

CMEF 2014 Vignette
A pedagogical reflection.

A 'rubrics cube' for the teaching and learning of mathematics.

Dr. Jamie S. Pyper
Faculty of Education, Queen's University

The theme of this vignette is about efforts to improve learning that emphasizes and encourages learner ownership more than teacher or instructor control. But first, a vignette within a vignette...

I like games and puzzles, and metaphors. The Rubik's cube was popular when I was an early high school student. A good friend of mine, whose nickname was 'fast Eddie' because he approached everything at a slow methodical thoughtful pace, doubly earned his nickname because he could solve the Rubik's cube consistently under twenty seconds. My fastest times are not important to this vignette. What is important is the little aha moment I had remembering my friend 'fast Eddie' and the Rubik's cube. The Rubik's cube became a metaphor for teaching and learning mathematics in which the faces are various perspectives to the teaching and learning of mathematics. Each coloured face represents a different perspective, for example, how we are thinking about mathematics, how one is a learner of mathematics, how one is a teacher of mathematics, etc.

So, to come out of that nested vignette I will position a 'rubrics cube' of the teaching and learning of mathematics as the center of this larger vignette.

I have been a secondary school mathematics teacher, an Associate teacher to teacher candidates in my secondary school classroom, and I am now a B.Ed. program instructor of a mathematics teaching and learning theory course. Principles of formative assessment (for example see Black & Wiliam, 2009) or *assessment for learning* means that in all of these contexts I get to be a collaborator in learning. As a collaborator in learning I offer feedback on learners' efforts, assisting in their development of their teaching and learning of mathematics. A strategy I have grown to appreciate as a valuable formative assessment and feedback tool to help learners simultaneously become better self-assessors and peer-assessors is the rubric. This vignette presents rubrics for three of the faces of the 'rubrics cube' of the teaching and learning of mathematics – learning skills, professional practice, and thinking mathematically.

Some other important guiding perspectives to my development of the following three rubrics come from, i., from the Harvard Balanced Assessment project (Harvard School of Education, 1995), in which math is a verb, something we do rather than just something we know, ii., a picture is worth a thousand words, and modeling can be algebraic, numerical, and *graphic*, iii., assessment for learning (see the Ontario Ministry of Education, 2010) is possibly more important than evaluation e.g., during a secondary school mathematics course, and iv., the necessity of independence as a learner rather than dependence upon the teacher. Self-regulation (Bandura, 1991) and conceptualizations of classroom practice that embed learning mathematics in context (for example, see Davis & Simmt, 2006; Simmt, 2011), are also key perspectives to my use of these rubrics when secondary school students are learning mathematics, and when teacher candidates are learning about the teaching and learning of secondary school mathematics.

The first rubric concerns learning secondary school mathematics. I believe students need to have learning skills before they can learn other things, like mathematics. Coinciding with the implementation

of the new Ontario mathematics curriculum in 2000 I developed a Learning Skills rubric. I used sheets of paper for each cell and posted them as a large rubric on my classroom wall. I used a daily tracking sheet (Pyper, 2005) to help facilitate its use with my students. The following is a modification of that rubric to align with the changes to Growing Success in 2010. This version is a collaborative effort with a few teacher colleagues in the secondary school in which I was teaching; Mr. Niall Cooke (media and English), Mr. Scott MacGregor (history), and Mr. Jason Broderick (science).

References

- Black, P., & Wiliam, D. (2009). Developing the theory of formative assessment. *Educational Assessment, Evaluation and Accountability*, 21(1), 5-31.
- Bandura, A. (1991). Social cognitive theory of self-regulation. *Organizational Behavior and Human Decision Processes*, 50(2), 248-287. doi: [http://dx.doi.org/10.1016/0749-5978\(91\)90022-L](http://dx.doi.org/10.1016/0749-5978(91)90022-L)
- Davis, B., & Simmt, E. (2006). Mathematics-for-teaching: An ongoing investigation of the mathematics that teachers (need to) know. *Educational Studies in Mathematics*, 61, 293-319. doi: 10.1007/s10649-006-2372-4
- Harvard School of Education. (1995). Harvard Balanced Assessment Project: Harvard.
- Ontario Ministry of Education. (2010). *Growing Success: Assessment, evaluation, and reporting in Ontario schools*. Toronto: Queen's Printer for Ontario Retrieved from <http://www.edu.gov.on.ca/eng/policyfunding/success.html>.
- Pyper, J. (2005). Making effective use of our time: A tracking sheet for daily classroom assessment of student learning. *OAME Gazette*, 43(4), 23-30.
- Simmt, E. (2011). Teacher expertise explored as mathematics for teaching. In Y. Li & G. Kaiser (Eds.), *Expertise in mathematics instruction* (pp. 151-164). USA: Springer.

