Rubrics as a Doorway to Achievable Challenge

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As neuroscience has delved more into learning research, evidence is mounting about which brain activities are most associated with information processing and memory retention. (Cicchetti & Curtis, 2006) (Willis, 2007) Use of rubrics is consistent with brain-learning research about patterning and neuroplasticity. Rubrics can be designed to increase successful learning and executive functions, such as organizing, prioritizing, analyzing, comparing/contrasting, and goal setting. (Carter, 2000) Rubrics can motivate sustained effort toward goals and create assessments that go beyond passive checklists of achievement. Rubrics can become support systems to scaffold active, participatory learning experiences, motivate sustained effort toward goals, and provide on-going formative feedback.

A rubric is often thought of as a tool used by teachers and sometimes shared with students for assessment of completed reports or projects. The typical rubric includes the criteria for success in multiple aspects of a report, project, or other assignment. There are gradations that indicate the expectations for each level of quality and categories based on the criteria that will be assessed such as organization, details, mechanics, and others depending on subject and activity. (Goodrich,
After describing the neuro-logical aspects of using rubrics for teaching as well as for interactive, on-going, formative, and final assessments, the author will offer suggestions for additional uses of rubrics. These will include opportunities to use rubrics for goal planning, strategy development, and scaffolding for the brain’s subsequent patterning of new information.

Rubrics can serve students as supportive scaffolding to guide them in ways to relate to the new material or plan for and organize a complex assignment. Rubrics can be powerful tools for scaffolding through predictability and patterning. The process of patterning, encoding new information into matching networks of neurons that hold related information, will be described first. Next will follow a description of how relational memories are constructed during patterning when new information is consolidated with prior knowledge. The theory of neuroplasticity in relation to rubrics and how predictability promotes learning will be described.

Rubrics will be described as to how they can build students’ organizational skills, creative problem solving, prioritizing, judgment, and critical analysis. These executive functions can then become part of students’ growing academic toolbox for successful learning and higher level thinking while also helping them remember factual information and acquire the conceptual understanding needed for standardized test success and all future learning. (Goodrich, 1997) This background will be followed by rubric designing suggestions to promote predictability, patterning, and plasticity as students process information into permanent long-term knowledge.

Rubrics can communicate teacher expectations and provide a template onto which students' brains can store new information. Teachers can use rubrics as tools to help differentiate instructional goals for individual student needs and interests and help students know what they need to do to meet individualized, appropriately challenging expectations. After
understanding how rubric scaffolding can literally change your students’ brains, you will have new tools for differentiation of instruction to help all students grow, not only in accumulated facts, but also in knowledge.

**Pattern Detecting and Constructing in the Brain**

Thinking of the brain as a pattern-seeking device in search of meaning correlates with a way of looking at learning as the acquisition of mental programs for understanding our world by using what we know to interpret new information. (Olsen 1995) Information processing, based upon neuroimaging and time sequencing of brain regional electrical activation, starts with sensory input from sensory receptors that travels along neuronal pathways through the thalamus and amygdala to the hippocampus. In the hippocampus the new input is linked to related information that has simultaneously been activated and pulled in from memory storage networks in the cerebral cortex. (Davachi and Wagner 2002) The resulting consolidation of newly coded data matched with patterns from previously stored information is termed *relational memory*. (Shadmehr and Holcomb 1997; Grabowski, Damasio, Damasio 1998; McGaugh, McIntyre, and Power, 2002)

*Neuroplasticity* (sometimes just called plasticity) is the process by which the newly constructed relational memories become structurally stronger. With practice, the new memory link, represented by connections among neurons in a neural network, is restimulated. This stimulation of the network is represented on neuroimaging as increased metabolic activity. (Repeated neural network stimulation can be followed by increased production of genetic material for building of cellular proteins. These proteins form the basis of new synapses and intercellular connecting dendrites). (Giedd, Gogtay, Lusk, Hayashi, Greenstein, Vaituzis, Herman, et al., 2004)

Increased network activity also calls forth support cells, called glia, that produce insulating layers of myelin that coat the axons and increase their permanence and speed of transmission. (Draganski, Gaser, Busch, & Schuierer 2004) This is the
theory for neuroplasticity sometimes called, “neurons that fire together, wire together.” In essence, as practice stimulates the neuronal network it physically grows and is strengthened through neuroplasticity. The reinforced stored memory can more easily be retrieved and with time and repeated stimulation (practice, review), relational memories can become long-term memories.

