

Culturally Responsive Formative Assessment: Metaphors, SMARTER Feedback, and Culturally Responsive STEM Education

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Abstract: Over the last two decades, discourses relating to educational assessment have mushroomed, especially with the educational community's observation of the proliferation of formative assessment at various levels and contexts. Yet, most of these recent formative assessment discourses have little to no consideration of the cultural factors that may directly influence the level of quality and equity for learning opportunities in education. The purpose of this paper is to conceptualize the notion of a culturally responsive formative assessment through metaphorical understandings that not only illustrate an image of the teacher embracing the professional ethics of continuous improvement but also detail the exploration of culturally SMARTER feedback and introduce a culturally responsive STEM education example. Becoming culturally responsive teachers entails the ability to employ systematic and empathetic aspects in both the formal and informal formative assessment plans they create while giving evidence-seeking efforts that mutually take place between teachers and students with diverse backgrounds.

Keywords: formative assessment, culturally responsive, feedback, STEM, metaphor

1. Introduction

Assessment should be an integral part of teaching and learning [3]. Over the last two decades, assessment has been everywhere in educational policy and practical discourses. How to effectively assess student learning is one of the most common discussion topics in teacher learning communities across the nation. The educational community has observed a proliferation of assessment discourses, conferences, and workshops that are initiated by varying public and private agencies such as the State Departments of Education, School Districts, Marzano Research Center, Dylan Wiliam Center, Solution Tree, etc. Nonetheless, it is likely that many of current school teachers are overwhelmed with a great deal of information associated with assessment as the active consumer of all sorts of measurements, particularly from formal assessments such as state standardized tests, district assessments, MAP (Measure of Academic Progress) tests, formal standardized reading or math tests, etc. [12] [16] [20].

At the same time, the messages that teachers receive from outside sources and professional development workshops appear positive and promising [35] [36]. Teachers hear that assessment paradigms have shifted in recent years so that new assessment languages and methods have become available. The word, *assessment*, in this context is more positive in that teachers are likely to be in control of their classrooms with a collective aspiration of professionalism [1] [2] [3] [13] [15] [34].

Together, we authors observe that while recent formative assessment theories are built in the context of instruction, cultural considerations are seldom addressed [10] [11]. There is a need to construct a formative assessment theory in culturally responsive/relevant/sustaining instructional context, which encourages teachers to be active producers of assessment. To accomplish the purpose of this paper, we first set a conceptual framework for culturally responsive formative assessment that consists of goal, feedback, and context. Second, this paper explores ways in which teachers would respond to educational change initiatives and presents three metaphors that would represent what teachers as professionals better think and do in action. Third, after introducing a notion of pedagogical formative feedback and identifying a lack of cultural consideration in selected assessment textbooks (N=16), this paper attempts to conceptualize an idea of culturally SMARTER feedback as a platform for culturally responsive formative assessment. And lastly, this paper briefly introduces a culturally responsive STEM education example in which culturally SMARTER feedback is embedded.

2. A Conceptual Framework

It is typical to define formative assessment as providing teachers with information about how students think and do in terms of learning goals and objectives [2] [4] [21] [22] [24] [25]. This commonly agreed

definition of formative assessment is a-theoretical in that it simply denotes a thing, onetime event, or a simple technique. For example, a teacher wants to know whether or nothis/her students grasp a concept being taught. He/she asks them to show a number of fingers: one for *I don't know*, two for *I kind of know*, and three for *I know for sure*. This is one of at least 25 quick formative assessment techniques [8]. This traditional definition of formative assessment is so narrow that it doesn't capture the complexity of classroom interactions from a pedagogical and cultural standpoint[27] [28] [32] [34]. Recently, Furtak, Ruiz-Primo and Bakeman[11] criticize the typical view of formative assessment that it is a formal process requiring curriculum-embedded tasks possibly developed outside of classroom. In order to address the issue, they emphasize that formative assessment should be focused on interactions between a teacher and his/her students occurred in their classrooms in order to better listen and respond to students' and the teacher's thinking. Although their emphasis on formative assessment lies on interactions between students and the teacher, still there is a lack of cultural standpoint in formative assessment. Below, presented are the three elements that consist of a new configuration of *Culturally Responsive Formative Assessment*(CRFA, hereafter) (Figure 1).

