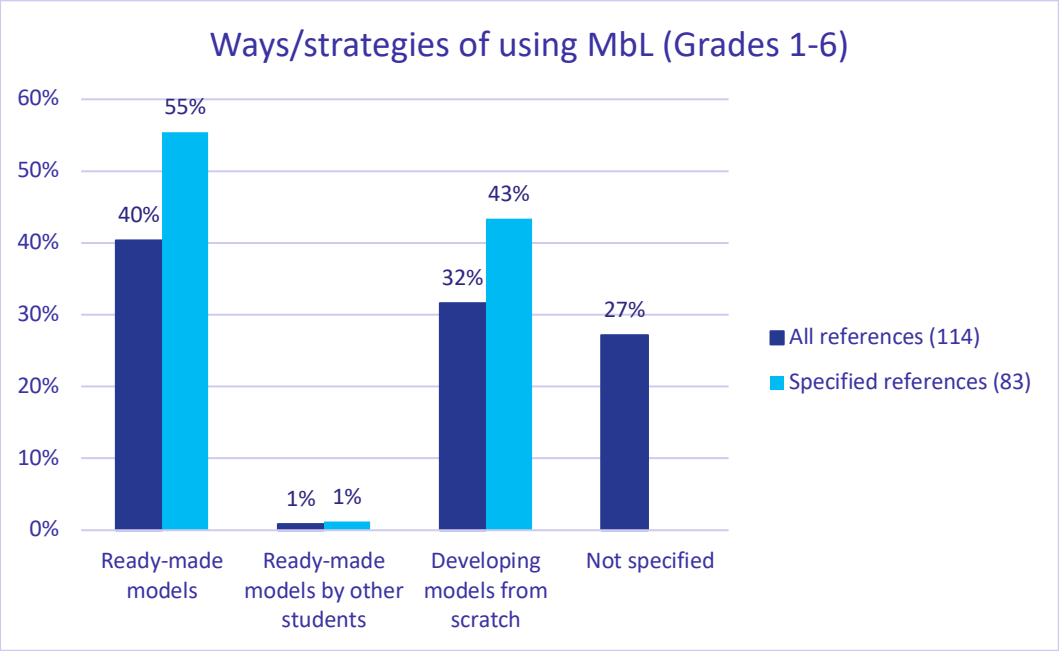

Figure 1. Distribution of MbL strategies across Grades 1–6: all references and specified references