This process of network construction and strengthening seen on fMRI as increased metabolic activity and in animal experiments as increased numbers of dendrites, synapses, and myelinated axons is the proposed explanation for the theory that practice builds permanence, through neuroplasticity. The region of greatest metabolic activity in animal research, following the hippocampal activity burst associated with the forming of relational connections, is the prefrontal cortex. (Lee and Solivan 2008) The prefrontal cortex is where it is proposed that the newly patterned relational memories that have just been linked in hippocampus are categorized for placement in long-term memory storage. fMRI investigations support the theory that the prefrontal cortex is particularly active during the executive functioning such as organizing, prioritizing, analyzing, comparing/contrasting, and other higher cognitive functions that involve active mental manipulation. (Gabrieli 1998; Phelps, Hyder; Blamire, and Shulman 1997)

When information is presented in organized relational patterns these can be aligned with the categories in the rubric. Using rubrics can help students recognize patterns and make associations connecting the new material with prior knowledge to help their brains organize, categorize, and store the new information in long-term memory (Davachi & Wagner 2002)

The more patterns students have for identifying information, the more efficiently their brains can respond to new information and add it to the appropriate neural networks. This pattern-based identification is similar to life adaptive processes by which animals build survival skills by recognizing repeated patterns in their environments and being able to predict what might happen after their brains’ receive an early cue. An example would be a fawn making the connection or
conditioned response to the raised tails of the heard as a signal for danger. The fawn’s brain predicts the probable approach of a predator and the fawn runs for shelter even before it sees, hears, or smells the predator.

**Predictability** is also a powerful component of successful learning for children. When students are in classrooms where there are comforting, predictable routines and consistently enforced rules of classroom behavior they are less stressed and the learning environment is more conducive for thinking. (The limbic system, especially the amygdala through which sensory information must pass to reach the memory consolidating hippocampus, is assessed on fMRI scans as acting as an emotional filter that influences the brain’s receptiveness to sensory input based on levels of stress or relaxed alertness. (Yaniv, Vouimba, Diamond, & Richter-Levin 2003)

When students are stressed, anxious, or very confused, the sensory input is directed to the automatic, reactive, fight-flight/freeze networks in the brain and does not reach the reflective networks in the prefrontal cortex where higher thinking and memory take place. (McGaugh, McIntyre, & Power, 2002). The neuronal circuitry of the limbic system is also attuned to patterns, so when new information can be recognized, categorized, and patterned, children are in a better position to connect with the new input, predict what might come next, or evaluate how the new information might be used predictable sequences of behavior or problem solving. (Eliassen, Souza, & Sanes, 2003).

Rubrics can give students the stability and reassurance of knowing what categories are included in the topic and guidance to make predictions of where new information might fit into the big picture. If they have rubrics from the start of the unit students have templates that scaffold their brains’ attempts to evaluate and connect with new information with prior knowledge. The benefit of the rubrics for these students is not only the help with pattern new information, but also of keeping information flowing through their amygdalas rather than having it blocked by the stress of confusion.
Visualization Aids

Visualization is another way of pre-programming the neuronal circuits for activation; the way athletes visualize the movements they want their muscles to make. Visualizing brings the brain circuits on line to direct those movements and is the subject of much recent research about mirror neurons in the development of speech and emotional response. (Buccino, Lui, Canessa, Patteri, Lagravinese, Benuzzi, Porro, & Rizzolatti 2004)

Neuroimaging of their brains, when subjects begin to think about a specific type of learning, shows activation in the area of the brain that controls that particular type of learning. For example, the frontal executive function areas become more metabolically active as subjects think of organizational strategies needed to prepare material for a debate, even before they are given the debate topic (Small, Silverman, Siddarth, Ercoli, McGaugh, McIntyre & Power, 2002). A rubric can serve as a visualization stimulus for the brain circuitry that will be called upon in the learning process.

