VOLUME OF A CYLINDER: A COLLABORATIVE APPROACH FOR CO-DESIGNING RICH TASKS

TEACHERS CO-DESIGN RICH MATHEMATICAL TASKS

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SUITABLE FOR	SUBJECT(S)	KEY FOCUS
Teacher collaboration	Physics, Mathematics	Collaboration Co-design

INTRODUCTION

The use of problem and inquiry-based learning approaches to develop skills and competences in physics and mathematics education have been strongly promoted over the past two decades. Recent studies highlight that an integrated approach to STEM education can be effective in supporting students to develop a range of transversal competences such as problem-solving, innovation and creativity, communication, critical thinking, meta-cognitive skills, collaboration, self-regulation, and disciplinary competences (McLoughlin et al., 2020). A central theme in integrated STEM education research is the value of using real-world contexts as a basis for designing 'authentic' learning opportunities in the classroom (McLoughlin et al., 2020). The age group of 10-16 years is a critical period for the formation of science aspirations of young children (DeWitt & Archer, 2015). This is also the age when students undertake several educational transitions, including transitions across school systems (e.g., primary level to second level), transitions between teachers, transitions across subjects (e.g., moving from a general science curriculum to a specialised physics curriculum). A systematic review of research on science and mathematics transitions noted that the experiences of transition, if negative, may impact not only on students' academic performance but also strongly associate with the development of their scientific identities and their aspirations for scientific careers (Kaur et.al., 2022a). The review highlighted that a lack of communication and collaboration between teachers is a key factor that influences students' experiences of science learning across primary-secondary transitions. The approach presented below proposes one way in which teachers can work collaboratively to design rich tasks for their classrooms.

TASK DESCRIPTION

Here, we present a framework for supporting teachers in co-designing rich tasks. It is presented in the context of a problem where students are asked to calculate the volume of a cylinder.

To support teachers in codesigning rich tasks in physics and mathematics, a structured approach via the six-step SAMRII (Solve, Anticipate, Modify, Reflect, Implement, Inquire) model is presented. The SAMRII model offers a structured approach to designing rich tasks for differentiated instruction.

This is a collaborative task for teachers, allowing them to adapt and co-design a rich task suitable for the contexts in which they work.

TASK IMPLEMENTATION

The SAMRII Model

Figure 1 shows the six-step structured approach – the SAMRII model for co-designing rich tasks.