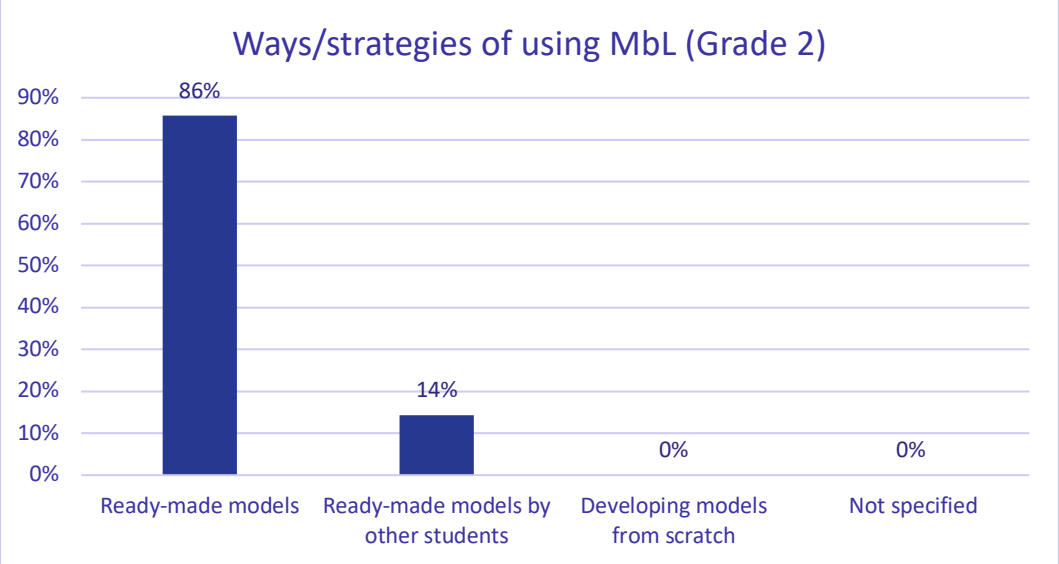

Figure 2. Distribution of MbL strategies across Grade 2

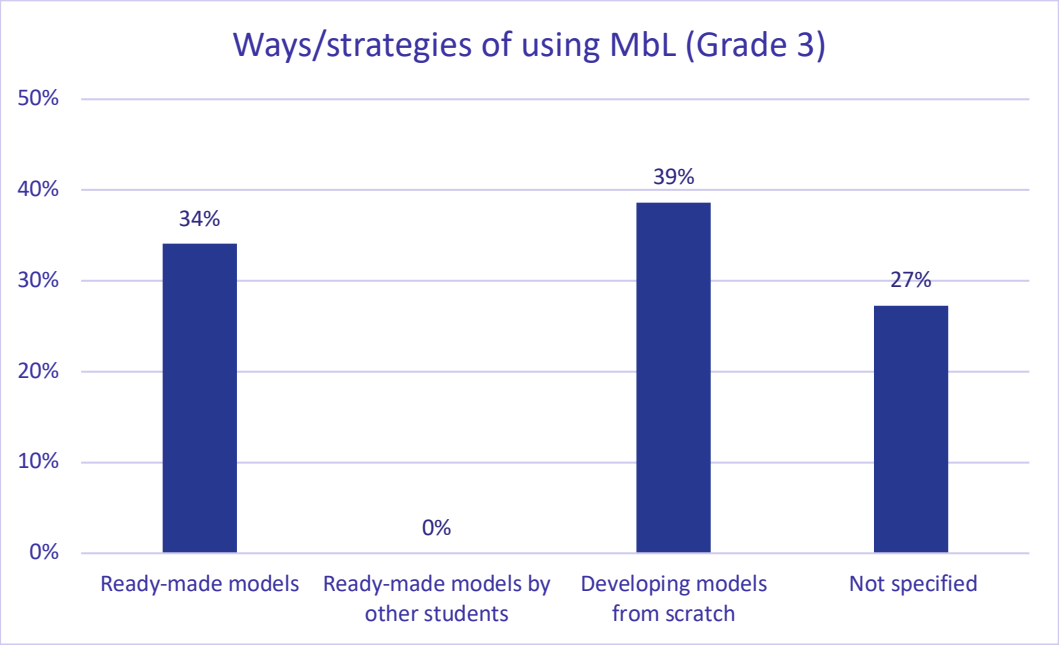

Figure 3. Distribution of MbL strategies across Grade 3

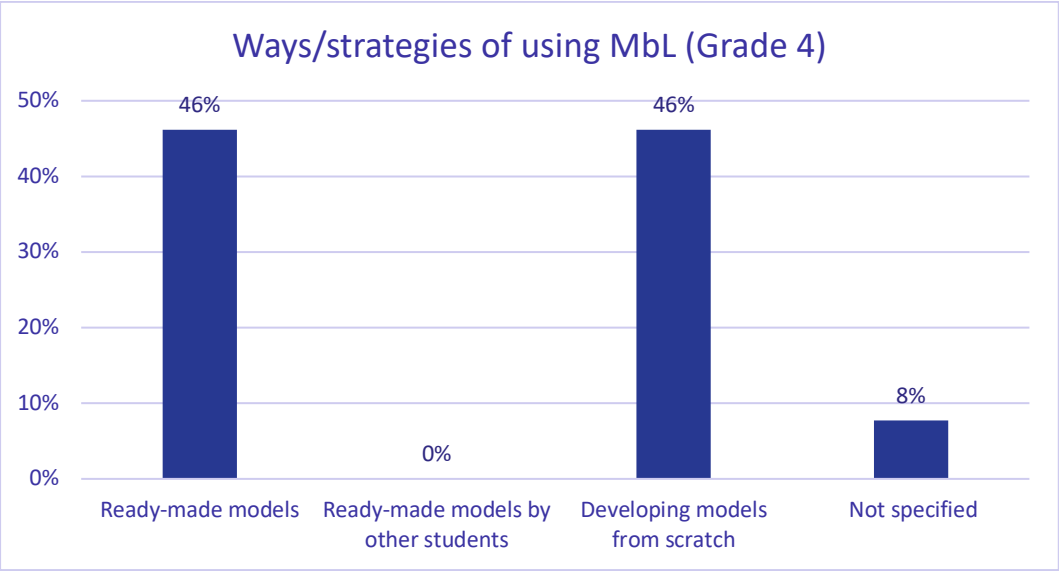

Figure 4. Distribution of MbL strategies across Grade 4

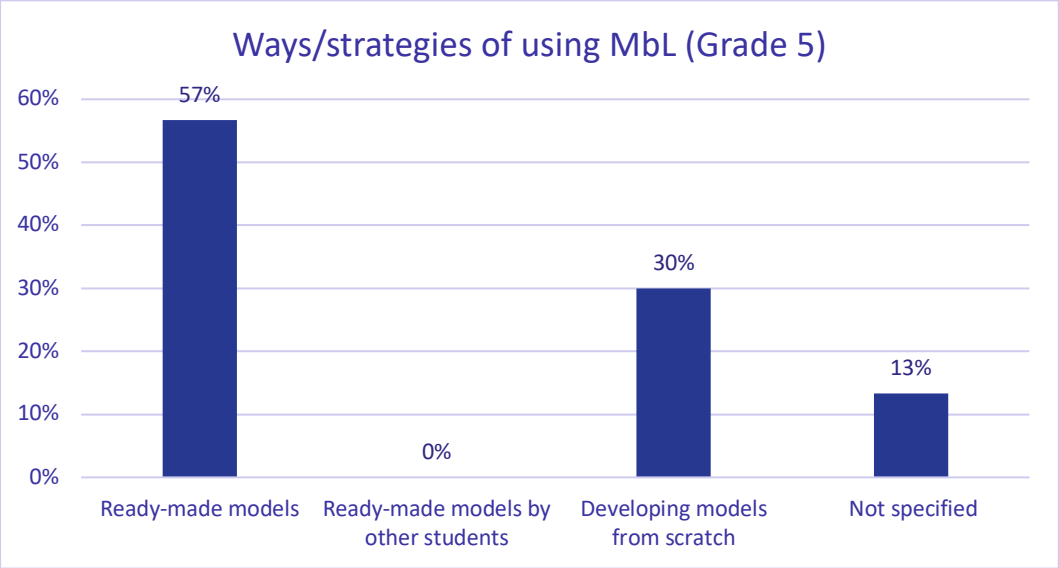

Figure 5. Distribution of MbL strategies across Grade 5

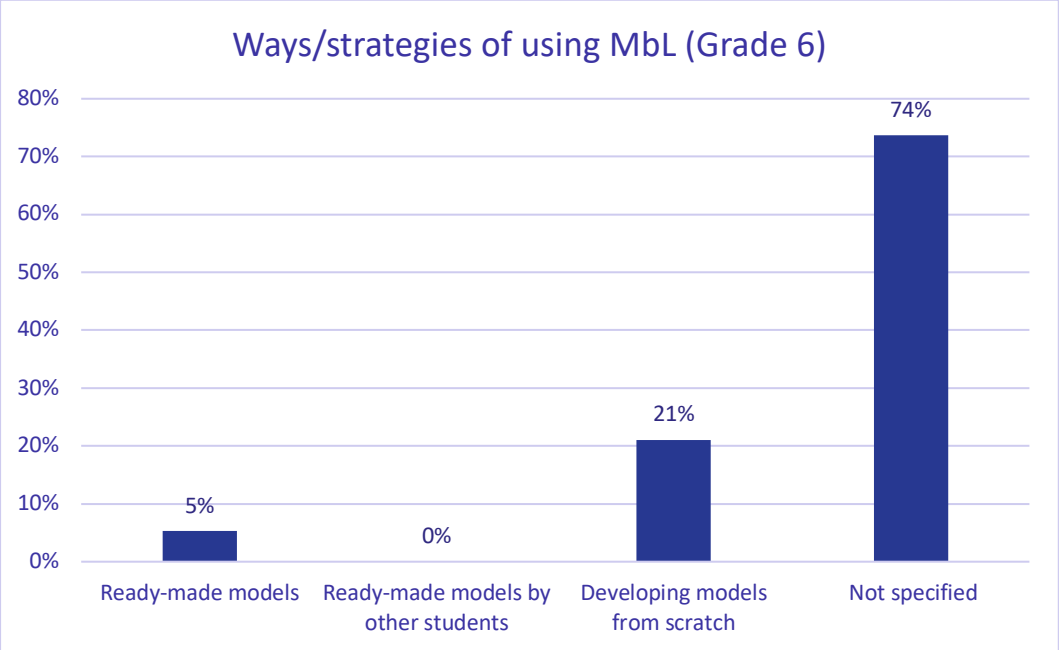

Figure 6. Distribution of MbL strategies across Grade 6

4.2 Definitions of modelling competence

Only two references were identified under the category Definitions of modelling competence, appearing in Grade 3 and Grade 6. Both references were addressed to teachers, rather than directly to students, and described modelling as a competence or skill related to scientific inquiry and working with models. This suggests that the curriculum materials provide only limited explicit explanation of what modelling competence means, and that these explanations mainly function as background guidance for teachers.

Overall, modelling competence is not strongly foregrounded as an explicit learning goal across the primary curriculum. Instead, students appear to encounter modelling mainly through practical activities and topic-specific tasks, while the broader meaning of modelling as a scientific competence remains mostly implicit or not fostered at all.

4.3 Significance of models in the natural sciences

References to the significance of models in the natural sciences appeared relatively infrequently in the analysed curriculum materials. Overall, this category was identified in 12 references across the grades. The general category *Significance of models* in the natural sciences appeared in 6 references, mainly describing the role of models as tools for representing, explaining, or understanding scientific phenomena. The subcategory *Significance of models* in the educational process appeared