Chapter 20
Cloud–Based Continuous Formative Assessment (CFA)

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ABSTRACT

Continuous Formative Assessment (CFA) is a strategy that employs free and accessible collaborative cloud-based technologies to collect, stream, and archive evidence of student knowledge, reasoning, and understanding during STEM lessons, so that instructors and students can make evidence-based decisions for adjusting lessons to optimize learning. Writing samples, diagrams, equations, drawings, photos, and movies are collected from all students and archived in cloud-based databases so that instructors can assess student understanding during instruction, and monitor learning gains over time. This chapter introduces and explains CFA techniques and provides preliminary research pertaining to the effectiveness of CFA instructional strategies in promoting student accountability, metacognition, and engagement in STEM courses, and suggests avenues for future research.

INTRODUCTION

The development and availability of new technologies has repeatedly transformed teaching and learning. The chalkboard (c.1890), pencil (c.1900), film projector (c. 1925), radio (c.1925), overhead projector (c. 1930), ballpoint pen (c. 1940), mimeograph (c.1940), videotape (c. 1951), educational television (c. 1958), photocopier (c.

1959), Scantron® (c. 1972), personal computer (c. 1980), graphing calculator (c. 1985), interactive whiteboard (c. 1999), and iPad (c. 2010) are just a few of the myriad of technological innovations that have had a profound influence on teaching and learning (Dunn, 2011). Puentedura (2009) has proposed the SAMR (substitution, augmentation, modification, and redefinition) model to gauge the influence of new technologies on teaching

and learning. While some technologies simply substitute for, or augment traditional strategies and modes of instruction and learning, others have the potential to transform learning experiences through modification and redefinition or learning activities. The advent of cloud-based computing has the potential not only to modify, but also redefine a variety of educational activities, not the least of which is formative assessment. This chapter introduces Continuous Formative Assessment (CFA), a potentially transformative strategy that employs free and accessible collaborative cloud-based technologies to collect, stream, and archive evidence of student knowledge, reasoning, and understanding during STEM lessons, so that instructors and students can make evidence-based decisions for adjusting lessons to optimize learning.

Summative Assessment: Today's educators, students, and educational institutions live in a culture of assessment, being accountable for their work to their clientele, parents, governmental institutions, and the general public. Assessment is the process of gathering and evaluating information to develop an understanding of what students understand and can do with their knowledge as a result of their educational experiences. Assessments provide data by which we can evaluate the competency of students, educators, and educational systems. Teachers, schools, districts, states, and national organizations develop assessment tools to evaluate student learning and the effectiveness of the educational process so that decisions can be made regarding the placement and promotion of students as well as the effectiveness of educational programs (Huba & Freed, 2000; Jago, 2009).

Standardized assessments have been instituted in educational systems around the world and have been used to compare the effectiveness of education not only within schools, but also within and between states, provinces, and countries. Major federal legislation, such as the United States' *No Child Left Behind Act of 2001*, have substantially increased assessment requirements and set ac-

countability standards for schools, districts, and states with measurable adequate yearly progress objectives for all students (Guilfoyle, 2006; Linn, Baker & Betebenner, 2002). The standards and accountability movement has grown dramatically in many countries, and has recently been expressed in the US through the wide-spread adoption of the Next Generation Science Standards (NGSS) as well as the Core Standards in English and mathematics. These standards have been designed to provide all students with an internationally benchmarked education that is evaluated through periodic assessments (Common Core State Standards Initiative, 2010a, b; NGSS, 2013; Porter, McMaken, Hwang & Yang, 2011).

Former US Secretary of Education Margaret Spellings often stated, "What gets measured gets done," reflecting the standards-based logic that has undergirded the development of NCLB, Common Core, and NGSS (Guifolye, 2006, p. 8). When politicians and community activists call for educational accountability, they are generally referring to summative assessments that provide information on what students can do as a result of their educational experiences. Such assessments are "summative" in that they provide a summary of how students, teachers, and institutions have performed.

Formative Assessment: Although growing demands for educational accountability have produced a wealth of literature, legislation, initiatives, reforms, and professional development, the vast majority has focused on assessment *of* learning (summative assessment) rather than assessment *for* learning (formative assessment). Although summative assessment is invaluable in providing data regarding student learning and the effectiveness of educational programs, it does little to shape teaching and learning during instruction. Summative assessments, such as tests, reports, papers, and quizzes, provide valuable information regarding what students have learned, but formative assessments are needed to provide critical information to optimize learning *during* instruction. Simply

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