Designing Rubrics

Rubrics can be powerful tools for predictability, patterning, organization, and other executive functions. By providing an outline of the criteria that will be evaluated in determining a grade, rubrics are templates that assist the brain’s executive functions of planning, prioritizing, and goal-directed behavior. It is beneficial for all students and can be a lifeline for students with attention difficulties to use the templates provided by rubrics to monitor and acknowledge the relationship between their practice and focused work input with mastery and successful outcomes. This self-knowledge allows students to understand the relationship between their work, attitude, and effort and the ultimate measurement of their success and achievement.
Teachers almost always use mental rubrics to determine grades, even if these are unconscious and intuitive. Preparing, distributing, and discussing written rubrics can incorporate the brain-friendly processes of patterning and goal-directed learning.

- Before even writing the rubric, consider what the goal of the assignment is and what the ideal end product would look like.
- When the rubric is written down and offered to students at the beginning of a new assignment or unit of study, emphasize your partnership with the students in the process of their achieving success.
- Help students see the rubric as a guide for success. Students are more engaged and confident when they are see a predictable process offered by rubrics where the outcome is clearly the result of specifically defined input.
- Good rubrics offer specific goals in multiple areas of achievement, not just a single final product. Seeing that at least some of their strengths will be valued in the assessment is reassuring to students who are challenged by learning difficulties. Beyond subject-specific categories you can include effort, organization, prioritizing, judgment, analysis, charts/diagrams, creativity, peer cooperation, proper use of resources, focus, and metacognition.

**What To Include in Rubrics**

Expert thinking and complex communications are important skills for this generation of students who will enter a job market where computer skill, creativity, communication, and analysis are marketable commodities. In addition to the traditional areas of rubric assessment such as following instructions, citing examples/giving evidence, neatness/organization, and completeness, consider the positive message students get when areas of executive function are included in rubrics. Rubric categories can be included to emphasize such importance of the executive functions of recognizing and organizing patterns and relationships, identifying and solving problems, following instructions, and clear communication with others.
The more specific the rubric is in terms of expectations, the more likely the students will feel capable of achieving success. Instead of saying that a top score of 4 in completeness means that “All questions will be answered in detail”, a more specific rubric could state, “All questions will be clearly incorporated into the report by using topic sentences that tell the reader what information will follow that answers the question. Excellent responses to questions will include three cited sources of evidence and one personal opinion response to the question.”

Rubric categories can also emphasize the behaviors that promote positive classroom and school communities and personal responsibility. These categories can recognize attitude, effort, and what students have done to reach the study habit goals they set during student-teacher conference about the project.

Behavior, attitude, motivation and effort are reasonable considerations as study habit goals to consider in rubrics. Findings from studies support high motivation as promoting greater attention and increased willingness to change behavior related to attention and engagement (Engelmann & Pessa, 2007; Raymond, 2009).

The use of rubrics for progress tracking is supported by classroom research such as those reported in meta-analysis of 14 different studies in which teachers had students track their progress. In one class in each study students used rubrics to track their progress; in the control class groups, teachers taught the same content for the same length of time without having students track their progress. On average, the practice of having students track their own progress was associated with a 32-percentile point gain in their achievement (Haystead & Marzano, 2009).

