Ten Years of Engagement, Capacity and Continuity: Reflections on a Trilogy for Student Success

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In the ten years since Engagement, Capacity and Continuity: A Trilogy for Student Success (ECC Trilogy) was published (Jolly, Campbell & Perlman, 2004), it has had much greater spread and impact than we expected. The tenth anniversary seemed an appropriate time to reflect on the roles the EEC Trilogy has been playing in education and what its future might be.

Defining Engagement, Capacity and Continuity

In 2002 we reported that fewer American students were going into the sciences, engineering and quantitative disciplines in college and beyond (Campbell, Jolly, Hoey and Perlman, 2002; NSF, 2000). At that point we concluded that programmatic, instructional and curriculum successes had not led to expected increases in the numbers and diversity of those achieving at high levels and going into careers in the sciences and quantitative disciplines. We wondered why this was the case and concluded that a process was needed to analyze what individual students need to be successful in science, technology, engineering and mathematics (STEM). As a result, with support from the GE Foundation, we developed the ECC Trilogy. The Trilogy is composed of three factors:

- **Engagement:** Having an orientation to the sciences and/or quantitative disciplines that includes such qualities as awareness, interest and motivation.
- **Capacity:** Possessing the acquired knowledge and skills needed to advance to increasingly rigorous content in the sciences and quantitative disciplines.
- **Continuity:** Institutional and programmatic opportunities, material resources and guidance that support advancement to increasingly rigorous content in the sciences and quantitative disciplines.

The underlying assumption of the ECC Trilogy is that all three factors must be present for student success. Each of the factors is necessary, but not sufficient, to ensure student continuation in the sciences and quantitative disciplines.

While we still agree with those definitions, over time we have made some clarifications and expansions. Engagement, we found, needs to include an individual's belief or confidence in their ability to successfully pursue studies in a discipline. Capacity needs to include acquired knowledge and skills beyond that which are measured by standardized achievement tests. Readiness to learn is another important component of Capacity. Continuity is not just opportunities, resources and guidance; it is the structure surrounding the individual, which does or does not provide that person with what is needed for continued or increased Engagement and for improved Capacity.

The ECC Trilogy is organized around a systems approach to better explain the dynamics that effect individual success in STEM. The essential elements for success, described in the ECC Trilogy, can come from any

number of sources and can be in a wide range of contexts. Individual success is dependent on individually achieved levels of Engagement and Capacity but system supports that make up Continuity are also needed. It may take an entire system of organizations and people to work together to provide what individuals need to experience success.

For many users, the ECC Trilogy allows for a more complete understanding of what it takes to advance learner success, a clearer understanding of what accounts for program failures and a model for intervention and remediation that is not necessarily dependent on a single program source. Part of what makes the ECC Trilogy popular may be the intuitive recognition of the continuous interplay between and among individual needs and achievement and system supports that provide for, and accommodate, individual advancement. Additionally, the model reduces, to a manageable number of three, the elements for success that must be provided while broadening the manner in which these elements are understood.

How the ECC Trilogy has Been Used

Initially we assumed that the ECC Trilogy would be used primarily by formal and informal science educators working with K-12 students. As the following examples show, while the ECC Trilogy is being used by educators working with students, it is also being used with a variety of different groups at different levels of education both in and out of the sciences. For example:

College

Faculty at Virginia State University are using the ECC Trilogy to examine program components that lead to the preparation of highly qualified biology majors with the interest, confidence and motivation to pursue terminal degrees in biomedical research or health careers (Virginia State University, No Date).

At Johnson C. Smith University (JCSU) "The EEC Trilogy serves as the conceptual framework for both reviewing current JCSU initiatives, and planning future programs. All STEM services @JCSU are delivered within the Trilogy." (Johnson C. Smith, No Date).

Pre-college

Stillwater (OK) Junior High School uses the ECC Trilogy to help their STEM Design Team come to the common understandings that they feel are necessary to develop and implement a quality program (Stillwater Public Schools, No Date).