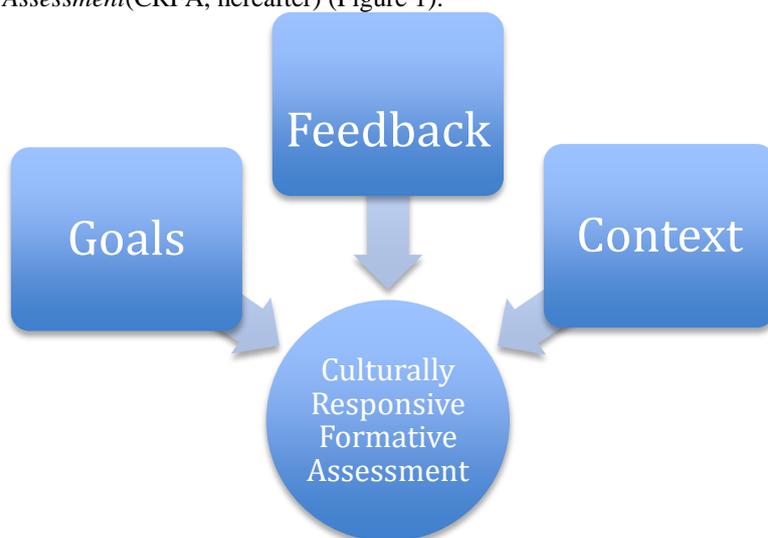


Figure 1: Three Elements of Culturally Responsive Formative Assessment

The three elements of our conceptual framework are goals, feedback, and context. First, CRFA begins with what is worthy learning and why (Goals). Goals that guide CRFA, just like any other educational activities, become a resource of generating instructional objectives (teachers' view) as well as learning targets (students' view). In order to explain the intent and meaning of what assessment goals are of importance to begin with, we will use metaphors to shed much light on why teachers and students do what they for what purpose.

Second, formative assessment and feedback are not separable from each other. Both terms literally coexist, that is, "all those activities undertaken by teachers, and/or by their students, which provide information to be used as *feedback* to modify the teaching and learning activities in which they are engaged" [2: 10]. Research about feedback over the last several decades is proliferating[5] [32]. While some new conceptualizations on feedback have just been circulated [30], Hattie and Timperley's [13] classic article, *The Power of Feedback*, is regarded as one of the most important contributions in the field of assessment. The purpose of their research on feedback is straightforward: "to reduce discrepancies between current understandings and performance and a goal"(p. 86). To do so, students are encouraged to increase more efforts while teachers provide students with appropriate challenges and alternative goals. Then, Hattie and Timperley propose a 3 x 4 framework for generating the power of feedback. The teacher raises three feedback questions associated with four levels (Figure 2).

	"Where am I going?" (The goals, Feed up)	"How am I going?" (Feed back)	"Where to next?" (Feed forward)
Task (FT)			
Process (FP)			
Self-regulation (FR)			
Self or person (FS)			

Four levels of feedback questioned raised by a teacher

Figure 2: A Modified Framework for Generating the Power of Feedback [13]

In particular, Hattie and Timperley [13] argue that “FS is the least effective, FR and FP are powerful in terms of deep processing and mastery of tasks, and FT is powerful when the task information subsequently is useful for improving strategy processing or enhancing self-regulation” (pp. 90-91). And lastly, CRFA becomes more meaningful and inclusive in nature when integrating it with cultural knowledge and skills (Context). Let us take an example from the texts noted above. McMillan [22] explains:

Teachers don’t *deliberatively* produce biased assessment. It is most often unconscious and unintended.... Cultural differences that are reflected in vocabulary, prior experiences, skills, and values may influence the assessment.... The influence of these differences will be minimized to the extent that you first understand them and then utilize multiple assessments that will allow all students to demonstrate their progress toward the learning target.... *You should never rely solely on one method of assessment.* (p. 79, emphases in original)

