Quality Numeracy tasks: stress test of a rubric (background and notes).

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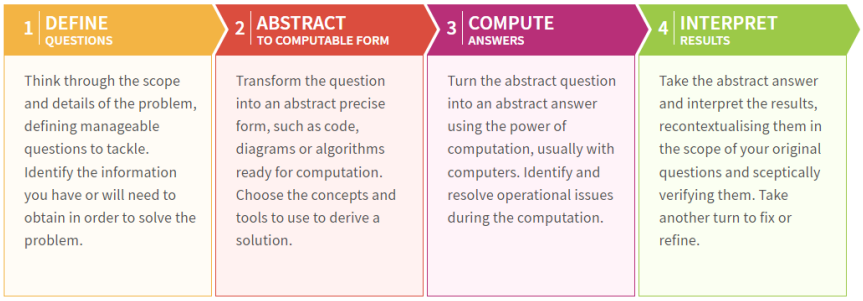
We will use numeracy as an umbrella term for Quantitative Literacy, Quantitative Reasoning and Mathematical Literacy, but there is no logical reason for its primacy. What unites them is the interest in helping students and citizens transfer the mathematics they are learning (or are deemed to have learned) in school math to 'real life'.

Rationale 1: numeracy (and its family members) needs to be disentangled from mathematics. Shifting the question from 'What are they?' to 'What are they about?' really Steen (2001) helps us out: Mathematics is abstract and Platonic, offering absolute truths **about** relations among ideal objects. Numeracy is concrete and contextual, offering contingent solutions to problems **about** real situations.

Rationale 2: the above conceptualization needs to be grounded into a form that is useful for teaching practice. We suggest that a dichotomy of mathematics vs numeracy tasks will better help shape what a numeracy task can be. The conceptualization flows from Steen's work.

Mathematics task: *about mathematical ideas and objects and their relations (stays in abstract).*
Numeracy task: *about concrete, context-centred phenomena (use abstract to make sense of concrete).*

Rationale 3: what is the thinking process involved. Verschaffel et al (2000) Burkhardt (2008) and OECD (2016) produced good ones. We chose Conrad Wolfram's computational thinking process: Source: https://www.computationalthinking.org/



Suggested characteristics of a good Numeracy Task as rough foundation of rubric development.

1. are about concrete situations involving concrete objects and their relations, not about predetermined mathematical structures.
2. must (as much as possible) take the student away from their 'in class' setting and place them in a context that is concrete 'real world' in nature.
3. are presented as close as possible to the way they would be in the concrete context they are about.
4. are set in a context that is relevant and accessible to the student/program of study.
5. require shifting from concrete to abstract (abstract to computable form… or mathematize/quantify concrete situation) or from abstract to concrete (interpret results)
6. may involve computations. The computations/calculations are an important element of numeracy task completion, but can be done by computer or other means. The actual method used is not what the task is about.

Rubric 1. Purpose: for the teacher/designer to assess the extent to which the task is well designed and to identify areas that can be improved. Any task that is presented to a student can be assessed with this rubric.

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criteria	**Highest sophistication**	**Mid sophistication**	**Low sophistication**
Concrete nature of context	The task description takes the student (or group of students) out of the classroom or away from their desk and places them explicitly in a concrete context, making it easy to decide whether a student (or group of students) is familiar with the language/culture of that context or has experience in it.	The task description implies that the student (or group of students) is in a concrete context and attempts to take them out of their student mode, though the concrete context is clear, the student (or group of students) is not explicitly placed in that context.	The task description does not attempt to place the student (or group of students) into a concrete context, instead steering a student to use a particular mathematical tool or series of operations.
Authenticity of Scenario within Context	The scenario is presented in a way that it would appear in the given context. The challenge or problem that is to be solved is one that would arise in that context.	The task presented is framed in such a way as to simulate a response to a concrete situation, but may or may not arise in that context or is not presented in a way that it would appear in that context.	The task presented is framed in such a way as to be unrealistic or impossible in the described context.
Task description (aboutness) content	The task presented demands a focus on and response to a concrete situation within the scenario. Though it demands the use of quantitative methods and/or mathematical tools, it is not about the mathematics that is/needs to be used. A solution using informal methods is just as valid as one using formal mathematical methods.	The task presented leaves some ambiguity as to whether it will demand a focus on and response to a concrete situation within the scenario, or whether the student (or group of students) is expected to use an appropriate formal mathematical tool as part of their solution.	Though framed in a concrete sounding context the problem or challenge is presented in a way that focuses attention (or directs students attention) towards a particular mathematical tool to be used, or a procedure to be followed.
Task description (required response)	The task described makes explicit the need for responses (however trivial) to each of the following actions of the adapted Wolfram computational thinking process (Define, Abstract, Compute, Interpret - see breakdown in rubric 2). More than one single correct set of responses to the posed task is possible.	The task described requires some but not all of the following actions of the adapted computational thinking model (Define, Abstract, Compute, Interpret). More than one single correct set of responses to the posed task is possible.	The task described requires a single numerical response (perhaps with units) simply plugging quantities into a pre-defined procedure/formula. Only one single correct response to the task is possible.

