Competency-Based Education in Aviation

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Introduction

The aviation industry is highly competitive and has a small tolerance for failure. For this reason, when organizations go through a hiring process, they work to match the applicants to the job competencies required (Watkins et al, 2016). It is up to educational organizations to ensure that applicants have mastered the competencies required by the industry. Thus, applicants will be prepared for the work required by the hiring organization creating effective work processes, increased safety, and reducing errors. In recent years, educational organizations have started to implement a competency-based education approach to ensure students are prepared for the work force. Competency-based education (CBE) is a term that has been used by various organizations to describe a method of design that focuses on the learner and incorporates a mastery of skills and/or abilities, otherwise known as competencies (Council of Independent colleges [CIC], 2015; Dodge, Bushway, & Long, 2018; Educause, 2014). Although CBE is slowly being implemented in educational organizations, especially in higher education, it is an approach to learning that could benefit aviation education. Through this approach, students in aviation would meet the various competencies required by the industry and be able to maintain a safe and efficient industry. In fact, support for CBE from the international governing body for the aviation industry, the International Civil Aviation Organization (ICAO), is proof that this approach is beneficial for the aviation industry and for aviation education. In this literature review, a discussion and explanation of competency-based education will be given. Second, the literature review will discuss why the aviation industry could benefit from this approach and how it is incorporating the competency-based education approach.

Competency-Based Education

Competency-based education (CBE) is a term that has been used by various organizations to describe a method of design that focuses on the learner and incorporates a mastery of skills and/or abilities, otherwise known as competencies (CIC, 2015; Dodge et al., 2018; Educause, 2014). More specifically the Competency-Based Education Network in 2015 defined CBE as "…an intentional and transparent approach to curricular design…. [where] students acquire and demonstrate their knowledge and skills by engaging in learning exercises, activities and experiences…. [and] learners earn credentials by demonstrating mastery through multiple forms of assessment…." (Dodge et al., 2018, p. 2).

As mentioned in the CBE definition provided above, one aspect of CBE focuses on the mastery of skills and/or abilities, i.e. competencies. As the mastery of a skill or ability is an important aspect of CBE, it must be mentioned briefly in this literature review. The following section will provide a brief description of this topic prior to discussing CBE in more detail.

Mastery Learning

Mastery-based learning, or mastery learning, is derived from the study of the goal orientation theory of motivation (Kaplan & Maehr, 2007; Schunk, Meece, & Pintrich, 2014) and achievement goal theories (Harackiewicz, Pintrich, Barron, Elliot, & Thrash, 2002; Pintrich, Conley, & Kempler, 2003). Through these theories, researchers found that students' motivation and achievement were influenced through the selection of two distinct orientations, a mastery goal orientation or a performance goal orientation (Pintrich et al., 2003). A mastery goal orientation focuses on the development of competence, mastering a task, and gaining understanding. On the other hand, a performance goal orientation focuses on demonstrating competence and not appearing weak to others (Kaplan & Maehr, 2007; Schunk et al., 2014; Senko, Hulleman, & Karackiewicz, 2011). As a student selects one or both orientations, his/her

behavior, cognitive strategies, and affective domain will be influenced differently, as can be seen in Figure 1.

Definitions/Outcomes	Mastery Goals	Performance Goals
Goal definitions		
Success defined as	Improvement, progress, mastery, creativity, innovation, learning	High grades, better performance than others, higher achievement on standardized tests, winning at all costs
Value placed on	Effort, attempting challenging tasks	Avoiding failure
Reasons for effort	Intrinsic and personal meaning of activity	Demonstrating one's worth
Evaluation criteria	Absolute criteria, evidence of progress	Norms, social comparison with others
Errors viewed as	Informational, part of learning	Failure, evidence of lack of ability or worth
Outcomes associated with different goals		
Attributional patterns	Adaptive, failure attributed to lack of effort, outcome is seen as contingent on personal effort	Maladaptive, failure attributed to lack of stable ability
Affect	Pride and satisfaction for effortful success	Negative affect following failure
	Guilt associated with lack of effort	
	Positive attitudes toward learning	
	Intrinsic interest in learning	
Cognition	Use of "deeper" processing strategies	Use of more surface or rote learning strategies
	Use of self-regulatory strategies including planning, awareness, and self-monitoring	
Behavior	Choice of more personally challenging tasks	Choice of easier tasks
	More risk-taking, open to new tasks	Less willing to take risks, try new tasks
	More willing to seek adaptive help	Less willing to seek adaptive help

Material drawn from Ames (1992b), Anderman and Maehr (1994), and Maehr and Midgley (1991).

Figure 1. Goal Orientations' Effects on Domains (Schunk et al., 2014)

Figure 1 shows that mastery goal orientations lead to more positive connections to learning strategies, persistence, and well-being (Kaplan & Maehr, 2007; Schunk et al., 2014), whereas, performance goals are mostly associated with maladaptive behaviors (Kaplan & Maehr, 2007; Schunk et al., 2014). It is because of these reasons that mastery orientations are highly valued at educational institutions, specifically higher education (Dompnier, Darnon, & Butera, 2009) as they are more effective on student performance, interest of topic, and work effort (Harackiewicz, Barron, Carter, Lehto, & Elliot, 1997). It is for this reason, that the author of this paper believes that mastery of a skill or ability is an important aspect of CBE.