Just as graphic organizers can be more effective when they are student-designed, students benefit from participating in the construction of their rubrics. Involving students in the rubric construction adds personal connection to their work and gives them practice in planning. Choice and personal relevance increase investment and engagement in the learning process. The
increased personal interest associated with choice, such as participation in design, can be intrinsically motivating and satisfying (Vansteenkiste, Simons, Lens, Sheldon, & Deci, 2004). This increased motivation can lead to greater attention and increased willingness to learn (Engelmann & Pessa, 2007).

In group work, rubrics can add to cooperation when students use rubrics to rate their own effort, contributions, and cooperation as group members and then use the rubrics to give constructive feedback to their partners.

When students are given the rubrics at the beginning of a unit of study their assignments, these can become opportunities tools for patterning, predicting, organizing, goal-planning, tools to direct student-teacher conferences about the unit or assignment, and guides for visualization of success.

<p>| Rubric for Written Report That Could be Applied in Literature, History, Expository Writing in Science, and in Cross-Curricular Reports. There are optional categories for presentations and for enrichment-challenge. |
|---|---|---|---|---|
| Category | Excellent | Good | Satisfactory | Needs Improvement |
| Organization | The outline, notes, and first draft were complete, turned in on time, and well referenced. There was evidence of your interest. | The outline, notes, and first draft were complete, turned in on time, and well referenced. | The outline, notes, and first draft were minimal, turned in several days past due date, and only partially referenced. | The outline, notes, and first draft were incomplete, turned in late, and poorly or inaccurately |
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<table>
<thead>
<tr>
<th>Planning as you moved from notes to final draft. references. There was some evidence of your planning as you moved from notes to final draft.</th>
<th>There was minimal evidence of any planning as you moved from notes to final draft.</th>
<th>There was no evidence of your planning as you moved from notes to final draft.</th>
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<tbody>
<tr>
<td><strong>Introduction</strong> You introduce your topic clearly including your thesis and describing how you will support it. You use one of the types of topic sentences we studied to grab your reader's attention. Spelling, grammar, and punctuation are accurate and you showed interesting variation in sentence work to grab your reader's attention.</td>
<td>You introduce your topic in a way that shows you understand the assignment but do not describe much about how you will support your thesis. You may have tried to use one of the types of topic sentences we studied, to grab your reader's attention. Spelling, grammar, and punctuation are as evidence of your topic clearly. There is little evidence of your own thesis or how you will support it. You did not use a topic sentence, such as one of the types of topic sentences we studied, to grab your reader's attention. Spelling, grammar, and punctuation have a number of errors and you</td>
<td>You have a topic demonstrated but don’t introduce your topic clearly. There is little evidence of your own thesis or how you will support it. You did not use a topic sentence, such as one of the types of topic sentences we studied, to grab your reader's attention. Spelling, grammar, and punctuation have a number of errors and you</td>
</tr>
<tr>
<td>Structure</td>
<td>Spelling, grammar, and punctuation are mostly accurate and you showed some interesting variation in sentence structure. How you plan to communicate your theme is well laid out.</td>
<td></td>
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<tr>
<td>Body of Work</td>
<td>You included a variety of specific supporting evidence from different types of sources (Internet, reference books, journals, interviews). Accurate punctuation, online, interviews, documents).</td>
<td>You included several pieces of supporting evidence from different types of sources (Internet, reference books, journals, interviews). A few errors in punctuation, grammar, sentence.</td>
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<tr>
<td><strong>Grammar, Sentence Variety, and High-Level Vocabulary Words.</strong></td>
<td><strong>Grammatical Variety, Incorporation of Some High-Level Vocabulary Words.</strong></td>
<td><strong>Grammar, Sentence Variety, and Incorporation of High-Level Vocabulary Words.</strong></td>
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<th><strong>Oral Presentation</strong></th>
<th><strong>You started strong to capture audience attention.</strong> You started with good opening remarks. Your presentation used high-level vocabulary, and your conclusion provided a summary. Your body language, eye contact, volume, and speed of speech did not summarize most of your conclusion. Your opening statement was not completely clear from your audience. Your topic was not completely included in your opening remarks. Attention from your audience was not complete. A strong opening to capture audience attention. It was not clear what your presentation would be speaking about. Your presentation used no high-level vocabulary. You gave minimal support to your theme. You did not have any summarizing support.**</th>
<th><strong>You didn’t have a strong opening to capture audience attention. It was not clear what your presentation would be speaking about. Your presentation used no high-level vocabulary. You gave minimal support to your theme. You did not have any summarizing support.</strong></th>
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| **Challenge Yourself** | You used many of your executive functions (selecting fact-supported sources, comparison/contrast, extending the topic with your questions, analyzing the topic through multiple perspectives, connecting to information from) | You used several of your executive functions (selecting fact-supported sources, comparison/contrast, extending the topic with your questions, analyzing the topic through multiple perspectives, connecting to information from) | You used a few of your executive functions (selecting fact-supported sources, comparison/contrast, extending the topic with your questions, analyzing the topic through multiple perspectives, connecting to information from) | You didn't use your executive functions (selecting fact-supported sources, comparison/contrast, extending the topic with your questions, analyzing the topic through multiple perspectives, connecting to information from) |

