NCCA

Supporting Mathematical Modeling in the classroom

This Support Material highlights an important pedagogical approach for emphasising mathematical modeling in the classroom and provides a variety of examples of mathematical modeling activities.

Getting started with Mathematical Modeling

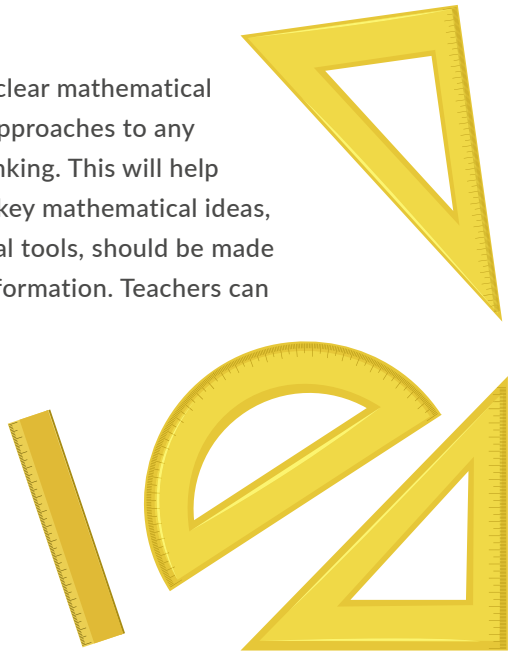
In emphasising mathematical modeling, children should be supported to develop their own ideas rather than directing them to follow pre-determined procedures. It is not necessary to pre-teach mathematical content as children build on existing knowledge and develop new understandings as they undertake modeling activities. Modeling activities used at the start of a unit of work can serve to make children's thinking visible and provide information to inform teachers' planning.

A suggested sequence or supporting Mathematical Modeling

- A problem is posed. This problem should be meaningful or imaginable for children. If necessary, prior work and discussion should be carried out to ensure that children are familiar with the problem context.
- The class discusses initial suggestions, estimates, and mental solutions if appropriate. These can be recorded on the board.
- Children then work in pairs or groups.
- Familiar resources, such as a selection of concrete materials, graph paper, or digital technologies should be available for children to choose from if they wish. The teacher should not specify which materials children should use for their solutions.
- Children are supported to describe or write about their solution methods and encouraged to question each other.
- A selection of solutions may be presented and discussed in the whole class setting with an emphasis on supporting children to make connections between different models and to evaluate the effectiveness of methods presented.
- Children have opportunities to refine their models or try out the methods of others as appropriate.

Planning and preparation

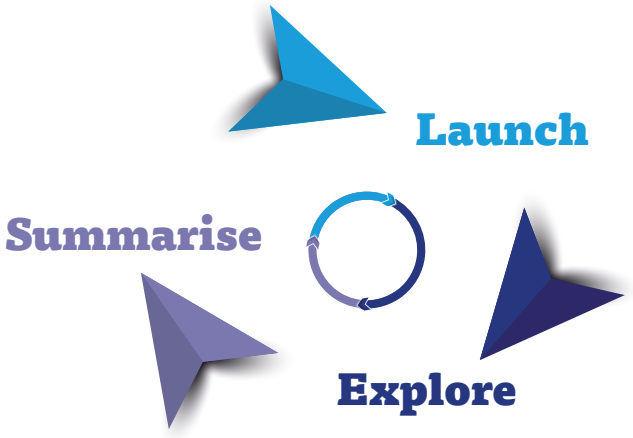
When planning for modeling activities, it is important that teachers have clear mathematical learning goals in mind. Teachers should take time to explore a variety of approaches to any modeling problems they intend to use in order to anticipate children's thinking. This will help teachers plan how to address misconceptions, orchestrate discussions of key mathematical ideas, and decide what supports, such as concrete materials, calculators or digital tools, should be made available. Many complex problems will require extra non-mathematical information. Teachers can identify how and when such data will be accessed.



Teachers should anticipate the different ways that children may think about modeling problems and consider what resources they may need to make available to support children's thinking.

There is no one way to orchestrate activities involving mathematical modeling but, as with problem-solving lessons more generally, following the Launch-Explore-Summarise structure (adapted from Suh and Seshaiyer, 2017), may be helpful.