Out of School: Informal Science

The Science Museum of Minnesota uses the ECC Trilogy in its informal science efforts as a framework and as a way to assess and improve individual programs (Jolly, 2014).

The Engineering Research Centers report that they used "A Trilogy for Student Success" to guide their core program components for effective out of school time programming" (ERC, No Date).

Out of School: At Risk Youth

The New York City based Youth Development Institute uses the ECC Trilogy as the framework for its College Access program which works to give at-risk youth access to college and the supports they need to be successful in college (Youth Development Institute, No Date).

Funders: Guiding Proposal Development

The 2012 National Institutes of Health Bridges to the Doctorate Grants Announcement for Proposals (R25) included the following: "The Bridges to the Doctorate program must select and employ well-integrated strategies, rooted in education research, that provide students what they need to progress to the next stage of

the science education pathway; for example, analysis of successful science programs by Jolly, Campbell, and Perlman entitled 'Engagement, Capacity and Continuity: A Trilogy for Student Success' (2004)." (Department of Health and Human Services, 2012).

In both 2006 and 2008 the National Science Foundation Informal Science Request for Proposals included the ECC Trilogy as a resource for potential applicants (NSF, 2008; NSF 2006).

Funders: Guiding Programming

Noyce Foundation executive director Ron Ottenger reported that the Noyce Foundation's theory for the development and funding of out of school science activities follows the conceptual framework of the EEC Trilogy (Ottenger, 2013).

Using It All

Ten years ago, as part of the ECC Trilogy we wrote "We don't need to do it all, but we must see that it all gets done". What we meant was that it was not necessary for one institution or program to provide individuals with opportunities to strengthen Engagement and Capacity and have access to needed Continuity. We were saying that together we, across institutions, need to be sure that individuals had all three. To do this there needs to be coherence, which for purposes of the ECC Trilogy, we define as "a logical and consistent alignment among individual sources to achieve a shared goal." Defining a shared goal, a coordinated timeline and agreeing upon appropriately aligned outcome measures are essential elements to coherence both within and across sources of programming if the ECC Trilogy is to be useful. Properly used, the EEC Trilogy justifies and helps organize collective efforts for mission-similar but program-divergent agencies (e.g., formal and informal, in-school and out-of-school) toward a shared goal.

The ECC Trilogy relies upon three components and each is essential for the Trilogy to be properly utilized. Individual programs cannot simply advance a single component independent of the rest and rely on the Trilogy as justification for the programming. Each component is independently necessary but not sufficient. It cannot be presupposed that the other components will be present, maintained or even developmentally appropriate if there is not a clear understanding (and tracking) of all of the essential elements for success in any program relying on the ECC Trilogy as a framework.

Research Challenges

While there have been a number of evaluations of programs using the ECC Trilogy as a framework or an organizing principle there has been little research done on it. Among the research that is being done is a study conducted by Vinetta Jones of Howard University to use the Trilogy to address issues associated with the underrepresentation of African American males in STEM (Jones, No Date).

We hope that more research will be done. Evaluations are useful and help us understand the impact of programs and projects using the ECC Trilogy. Evaluations are designed to assess program effectiveness rather than to move the knowledge base forward. They do little to help refine the Trilogy or to generate boundary conditions. We need research to:

- help us better understand the components' interdependency;
- see if the three components are sufficient; and/or
- determine boundaries that define best and appropriate use of the ECC Trilogy including testing the efficacy of the Trilogy for different populations and academic areas.

In Closing

We originally developed the ECC Trilogy to understand why so many STEM programmatic, instructional and curriculum efforts did not lead to expected increases in the numbers and diversity of those achieving at high levels and going into STEM careers. We are pleased with the degree to which it is being used and hope that it has been helpful in increasing understanding as to what needs to be done. As the ECC Trilogy moves into its second decade, we look forward to working with others to examine ways to refine it as needed and test its usefulness in different areas.

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