For formative assessment to be more differentially effective in improving student learning, contextual differences in general or cultural differences in particular need to be addressed from the beginning of lesson plan development and be embedded as an integral part of the whole learning and teaching process [3] [14] [30]. Therefore, CRFA that we now attempt to theorize is based on an inclusive, supportive, and multiple evidence-seeking process with an integration of goals, feedback and context. Ladson-Billings’ [17] best-selling book, *The Dreamkeepers: Successful Teachers of African American Children*, describes that “teachers with culturally relevant practices have high self-esteem and a high regard for others” (p. 37) and that teachers must take care not to ignore color. Eight successful teachers (five African American and three White teachers) demonstrated five core-teaching principles to make a difference in the lives of students at a margin. Following are two principles: When teachers provide instructional ‘scaffolding,’ students can move from what they know to what they need to know and real education is about extending students’ thinking and abilities. However, little is investigated in this seminal book with regard to a formative assessment theory that is culturally relevant in the classrooms/schools. In the field of educational assessment, culturally responsive, relevant or sustaining [26] assessment has not surfaced yet. Below, we illustrate three elements of the CRFA conceptual framework in more detail.

3. Goals: Three Metaphors

The word, *metaphor*, is defined as a “novel or poetic expression where one or more words for a concept are used outside of its normal conventional meaning to express a similar concept” [18: 1]. When defining a concept of formative assessment, Wiliam and Leahy [34] assert that “the term has been around for almost fifty years, but as yet, there is little consensus as to what it means.... there is little value in trying to define formative assessment in a restrictive way that includes a usage with which people may disagree” (p. 5). Therefore, we try to share our broad vision of what formative assessment is like metaphorically.

In order to speculate teachers’ responses to educational change initiatives, Cobb and Rallis’ [7] five response-types that school districts could make regarding the demand of NCLB (No Child Left Behind) are noteworthy. The five response-types are the “Elites, the Opportunists, the BandAids, the Militants, and the Swamped” (pp. 187-198). We add possible follow-up responses that they could have from a formative assessment standpoint (Table 1):

Table 1: Possible Responses to Educational Change Initiatives [7]

	The Elites	The Opportunists	The Band Aids	The Militants	The Swamped
Response-types that school district could make	"What I don't understand is how the NCLB proposes a valid accountability system? ... We make our own judgments about where to focus our improvement efforts.... we do have the resources to make improvement."	"We can use NCLB as leverage to get what we have been striving for.... I don't see anything good coming out of NCLB.... Our state test scores have always been good ... but we do have our problems."	"Look, we're just playing the game here ... this law has forced us into this. Let's just give them what they want and ride this one out.... to institute an after-school program to help those kids improve their [testing] skills."	"[NCLB] is the law of this land. We are obliged to follow it."	"We know our students don't do well, and we don't know where to begin."
Follow-up responses from a formative	Formative assessment is needed. Let us purchase	Formative assessment is definitely needed to make the good	Formative assessment is already in place. Why bother? We	Formative assessment must be closely aligned with state	Formative assessment is just like a test. We are busy

assessment standpoint	commercial practice books to prepare district and state assessments.	the best! Let us discuss and select common formative assessment methods.	have quizzes, homework, performance assessments, final exams, MAP testing, DIBBLE, and so on.	standardized testing. Let us break standards into small learning targets and hit them over time.	covering standards and benchmarks. Teaching to the test may be an option.
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We advocate a position where classroom teachers are willing to take the opportunity to improve the quality of the learning and teaching process through, with, and in formative assessment. Unlike other positions that superficially approach classroom problems, this opportunist position values a spirit of continuous improvement in action toward making the good the best! What formative assessment metaphors can be instrumental for those who practically accept that a challenge is an opportunity for improvement? Below are three formative assessment metaphors that are available to help classroom teachers elevate their practical decisions. While it is possible for opportunists to embrace all of the three metaphors (Google Translate→Active Consumers, Lighthouse→Pragmatic Users, and GPS→Assessment Experts), we suggest that the teacher be an assessment expert who is thoughtful, systematic, and intelligent, like GPS, in designing, developing, and utilizing all sorts of formative assessments tailored to meet different needs and interests of students for all.

3.1. Google translate daily done by active consumers

Nowadays, we teachers are expected to actively translate so many formative standardized assessments on a daily and monthly basis into our teaching practices, with the purpose of identifying whether or not our students are making progress. We have to constantly adjust our instructions or classroom activities, based upon the data received from these district-wide, computer-based formative assessments. Therefore, the formative assessments of this kind provide for a lot of data useful for our subsequent instructional plans. All we need is to translate all these data into differentiated instructional plans.