in 3 references, all in Grade 3, suggesting that models are sometimes explicitly presented as tools that support students' learning and understanding. The subcategory *Significance of models* in the modelling process in Science also appeared in 3 references, in Grades 2, 3, and 6, where modelling was linked more directly to scientific inquiry or the process of working with models.

The limited number of references suggests that the curriculum materials tend to emphasise what students should do with models rather than explicitly discussing why models are important in science. Within these limited references, the significance of models is mainly framed in terms of their role as tools for representing, explaining, or understanding scientific phenomena; however, this emphasis does not necessarily imply that students' epistemic understanding of the significance of models in the natural sciences is systematically fostered.

4.4 Types of models

In relation to the types of models represented in the curriculum materials, physical models were the most frequent category, appearing in 50 references. This indicates that students are often expected to work with concrete or material representations of scientific phenomena, particularly in Grades 2, 3, 4, and 5. Conceptual models were the second most frequent type, with 23 references, appearing mainly in Grade 5, especially in topics such as electricity. Not

specified appeared in 20 references, meaning that in these cases the text referred to models but did not clearly identify the type of model involved. Other model types appeared less frequently, including 3D models with 8 references, diagrams with 3 references, digital models with 3 references, multiple types of models with 3 references, mental models with 2 references, 2D models with 1 reference, and role-play/embodied models with 1 reference. The distribution of model types is presented in the following figure.