Learning Skills & Work Habits

GDHS 2010

		Level 1	Level 2	Level 3	Level 4
Responsibility	<i>Coursework (at home and in class)</i>	Completes ½ the work, submits consistently late.	Completes ¾ of the work, submits occasionally late.	Completes all work, submits on time every time.	Completes all the work, submits on time and sometimes earlier.
	<i>Choices</i>	Avoids, ignores, resists ownership for choices.	Accepts responsibility for choices after it is brought to one's attention.	Takes ownership and responsibility for choices.	Takes ownership and proactively makes necessary choices.
Independent Work	<i>Task accomplishment</i>	Does not start work until the teacher makes a personal request, does not complete task.	Starts work after a couple of requests by the teacher, uses about half the class period effectively.	Starts when told and uses the class period to complete task.	Starts right away and uses the full class period to complete the task.
	<i>Follows Instructions</i>	Misses most instructions from the teacher, follows others lead, copies work.	Misses some of the instructions from the teacher.	Listens to instructions and can get to work.	Listens to all instructions and provides leadership to others.
Initiative	<i>Academic risk taking</i>	Not willing to take risks, needs continuous prompting from others to try something new.	Hesitant, needs many prompts from others to try something new.	Willing, interested, needs few prompts from others to try something new.	Willing, curious, innovative, does not need prompts from anyone.
	<i>Attitude</i>	Focusses on one's wants and needs. Consistently negative outlook on the course.	Focusses on one's own interests and 'rights'. Often pessimistic outlook on the course.	Works for self and others' rights and responsibilities. Positive outlook on the course.	Works for, and advocates for self and others' rights and responsibilities. Optimistic and upbeat.
Organization	<i>Prioritizes</i>	Makes no plans. Does not prioritize.	Makes a plan. Does things in the order they are written.	Establishes a plan and prioritizes.	Establishes, prioritizes, and periodically updates the plan.
	<i>Managing resources</i>	Comes to class with nothing.	Brings some things, remembers once he/she gets to the classroom.	Before coming to class, identifies, gathers, then uses all resources.	Proactively identifies, gathers, uses, and evaluates the use of all resources.
Collaboration	<i>Peer relations/ Working together</i>	Dependent. Doesn't participate, just sits there.	Independent. But doesn't share with group.	Interdependent. Shares ideas, encourages others' participation.	Effective, positive, interdependence. Encourages critical thinking, elaborates on anyone's ideas. Everyone feels valued.
Self Regulation	<i>Goals</i>	Has no individual goals.	Sets unrealistic or vague goals.	Sets specific and achievable goals.	Sets, monitors, and re-evaluates measurable goals.
	<i>Persistence</i>	First, and often the only, reaction is to give up.	First attempt is considered acceptable, works for a 'pass'.	Sticks to it and doesn't give up.	Will improve work even after it has been assessed.

The second rubric is a result of our efforts as Associate Teachers with teacher candidates in our classrooms and thinking about our own professional learning. As Associate Teachers welcoming teacher candidates into our classrooms we have a different kind of learner than we do as secondary school subject teachers. For example, still within the metaphor of the 'rubrics cube' of teaching and learning of mathematics, teacher candidates experience a different kind of 'content' (that of the theory and practice of teaching and learning secondary school mathematics). It is conceivable that learning skills can continue to be improved and possibly adapted for new contexts such as this one.