3.2. Lighthouse guided by pragmatic users

There are so many useful assessment resources out there. Our school district adopts a package of curriculum and assessment and we don't have a choice. As a team, we must use it the way we are told by a workshop facilitator or our instructional leader. Like a lighthouse, this formative assessment toolkit will lead all of us to reach a desired destination. Just like a lighthouse as our ultimate guide under any circumstance, we, as a team, have to adopt these formative (and summative) assessment tools as much as we can, with some modification if needed. We are confident that our students will improve their achievement scores.

3.3. GPS performed by assessment experts

We have students with diverse backgrounds and with different abilities to learn. Formative assessment is a planned process in which we teachers take into consideration different teaching paths embedded in culturally relevant assessment methods. GPS is the opposite of the traditional radar system where the subject (operator) is on the ground in order to track down a moving object. For GPS, the subject (driver) is moving around to identify a fixed object (destination). Formative assessment in this paradigm signifies both teacher and student as subject in search of a collaborative chosen standard or rigorous expectation.

4. Feedback in Context: Culturally SMARTER Feedback

As noted above, formative assessment and feedback go hand in hand. We adopt Ruiz-Primo and Li's [30] comprehensive definition of *formative feedback* that has two characteristics. First, the most effective formative assessment that would support student learning is when the students are invited as essential players in the feedback process. Second, formative feedback, whether formal or informal, expands the simple feedback definition beyond oral and written comments to students' performance. Due to this comprehensive approach to formative assessment linked to feedback, this formative feedback leads to a more "blurred distinction between feedback and instruction.... Thus, the feedback event is not a discrete activity; rather, it combines looking for evidence of students' learning on ongoing interactions and communicating to students in the on-the-fly situation"[30:221]. Below, Ruiz-Primo and Li characterized seven elements of what formative feedback is about in the teaching and learning process:

1. Be seen as a process
2. Actively involve students in the feedback process
3. Be considered as an instructional scaffold
4. Be specifically intended to improve learning outcomes and process

5. Ensure its usefulness by making feedback accessible and practical
6. Consider different sources of information
7. Demonstrate, over time, alignment with a learning trajectory at least within a unit or module (pp. 219-221).

Taken together, it is certain that the formative feedback defined by Ruiz-Primo and Li [30] is practical and explanatory to the extent to which purposes, strategies, techniques, and contexts are well interwoven in a holistic manner. This holistic formative feedback approach can be more effective when the teacher is mindful of how to offer what each student needs the most in terms of a process of specific steps. We offer the word, *SMARTER*, which is George T. Doran’s [9] well-known approach to business management, called a S.M.A.R.T.E.R (Specific, Measurable, Assignable, Realistic, Time-related, Evaluated, Reviewed) way to achieve goals and objectives.

Workers in the field of business management can benefit feedback they receive in the manner that relates specific goals, progress-based measures, who is involved, setting attainable outcomes with support and reasonable time, fair evaluation, and reflective discussion for what to next. We relate this *SMARTER* feedback strategy in business management to the field of education in a way to embrace a notion of culturally specific pedagogy suggested by Leonard [19] who claims, “teachers must learn to scaffold children’s informal school knowledge by using cultural referents that go beyond memorization and decontextualized problems ... We develop agency” (p. 8). Student agency here is regarded as a sense of capability teachers believe for students to have in carrying out learning tasks for themselves.

Here, our argument is that if the students are “essential players” [30: 221] in the context of formative assessment, why aren’t we more explicitly addressing their cultural backgrounds? In order for the feedback theory to move forward, we should address an element of culture in increasingly diversified classroom contexts.

Following is our search for culture in college level major assessment textbooks published from 2006 to 2016. We looked over the Indexes of the following texts (N=16) and found the following 5 textbooks (31%) that included the word, *culture* (Table 2).