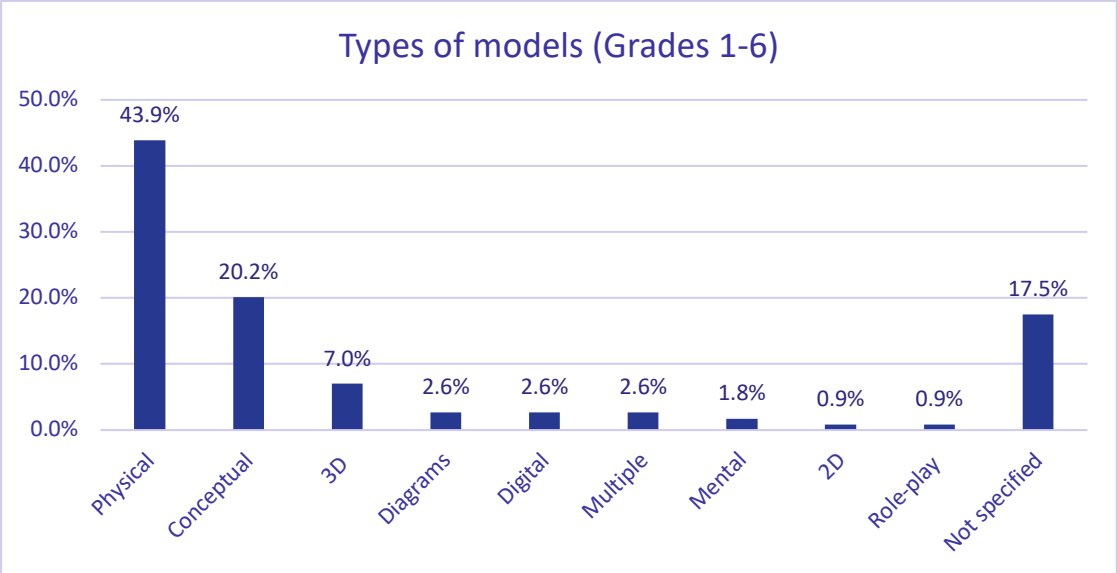

Figure 7. Distribution of model types across Grades 1–6

4.5 Contexts of model use

In relation to the contexts in which models were used, the references were distributed across several science content areas. The most frequent context was Earth and sky, with 51 references, mainly appearing in Grades 3 and 6. This indicates that modelling is strongly associated with topics such as the Earth, the sky, planetary motion, and related astronomical phenomena. The second most frequent context was Electricity, with 19 references, all identified in Grade 5, followed by Human body and health with 10 references and the Musculoskeletal system with 8 references. Other contexts appeared less frequently, including Light with 7 references, Energy with 4 references, Natural environment with 4 references, Forces with 3 references, Heat and temperature with 3 references, Body and health with 3 references, and Living organisms with 2 references. The distribution of contexts of model use is presented in Figure 8.