Launch	Explore	Summarise
Posing the Problem Familiarisation with problem context. What mathematical questions come to mind?	**Making assumptions to define and simplify the real world problem.** Considering the variables. What data/information is needed to answer the question? Generating models and solutions	**Analysing and validating conclusions. Does the model/solution make sense?** Applying the solution to the real-world scenario. How does it fit? What needs to be revised?



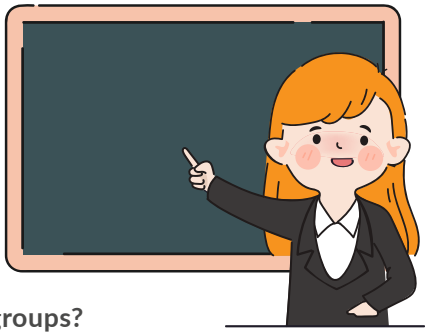
For cross-curricular topics warm-up activities to familiarise children with the context are very important. Intended learning outcomes and expectations should be made explicit, particularly if children are not accustomed to tasks with multiple solutions/ solution strategies. Collaborative groups are recommended, with teachers working to support genuine collaboration where necessary. Teacher interactions with groups should aim to elicit and support the development of children's own ideas rather than leading them to a correct or preferred solution. As teachers observe children's work, and with the intended learning goals in mind, they can select which groups should present their models to the whole class. Whole class discussion can be used to direct attention to the underlying mathematical structure of various models and should support children to evaluate the strengths and weaknesses of models. Children should be encouraged to produce multiple solutions and lessons (or sequences of lessons) should be structured to allow time for children to refine the models they create and/or to trial and evaluate other groups' ideas if appropriate. Importantly, a lesson may consist of one or more launch-explore-summarise cycles as children are supported to reflect on and revise their thinking.

Reflection and assessment

Mathematical modeling is a process, and assessing children's engagement in this process involves more than simply assessing the end-products of their work. Ultimately, the content and method of assessment should be meaningfully connected to the learning goals for the lesson and should inform planning for future lessons.

Teacher reflection on Classroom Activities

Some questions that might guide teachers' reflection on whether classroom activities display the characteristics of mathematical modeling (*adapted from Hirsch, 2016, p. 256.*)



Was the initial problem realistic or imaginable for students?

Did they ask questions and make assumptions about the problem context? *(Necessary for complex problems)*

Did they select/use mathematical tools and resources to solve and/or represent the problem?

Did they explain if/when their solution makes sense?

Did they test their model/solution and revise if necessary?

Did they compare their approaches with those developed by other groups?

Learner self-reflection

Some questions that might support learners to reflect on their engagement with mathematical modeling (*adapted from Suh and Seshaiyer, 2017*)

Application of mathematics to the problem

In what ways did mathematics help me solve the problem?

How did maths help me make predictions and decisions related to the solution to the problem?

Understanding the problem

What did the problem look like?

How did I define the problem?

What were my first thoughts about the problem? Were they reasonable?

Developing a model

What were the most important factors I considered to help solve the problem? Were they the right ones?

What data or information was most useful in helping me solve the problem?

What models did I use to help develop a solution?

What tools helped me formulate my models (e.g. diagrams, graphs, tables, equations, images)?

Applying a model

What models helped me best show my understanding of the problem or the solution to the problem?

In what ways does it help me justify my solution or explain my mathematical thinking?

Reflecting on the model used

If doing it again, would I use the same model? If no, why not?

How did I make sense of what other people did in approaching the problem?

If working with someone else, did they help refine my model?

Resources

Ideas from Suh & Seshaiyer (2017), including the '*Modeling Mathematics Ideas Toolkit*', available from http://modelmath.onmason.com/. The related website, http://sparkstem.onmason.com, contains ideas and samples of children's work on integrated STEM activities.

www.Maths4All.ie

Model-Eliciting Activities for upper primary and secondary students available at https://unlvcoe.org/meas

Guidelines for Assessment and Instruction in Mathematical Modeling Education (GAIMME) Report

References

Hirsch, C. R., (Ed). (2016). *Mathematical modeling and modeling mathematics: Annual perspectives in mathematical education* 2016. Reston, VA: National Council of Teachers of Mathematics.

Suh, J. & Seshaiyer, P. (2017). *Modeling mathematical ideas: Developing Strategic Competence in Elementary and Middle School.* London: Rowman & Littlefield Publishers