Rubric 2. Purpose: for teacher/designer to assess the tasks ability to provoke responses to each of the following actions: Define, Abstract, Compute, Interpret.

criteria	**Highest sophistication**	**Mid sophistication**	**Low sophistication**
Define the question.	Scenario described (with or without visual support) such that a person familiar with the context will need to reframe the scenario with a focus on quantitative elements in order to complete the task. The student will need to describe assumptions or simplifications made in order to reduce any ambiguity inherent in task description.	Scenario described (with or without visual support) such that a student familiar with the context will need to make slight adjustments in order to reframe the scenario with a focus on quantitative elements. Few decisions will have to be made to reduce any ambiguity inherent in the task description.	Scenario is described using quantitative language such that the student simply needs to locate and select the correct quantitative elements in order to complete the task.
Abstraction :	Scenario requires reframing into a formal or informal mathematical model (i.e. in preparation for computation) and allows for at least one correct approach. No new mathematics needs to be developed to solve the task(s) presented in the scenario.	Scenario requires a straightforward restatement into formal or informal mathematical model (i.e. in preparation for computation) and allows for at least one correct approach. No new mathematics needs to be developed.	Scenario is framed in a way that a student or group of students simply plug numbers into a well established formula in preparation for computation
Computation and result(s):	Scenario requires calculation(s) without indicating need for technological help. The calculation method used by the student can be similar to what would be expected in the context of the scenario, but does not need to be so. Expected results of calculations can include visual and or numerical formats, charts and/or graphs as warranted and appropriate.	Scenario requires calculation(s) with or without technological help. The calculation method used by the student can be similar to what would be expected in the context of the scenario, but does not need to be so. Expected results of calculations do not include visual and or numerical formats, charts and/or graphs as warranted and appropriate.	The calculation method used by the student is one that is directed by classroom parameters, not concrete context. Expected results of calculations focus on final numerical product.
Interpret results: Task response expectations	A correct response to the scenario is context based, and requires more than just presenting the result of calculations including some discussion of define and abstract actions, justifying any decisions made. Depending on complexity of task interpretation may include analysis, discussion, justification with logically sound narratives.	A correct response to the scenario is context based, and requires more than just presenting the result of calculations including some discussion of define and abstract actions, justifying any decisions made. Depending on complexity of task interpretation may include analysis, discussion, justification with logically sound narratives.	A correct response to the scenario requires simply the result of calculation with units.

Rubric 3. Purpose: for teacher who is deciding whether to use a numeracy task that passes the sophistication test (assessed at mid to high sophistication in steps 1 and 2) for students in their classroom.

criteria	Yes: use it	Maybe still ok (or possible to modify to shift to yes)	No: don't use it
Appropriateness of context	The concrete context that the student is placed in is one that the student (or group of students) have experience with directly or indirectly.	The concrete context that the student is placed in may be one that the student (or group of students) have experience with, or at least be expected to be somewhat familiar with second hand.	The concrete context that the student is placed in is one that the student (or group of students) do not have experience with, nor can they be expected to be familiar with it second hand.
Accessibility of language and terminology	The language used (especially technical terminology native to the context) is familiar to the student (or group of students) in the classroom setting for the course being taught.	The language used (especially technical terminology) may be familiar to the student (or group of students) in the classroom setting for the course being taught. Technical terminology that is unfamiliar can be rewritten to make the task accessible to all.	The language used (especially technical terminology) is not familiar to the student (or group of students) in the classroom setting for the course being taught. Technical terminology would require socializing in order to make it accessible.
Mathematical Expectations	The formal or informal mathematics needed to solve the problem can be expected to be familiar to the student (or group of students) to whom the task will be presented.	Some of the formal or informal mathematics needed to solve the problem may not be familiar to the student (or group of students) and thus some teacher intervention may be required.	The formal or informal mathematics needed to solve the problem are not be familiar to the student (or group of students) and need to be taught in order that the task be completed successfully.

References:

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Verschaffel, L., Greer, B. and De Corte, E. eds. (2000) Making sense of word problems. CRC Press.

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