Table 2: Textbooks and Indexed Words

No.	Textbook (Authors, year)	Indexed Words
1	Classroom Assessment (McMillan, 2014)	<i>Cultural differences</i>
2	An Introduction to student-involved assessment for learning (Stiggins & Chappuis, 2012)	<i>Cultural awareness</i>
3	Assessment is Essential (Green & Johnson, 2010)	<i>Culture, School Culture, students unfamiliar with, competition vs. cooperation, questioning patterns, unintended bias</i>
4	Classroom Assessment (Taylor & Nolen, 2008)	<i>Cultural sensitivity, Culturally diverse students, Cultures</i>
5	Classroom Assessment (Airasian & Russell, 2008)	<i>Cultural differences</i>
6-16*	See Endnote	None

(Note: * Even though these texts do not specifically include the word, *culture*, in their Indexes, we recognized the possibility for words, expressions, facts, or concepts to associate with culture in their main texts)

The importance of taking into consideration the diverse backgrounds of students who bring different cultural knowledge outside of the classroom is key to making this *SMARTER* feedback strategy applicable to the teaching, learning, and assessment process, which we call *Culturally SMARTER Feedback* (Standard/Student-centered, Mutual, Ability, Respectful, Timely, Effort, and Reassessment) (Figure 3).

In classrooms where *Culturally SMARTER Feedback* is intentionally adopted and explicitly utilized, “teachers must learn to scaffold children’s informal school knowledge by using cultural referents that go beyond memorization and decontextualized problems” [19: 8]. Culturally *SMARTER* feedback begins clearly with identifying meaningful standards that the teacher and the student work together to mutually make sense through multiple perspectives. It ends explicitly with reassessing how those standards are responsively embedded in cultural contexts. Meanwhile, feedback that is culturally *SMARTER* as a process takes place where teachers invite students to connect specific contents to their informal school knowledge and backgrounds. For example, following is a simple 2nd or 3rd grade math question:

It costs \$1.50 each way to ride the bus between home and work. A weekly pass is \$16.00. Which is the better deal, paying the daily fare or buying the weekly pass? [23: 170]

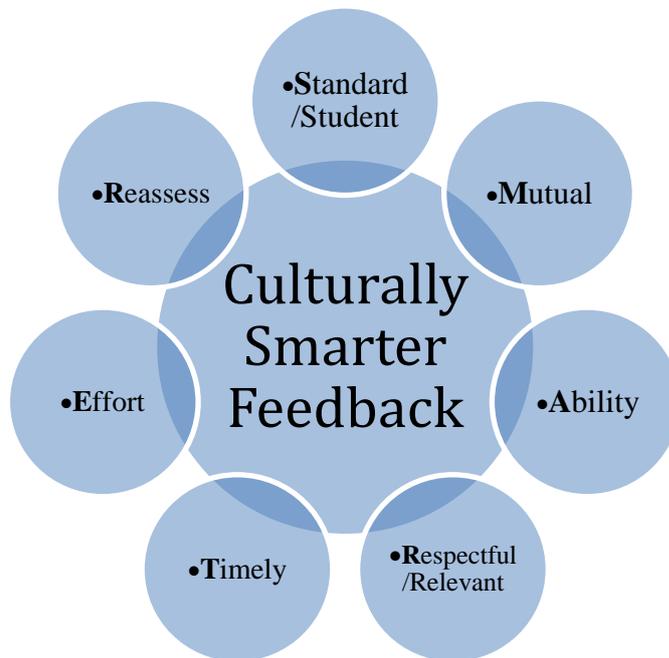


Figure 3: Culturally SMARTER Feedback

The question alluded to above is likely to have a neutral assumption about what most urban area Americans do on a daily basis, as with the focus on the idealized experience of the middle class. This kind of math question may appear at all grade levels and teachers can just teach it without making a further consideration. Yet, teachers who are sensitive to cultural diversity would teach this question in a different way, by appropriating it to different contexts, so the answer of this question can be depending on different family backgrounds or socioeconomic status: 1) if you or your parent(s) have two jobs or more, then the weekly pass is the better deal; 2) if having a good paying job, then you don't need a buy ride, and 3) if having a one job as directed, then buying the daily fare is the better deal based on a simple calculation ($\$1.50 \times 10 = \15 , which is less than $\$16$). As noted above, knowledge about diverse learners is key to utilizing content knowledge and instructional strategies [23].

Such informative formative SMARTER feedback is not so much a traditional one-size-fits-all model as a new culture of differentiated and individualized assessment dialogues where each student has a say about the work she or he does. For example, ESL (English as a Second Language) students are respectfully invited to engage in a dialogic feedback process with their teachers, and sometimes with their peers, to talk about a level of effort they have put while receiving timely feedback on a regular basis. To a large extent, culturally SMARTER feedback is a process, rather than an event, that, systematically as well as emphatically, addresses various academic, social, and emotional needs of all of the students, with a holistic pedagogy geared toward fostering their developmental growth at their own path and pace.