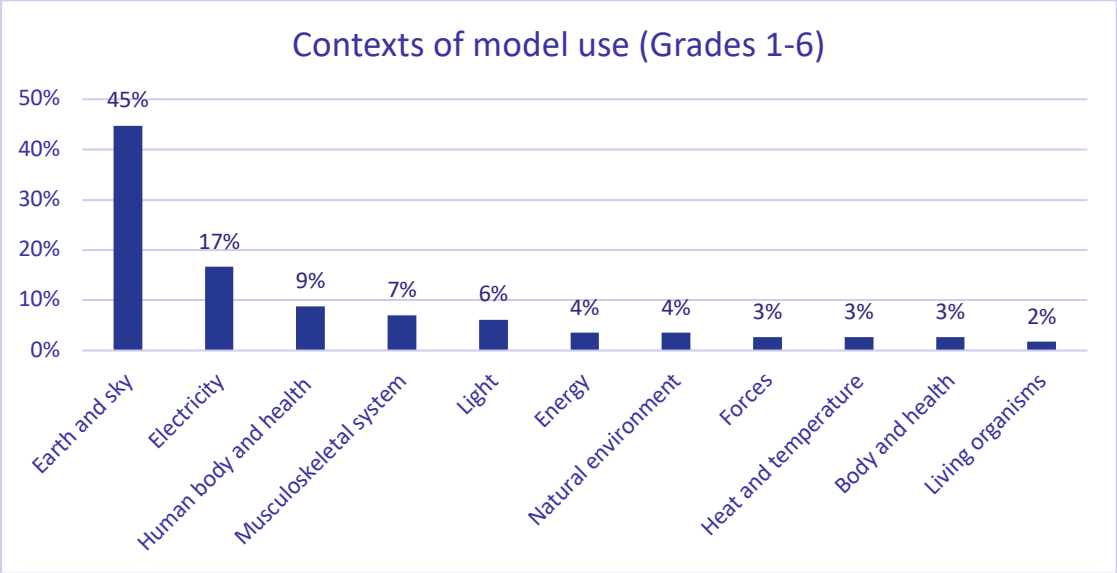

Figure 8. Distribution of contexts of model use across Grades 1–6

4.6 Modelling practices

In terms of modelling practices, 77 references (68%) out of the total 114 references explicitly mentioned a modelling practice, while 37 references (32%) did not specify a particular practice. The most frequent category was model use/selection of models, with 40 references (35%). This indicates that students are most often expected to use or apply existing models. Model creation appeared in 20 references (18%), showing that students are also given opportunities to construct or develop models, although less frequently than they are asked to use existing ones. Model evaluation appeared 12 times (11%), while model revision appeared only 5 times (4%), suggesting that higher-level modelling practices, such as evaluating and improving models, are present but less strongly represented. These results are presented in Figure 9. In addition, the distribution of each category by grade level is presented in the following figures (10-14). Grade 1 is not included in these figures, as it contained only one reference, which was coded as model use/selection of models.

The relatively low number of references to model evaluation and revision suggests that students may have fewer opportunities to engage with modelling as an iterative scientific process. While using and constructing models are important aspects of MbL, evaluation and revision are also central because they help students understand that models are tentative, purposeful, and open to improvement.

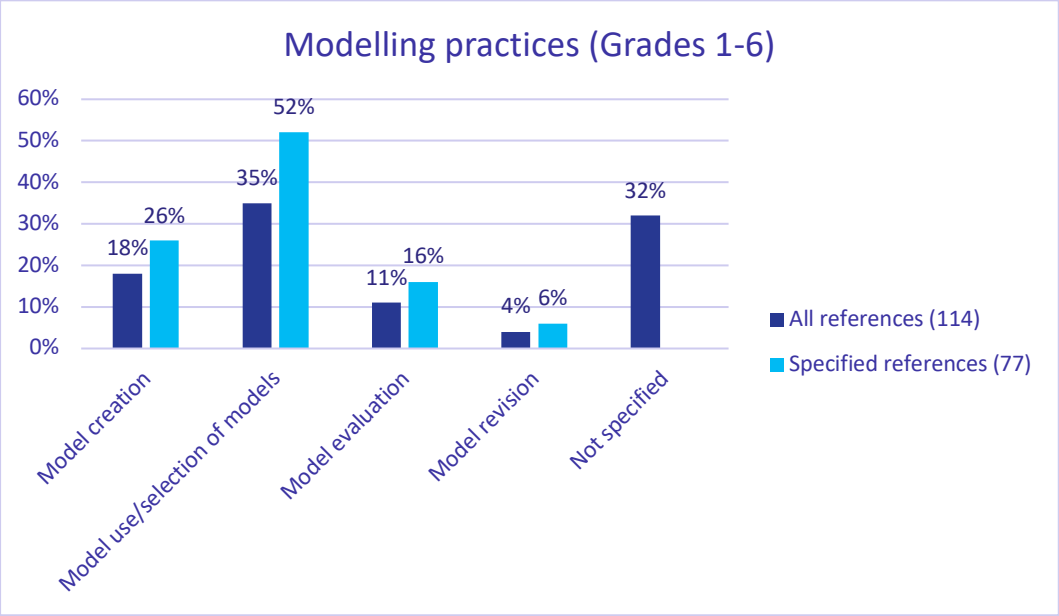

Figure 9. Distribution of modelling practices across Grades 1–6: all references and specified references