My teacher colleagues and I envisioned a rubric that would capture what we perceived as a proxy for learning skills in the context of teacher learning using the Ontario College of Teachers Ethical Standards and Standards of Practice (Ontario College of Teachers, 2012). We intended to put such a rubric up on our classroom walls as a transparent and overt way to show that we also work on improving ourselves as learners – just as our teacher candidates are learners, and our secondary school students are learners. That rubric didn't get off the drawing board because at the end of that school year I accepted an appointment to Queen's, and others accepted leadership and department head positions in other schools. However, that thinking continued in my mind and resulted in my efforts to create a rubric for teacher candidate learning.

In my first year at Queen's, I collaborated with my colleague, Dr. Geoff Roulet, who was teaching the other section of the Intermediate/Senior (grades 7-12) mathematics teaching and learning course. An initial draft was created to express our image of the complete professional and the progress from minimal competency within the context of the broader community of mathematics education. The evaluation schemes for individual assignments would be built from this rubric and provide details that operationalize the descriptions.

I have continued to modify the rubric for use in my courses to become an overt assessment tool rather than an evaluation tool. I attempted to make it a tool to facilitate self-assessment, peer-assessment, and instructor-assessment of teacher candidates' growth as learners. However currently, I have reconceptualised it to be more applicable to assessing and giving feedback to teacher candidates concerning their critical thinking of their pedagogical decisions throughout the course. The top three categories are used for assessing writing. The other two categories continue to express a more broad sense of professional practice.

References

Ontario College of Teachers. (2012). *Foundations of Professional Practice*. Toronto: Ontario College of Teachers Retrieved from [http://www.oct.ca/-/media/PDF/Foundations of Professional Practice/Foundation_e.ashx](http://www.oct.ca/-/media/PDF/Foundations_of_Professional_Practice/Foundation_e.ashx).

Used for assessment and evaluation of writing.

Standard	D <i>(e.g., you and your classroom)</i>	C <i>(e.g., teaching math)</i>	B <i>(e.g., learning mathematics)</i>	A <i>(e.g., mathematics education and community)</i>
Commitment to Students and Student Learning "Members are dedicated in their care and commitment to students."	Teaching decisions indicate an awareness of the classroom as a collection of students with a common purpose (e.g., passing the course).	Teaching decisions indicate an understanding of a classroom dynamic and that this dynamic influences student achievement and teaching decisions.	Pedagogical decisions grounded in 'student-needs' for course and schooling achievement. Pedagogical decisions are clearly made with student-needs considered first and foremost.	Pedagogical decisions demonstrate a 'student-needs' and integrated sense of classroom management, instructional strategies, and assessment and evaluation which facilitate ongoing student learning.
Professional Knowledge "Members strive to be current in their professional knowledge and recognize its relationship to practice."	Professional knowledge appears to come from connections to course work and course materials, and to personal practicum experiences.	Professional knowledge appears to come from explicit connections to the curriculum and associated professional practice documents, and/or professional mathematics education opportunities (referenced).	Professional knowledge appears to come from explicit connections to professional development (P.D.) opportunities, professional practice documents, and one of literature and resources, mathematics education literature, research literature on teaching and learning (referenced).	Professional knowledge appears to come from explicit connections to P.D. opportunities and documents, and two or more of literature and resources, mathematics education research literature, research literature on schooling as a cultural-social activity (referenced).
Professional Practice "Members apply professional knowledge and experience to promote student learning. They use appropriate pedagogy, assessment and evaluation, resources and technology in planning for and responding to the needs of individual students and learning communities."	Reflection primarily considering the subject content/materials. There is a focus on the mathematics.	Thinking and reflection considering one's actions as a teacher. There is a focus on mathematics and some teaching strategies.	Critical thinking and reflection considering one's pedagogy – i.e., discusses why teaching decisions were made. There is a focus on the 'pedagogical-content-knowledge' of mathematics.	Critical thinking and reflection considering the impact on students' learning. (i.e., School and classroom envisioned and embodied as a community of learners with Learning Skills and social-justice overtones.)
	Can present satisfactory lessons based upon the course outline and textbook. Lesson materials/manipulatives emphasise expression of the teacher's knowledge.	Classroom is a teaching space, i.e., a teacher-directed, teacher-guided and controlled, and/or teacher-centric space. Lesson materials/manipulatives employ resources commonly available and uses them to adequately provide for some student needs.	Teacher includes activities and cooperative learning experiences in student activities providing opportunities to learn with shared ownership with students. Appropriate lesson materials/manipulatives – Modifies found resources to make them appropriate for the needs of one's students.	Classroom is a learning space, i.e., 'authentic' tasks, collaborative, constructivist, student-learning focused, student-ownership and choice clearly evident. Innovative lesson materials/manipulatives – Creates and/or modifies resources to make them one's own and appropriate for the needs of one's students.
Ongoing Professional Learning "Members recognize that a commitment to ongoing professional learning is integral to effective practice and to student learning. Professional practice and self-directed learning are informed by experience, research, collaboration and knowledge."	Evidence of learning appears to come from immediate personal experience.	Evidence of learning appears to come from professional literature and/or participation in mathematics related activities.	Evidence of learning appears to come from (primarily mathematics) professional and research literature. Participates and collaborates in professional organizations and activities.	Evidence of learning appears to come from diverse, relevant, and related professional and research literature. Participates as a contributor to on-going professional learning communities.
	Works as an individual with a common goal in group settings.	Works with others and shares responsibility for parts of the product of the group work.	Works in a collaborative manner, shares, accepts others' input, and accepts professional criticism.	Collaborates with character traits such as humility and care, provides input, reflects upon and acts on received professional criticism. Encourages others to meet their potential.
Leadership in Learning Communities "Members promote and participate in the creation of collaborative, safe and supportive learning communities."	Takes responsibility for teaching and/or learning in one's own classroom.	Participates with other closely related professionals in the development of curriculum and policies, at a local school or Board level.	Collaborates, supports, and promotes the improvement of mathematics education with the broader school board, provincial, national and/or international professional communities.	Responsibly takes on leadership and contributor roles in local, provincial, national and/or international professional mathematics education communities.