5. A Culturally Responsive STEM Education Example

Given the fact that the student population in the U.S. is becoming more racially and ethnically diverse, it is time to address culturally responsive teaching in general and culturally responsive STEM education in particular. Designing and implementing quality and equitable STEM (Science, Technology, Engineering, Mathematics) education targeted on students of color is beyond the scope of this paper. Instead, we want to briefly introduce two examples of culturally responsive STEM education with much emphasis on use of formative assessment. Let us briefly take a look at an example entitled *Culturally Responsive Indigenous Science: Connecting Land, Language, and Culture* (NSF # 1720931) [6]

This culturally responsive indigenous science project seeks to advance the knowledge base through research and by catalyzing new approaches to Indigenous science, technology, engineering, and mathematics (ISTEM) learning. Using an ISTEM focused model, the project will develop, test, and implement a culturally responsive land-based curriculum that integrates Western science, multimodal technologies and digital tools, and Native American tribal knowledge, cultures and languages to investigate and address local

environmental science and sustainability concerns.... Over a three year period, hundreds of Native American students (grades 4-9) in tribal schools located in Oregon, Washington, and Idaho will engage in the project.... Formative and summative evaluations will be conducted....[29]

At the core of this ISTEM learning are culturally responsive activities that attempt to critically solve local problems related to the environment and sustainability from each tribe's traditional perspective, knowledge, and stories. Teachers and students utilize their project website and an iPad application to engage in interactive lessons, gather data, and create videos through project-based assessments. Specifically, being asked to apply what they have learned to real life contexts, students take a role of environmental scientists who collectively work together, regionally and globally, to explore ongoing problems they face daily, collaborate with real environmental professionals, and create videos to demonstrate a process of resolving those problems being investigated. We argue that an image of culturally responsive teachers is required to make project-based assessments successful and impactful in participant teachers must intentionally guide Native American students through a cycle of culturally SMARTER feedback (Standard/Student-centered, Mutual, Ability, Respectful, Timely, Effort, and Reassessment) in producing student-led videos with their choices and voices valued and embedded.

6. Conclusion

Conceptualizing what a teacher assesses out of contextual variables is neither ideal nor desirable, because classroom assessment is not just a series of whimsical, technical events for checking something, but a *planned process*[27] [28] closely linked to pedagogy and cultural context. Therefore, it is necessary to juxtapose a teacher's assessment-related thinking process with teaching methods in pedagogical and cultural context. For example, in order to assess higher-order thinking skills, a teacher must deliberately plan a lesson where the teacher includes "hinge questions" [34: 88], which will strategically inform the teacher of the valid evidence of students' learning progresses [33]. At the same time, the teacher must consider a strong connection between "what students experience in school, and their lives out of school, by providing in-depth, experiential learning in real-world contexts" [31: 1].

The pedagogical formative assessment approach in cultural context that resonates throughout this paper, e.g., culturally SMARTER feedback, will contribute to adding another perspective to recent efforts that scholars have made on clarifying what formative assessment is meant in relation to feedback, instruction, motivation, professional development, and so on. Because formative assessment is now reaching the status of theory, it should serve as a distinctive professional knowledge base or an area of expertise in which all teachers must carry out in the classroom. The culturally SMARTER feedback provides teachers with a practical lens with which they make both formal and informal plans when searching for evidence of learning from diverse learners, exemplified by a federally funded STEM education project. We hope that this culturally responsive formative assessment framework will guide empirical research on identifying specific characteristics of what is best for culturally and linguistically diverse subgroups of students.

Endnote

1. Formative assessment in a brain-compatible Classroom (Tate, 2016); Educational assessment of students (Nitko & Brookhart, 2015); Assessment of student achievement (Wangh & Gronlund, 2013); Classroom assessment for teachers (Witte, 2012); Formative assessment & standards-based grading (Marzano, 2010); Assessment and evaluation (Williamson, 2010); Foundations of meaningful educational assessment (Musial, Nieminen, Thomas, & Burke, 2009); Seven strategies of assessment for learning (Chappuis, 2009); Classroom assessment (Popham, 2008); Educational assessment (Hogan, 2007); A teacher's guide to classroom assessment (Butler & McMunn, 2006).

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