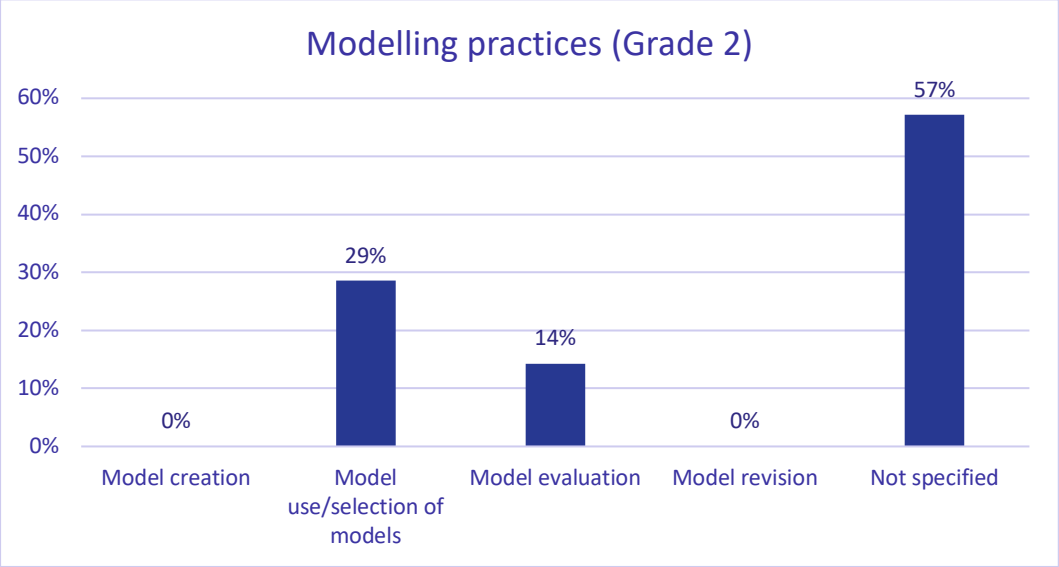

Figure 10. Distribution of modelling practices across Grade 2

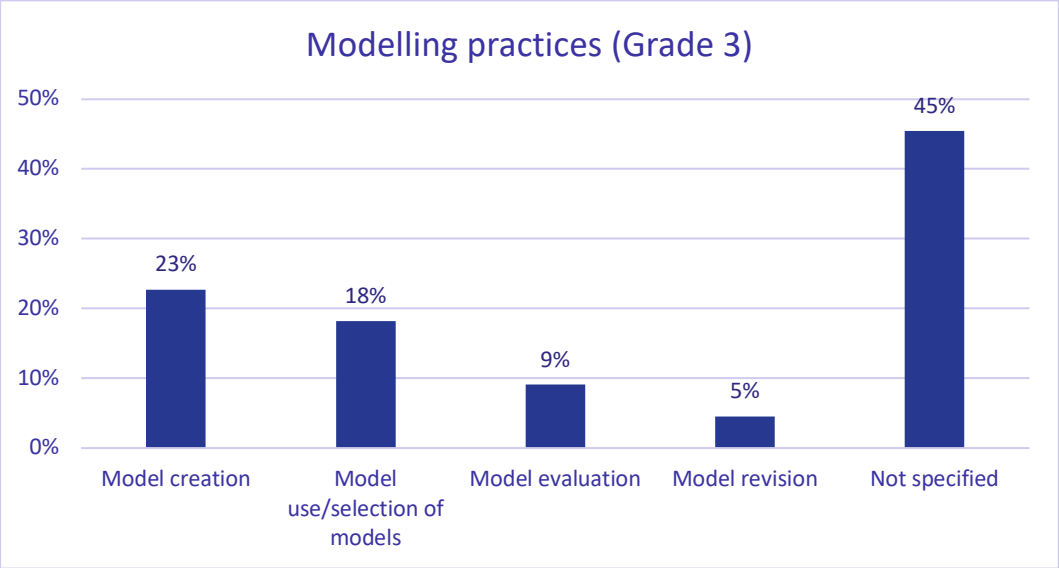

Figure 11. Distribution of modelling practices across Grade 3

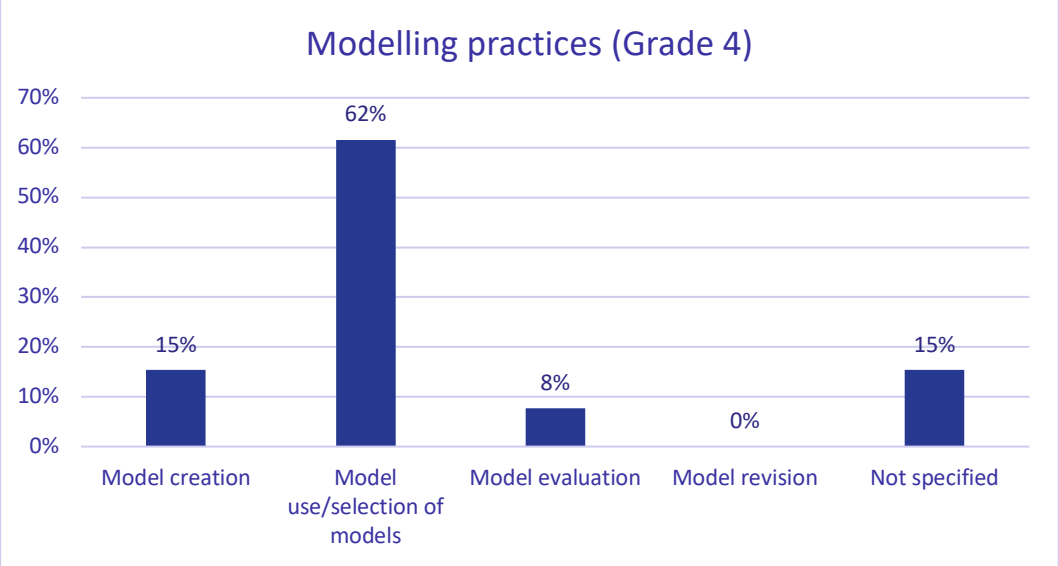

Figure 12. Distribution of modelling practices across Grade 4

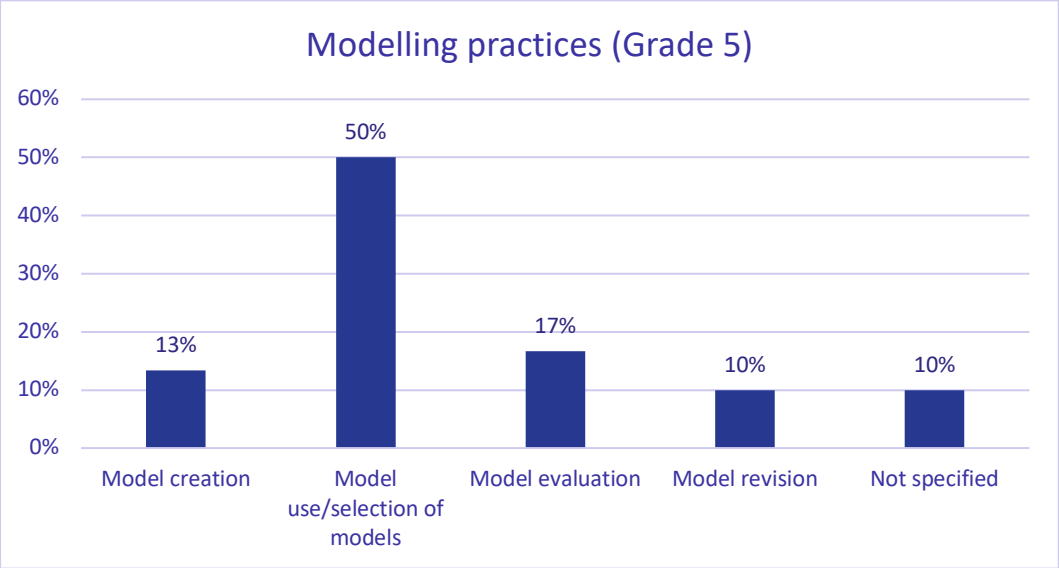

Figure 13. Distribution of modelling practices across Grade 5

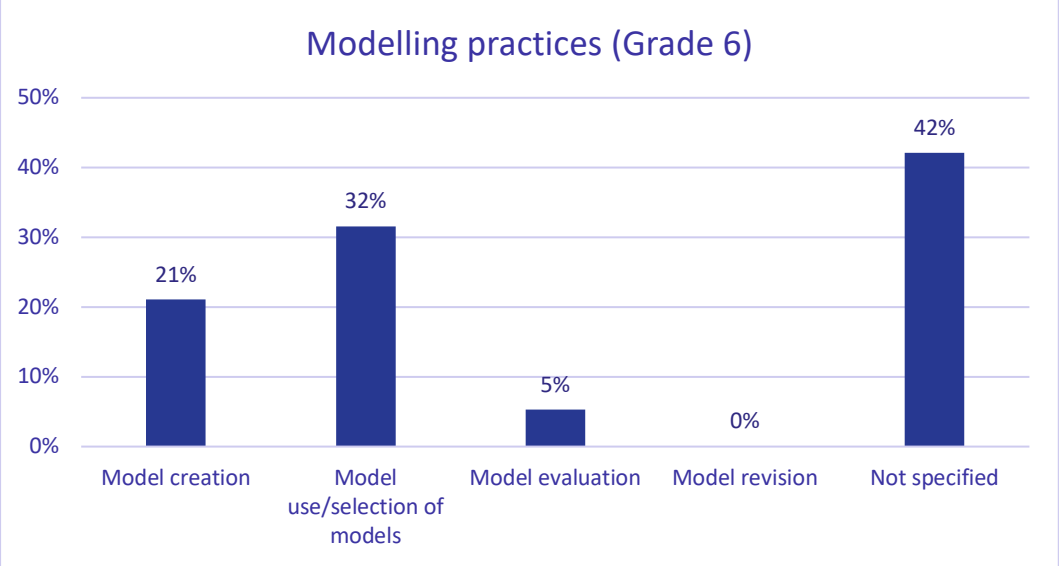

Figure 14. Distribution of modelling practices across Grade 6

4.7 Meta-modelling knowledge

In relation to meta-modelling knowledge, only 17 references out of the total 114 references explicitly addressed this category, while 97 references were coded as not specified. All identified references belonged to the subcategory knowledge about the properties and functions of models, which includes references to model characteristics, functions, limitations, scope, validity, or realism. No references were identified for knowledge of the modelling process, suggesting that the curriculum materials do not explicitly discuss the steps involved in modelling, such as developing, testing, evaluating, or modifying models as a process. The identified references appeared mainly in Grade 3, with 11 references, followed by Grade 5 with 4 references and Grade 2 with 2 references. No explicit references to meta-modelling knowledge were identified in Grades 1, 4, or 6. The results are presented in Figure 15.

This pattern suggests that students are more often asked to use models than to reflect explicitly on the nature and purpose of models. Strengthening references to meta-modelling knowledge could help students better understand why models are useful, how they differ from reality, and why they may need to be evaluated or revised.