- contact, volume, and speed of speech were correct for the topic and audience.
- were usually correct for the topic and audience.
- information in your conclusion.
- Your body language, eye contact, volume, and speed of speech were not always correct for the topic and audience.
- body language, eye contact, volume, and speed of speech were often incorrect for the topic and audience.
Rubrics Match With Executive Functions

The prefrontal cortex executive function of planning involves maintaining one main goal while working on subgoals for achieving that goal. Rubrics are like blueprints to guide executive function so students can plan, prioritize alternatives, monitor, and adjust their focus and goal-directed actions to suppress distracting material and keep on task (Meltzer, 2007).

Using rubrics to help students correlate their effort/practice to their success is a valuable, personalized and experiential tool. My experience using rubrics to build students’ goal-directed executive processing is that the process works best when students receive feedback at least weekly on a project or in a unit of study that has a rubric. Students first complete their effort rubrics with a self-rating of one to four in the preset categories. For example, under the category of focus there may be four gradations from which they select the one they believe best fits their behavior such as:

. I worked with focus to complete the task, and when I didn’t know the answer right away I tried to work it out or look it
up before asking for help

. I worked with focus to complete the task but asked for help as soon as I didn’t know the answer right away
. I worked with focus most of the time, but gave up when I didn’t know the answer
. I did very little focused work.

(An alternative to the 1 to 4 ranking is the use of descriptive words e.g., Excellent, Good, Needs Improvement followed by the worded description of that rating.)

After students complete their rubrics, there is an opportunity for peer and/or teacher assessment on the week’s work. By maintaining rubric based, effort-achievement charts for several weeks, students see how their effort and achievement correlate. The power of that visual proof correlating effort to achievement provides a predictable and dependable tool students can use to drive their self-actualization as learners. With that visual model they see that they can control their level of success because their honest assessment of their efforts corresponds to their achievement ratings.

An additional benefit to rubric-assisted assessment is in the area of the separate aspects of measurable written communication skills such as those evaluated on state proficiency tests and in the writing portion of the SAT. (There is a rubric used by the SAT essay graders that is available to students and teachers.) When students are experienced in working with rubrics to self-evaluate the quality of the separate aspects of their work, they are building skills of planning and goal-directed learning that suit their learning strengths and incorporate strategies for their areas of challenge. These skills will increase their success on future assignments, even from teachers who don’t provide rubrics, as they develop the capacity to design rubrics and schedules on their own.

I have seen and heard how my students respond the first time they are given a rubric and told that it is what will be used to
determine their grade. Many feel as if they have been given the answer key to a test. In a way, that is true. Students understand that their grades are indeed within their control. If they are willing to put in the effort, they see the path they need to follow to reach their goals.

References