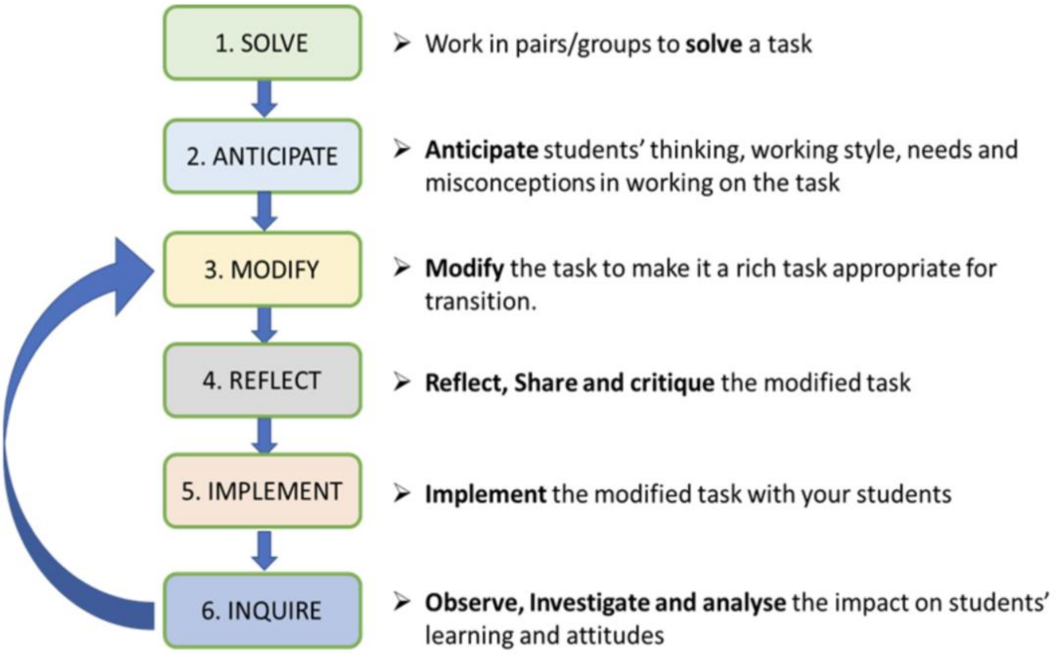


Figure 1. SAMRII model for co-designing rich tasks

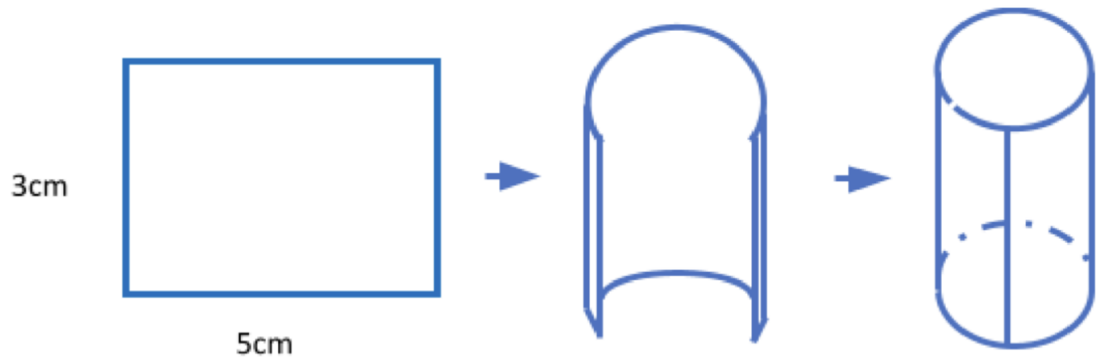
Teachers (ideally working as part of a professional learning community) can be facilitated to complete the different steps of the SAMRII model, culminating with implementing their own rich tasks in the classroom and examining the influence on their students' learning. Further prompts for each of the first four steps can include the following:

Co-designing rich task

1. SOLVE	**Solving a given task in pairs/groups** *Solve/Develop a task of your choice* *The task can be taken from an existing resource or you can design a new task.*
2. ANTICIPATE	**Anticipate students' conceptions, pre-conceptions and misconceptions/errors** *Think of your own students, anticipate the students needs, preconceptions and difficulties your students may have while working on this task.*
3. MODIFY	**Modification in the task (Modify the task as needed)** *Does the modified task address student difficulties/alternative conceptions ?* *(include Brainstorming questions required at various steps)* *What transition factors does it address?* *Does it allow students to apply their previous knowledge and understanding?*
4. REFLECT	**Reflect individually. Share and Critique in your PLC**

Initial Task – Volume of a Cylinder

A rectangular piece of paper is rolled into a cylinder to form a cylindrical tube (as shown). What is the volume of the cylinder that is formed?



Teachers, working in pairs, first work in pairs to solve this task and then modify it, based on the steps of the SAMRII model.

The above approach was implemented with a professional learning community of teachers in Ireland. An example of some of the ideas for task development that emerged is presented in the image below.

Modifying the task

(Modify the task as needed)- Example from PLC

Learning Outcomes:
- Appreciating the relationship between 2D shapes and 3D shapes
- Understanding the links between Area of 2D with Volume of 3D shapes
- Recognising nets of 3D shapes
- Taking appropriate measurements to calculate Area, Volume and Surface Area

Modifying the task:
- Start with 2D familiar shape e.g. rectangular page
- Build up to 3D Volume of Cuboid
- Bring in the net of the cylinder
- Use a beans tin label to show connection to surface area and volume

For Physics
- Use tin with base removed and another with base in place
- Show displacement = volume
- Archimedes principle

KEY LEARNINGS

Teachers reported that they appreciated the opportunity to co-design a rich task and identified that this activity provided them with opportunities to explore different perspectives on teaching a given topic and learn from each other's experiences. Anticipating students' needs (step 2 of SAMRII) was perceived to be very helpful to the teachers as it provided them with the basis for modifying the task according to different students' abilities and backgrounds.

Teachers' feedback included:

- *'Enjoyed the collaboration of designing the task and teasing out thoughts with the group members'.*
- *'When designing the rich task we can develop the task on 'either side' of where we might initially think that we are beginning. e.g. As teachers we think that we are beginning at the volume of a cylinder but we made the task richer by working it backwards to the area of the rectangle and/or working it forwards to Archimedes' Principle'.*
- *'What stood out most is 'the difference of ideas and how others approach a problem' and 'The different takes on the Rich Task'.*
- *'The co-designing of the task highlighted potential student misconceptions. Additionally this allowed me to hear how other teachers would manage these misconceptions in their classroom. I also was reminded of the power of collaborative learning. Doing the task together allowed me to hear about how others would solve the problem that I wouldn't have otherwise thought of. It showed me how collaboration could help my students with problem solving'.*

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CONCLUSION

The SAMRII model presented here offers one approach for teachers to work collaboratively to design a rich task. Teachers' engagement in co-designing tasks can provide worthwhile learning experiences not only for their own professional learning but also designing appropriate learning opportunities that address their students' needs.

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