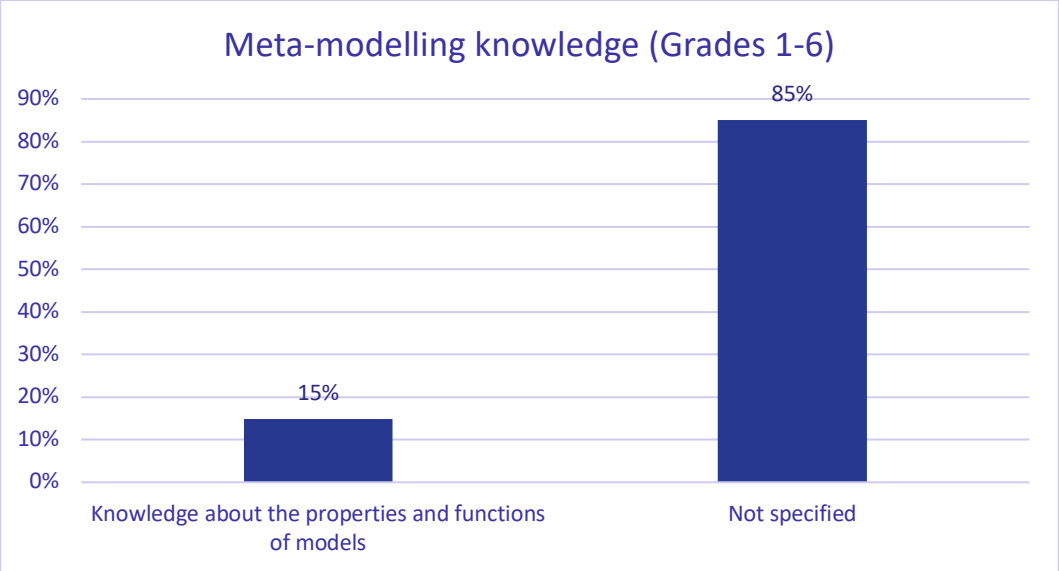

Figure 15. Distribution of meta-modelling across Grades 1–6

4.8 Aim of the text

In relation to the aim of the text, the majority of references were addressed to students. Specifically, 75 references out of the total 114 references were coded as student-oriented, while 39 references were addressed to teachers. This indicates that modelling is most often embedded in learning objectives, student activities, or classroom tasks, rather than appearing

only as background information or guidance for teachers. However, the presence of 39 teacher-oriented references also shows that the curriculum materials provide teachers with explanations, instructional guidance, and contextual information about how models can be used in science teaching. The results are presented in Figure 16.

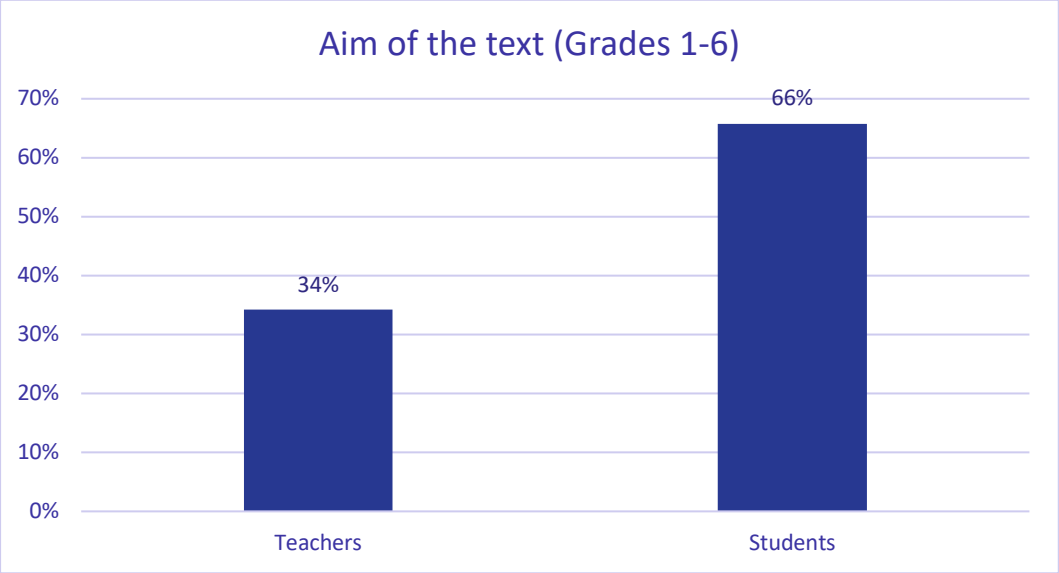

Figure 16. Distribution of references by target audience across Grades 1–6

This distribution suggests that the curriculum materials do not present modelling only as teacher background knowledge, but also as an activity-oriented approach for students. Nevertheless, teacher-oriented references remain important, as they provide the pedagogical framing needed for teachers to guide students' engagement with models.

5. References

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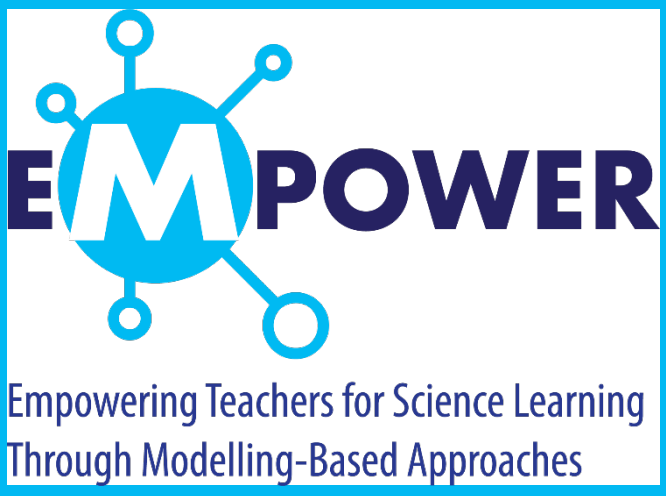

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