Used for assessment and evaluation of contribution and professionalism.

The third rubric is a product of my thinking about making Achievement Categories – Thinking, Application, Communication, Knowledge and Understanding (Ontario Ministry of Education, 2010) more accessible and more explanatory of performance (rather than descriptive of achievement as is seen in the curriculum documents) for teacher candidates thinking about the nature of the mathematics they will be teaching, and learning about such curriculum content and assessment aspects as Achievement Categories. Visual and graphic imagery can often be remembered better than paragraphs of text descriptions. I believe this rubric may also make Achievement Categories more accessible conceptually for secondary school students too.

This rubric expresses how I conceptualize what mathematical thinking is about with respect to the Ontario curriculum. I have a book to read that has an image of the Mona Lisa on the cover, and this inspired me to select 'Leonardo' as the theme for the rubric.

Level 4 (the exceptional, the sense of 'wow!') was easy – Leonardo Da Vinci seems to be a brilliant mathematical thinker as an engineer, scientist, artist, architect/draftsman/inventor, mathematician, etc. The image for Level 1 was selected, not because I believe Leonardo Di Caprio is not a mathematical thinker, far from it, but this character portrayal gives me a strong sense that mathematical thinking is not at the forefront of his mind. Level 2 is the Teenage Mutant ninja Turtle – a 'close but not quite' mathematical thinker. He and his brothers have 'law enforcement' problems to solve, and pizza sharing problems to solve – thinking opportunities that are for them, somewhat mathematical. Level 3 (the standard level of performance) was a challenge. First, I had not remembered the natural name of Fibonacci, and hence was at a loss for a Level 3 'Leonardo' image. I was almost ready to concede defeat and accept a 'Leonard' and choose Leonard Nimoy as Spock (an exceptional scientific and mathematical thinker but with somewhat less acumen for artistic and emotional insight to his thinking) until Leonardo da Pisa finally came to me with the help of Mr. Google.

Space, positioning, and imagery are also important aspects to this rubric.

References

Ontario Ministry of Education. (2010). *Growing Success: Assessment, evaluation, and reporting in Ontario schools*. Toronto: Queen's Printer for Ontario Retrieved from <http://www.edu.gov.on.ca/eng/policyfunding/success.html>.

Graphic rubric for

"Leonardo"

	Level 4	Level 3	Level 2	Level 1
"Mathematical Thinking"				