Explanation of Competencies

A second aspect of CBE that must be defined to further understand this approach is the competency. In general, competency is defined as the "capability to use a set of related knowledge, skills, abilities, and intellectual behaviors to successfully perform a task" (Jones & Voorhees, 2002) regardless of the time required to achieve the mastery of the competency (CIC, 2015). The National Postsecondary Education Cooperative (NPEC) created a working group in 2002 that developed a hierarchy of outcomes. This hierarchy, observed in Figure 2, shows that competencies are created after certain skills, knowledge, and abilities are mastered (Jones & Voorhees, 2002) but before a demonstration is required.

Figure 2. Hierarchy of Outcomes (Jones & Voorhees, 2002)

Challenges of Implementing CBE

As with any approach, there are challenges institutions and organizations will have as they implement a CBE approach. One challenge that is faced by these organizations is the lack of

consensus on what competencies should measure to be transferrable across contexts (Jones & Voorhees, 2002; R. Voorhees, 2001; A. Voorhees, 2001). In addition, Jones & Voorhees (2002) and R. Voorhees, (2001) propose that industries could use competencies in different ways to meet the various demands of the different contexts. In other words, organizations must figure out how to combine competencies, or skills and abilities, to get the most performance of the task that could be used in various contexts.

A second challenge faced when implementing a CBE approach is the assessment of competencies (Dodge et al., 2018; A. Voorhees, 2001). To determine that a student has reached mastery of the competency, the assessment has to be clearly defined and rigorous assessments created (Dodge et al., 2018; Jones & Voorhees, 2002). A. Voorhees, (2001) suggests that creating rubrics that incorporate both quantitative and qualitative inputs could be a start to ensure reliability and validity of the program implemented through the CBE approach. Regardless of the type of assessment, it could be beneficial, according to A. Voorhees, (2001), to look at the competency criteria and assessments that vocational and technical careers use as they are closer to a competency-based approach.

Another challenge faced by institutions or organizations attempting to implement a CBE program is the accreditation process. Most higher education institutions have some type of accreditation process that they must comply with and pass. Since CBE can change many aspects of how the institution provides education, accreditation bodies must adapt to these changes (Eaton, 2015). In fact, Eaton (2015) notes that most accrediting organizations see CBE as a significant shift in the processes of an academic institution processes, requiring review, and evaluation. Further, this study demonstrated that most accrediting organizations are not quite

prepared to evaluate CBE as many of the accrediting organizations are either using the same criteria for traditional programs or have added a few items to their current criteria.

A last challenge that is faced is that there is no national consensus on how to recognize the various competencies that could be attained at academic or professional institutions (Jones & Voorhees, 2002; A. Voorhees, 2001). Currently, if a student achieves a competency at his/her academic institution, that student could struggle to transfer the competency to another institution or for an employer to accept that competency as a hiring criteria (A. Voorhees, 2001). As CBE becomes more prominent in education, an agreement has to be made with academic institutions, unions, industries, and other essential organizations have to align expectations, to ensure competencies can be transferred across contexts (Jones & Voorhees, 2002; A. Voorhees, 2001).

Regardless of these challenges, there are many higher education institutions that are interested, in the process, or have implemented a CBE program due to the benefits. These benefits include a self-paced and personalized learning environment, faculty guidance and mentoring (Educause, 2014), frequent and meaningful feedback and an ability to prepare students for the workforce (CIC, 2015). One higher education institution that was one of the first institutions to use a fully developed CBE program is the Western Governors University (McClarty & Gaertner, 2015). As the university was successful in using the CBE approach, an organization was created, the Competency-Based Education Network, that helps any institution or organization that wants a CBE program.

Just as various industries and organizations are drawn to CBE for their benefits, one industry that could benefit from this approach is the aviation industry. The next section of the literature review will discuss CBE in the aviation industry.

CBE in the Aviation Industry

A discussion of CBE in the aviation industry will start with explaining the educational and training approach currently used in the industry followed by how CBE is incorporated in the industry.

Current Educational Approach in Aviation Education

Due to the heavy regulations on personnel education for the aviation industry, the current approach to aviation education is based on the approaches that are supported by the regulatory and governing bodies of the industry. For example, two decades ago the Federal Aviation Administration (FAA), which is the federal regulatory body for aviation in the United States, started a program called FITS (FAA, n.d). This program was created to meet the need from industry regarding the preparedness of pilots entering the workforce by focusing on scenario-based and learner-centered strategies (FAA, n.d.). Since the implementation of this philosophy, most of aviation education use this scenario-based approach to learning instead of other approaches.

Furthermore, aviation education approaches may also be selected based on the criteria established by accrediting bodies. For example, in the aviation industry the Aviation Accreditation Board International (AABI) evaluates collegiate aviation departments and schools, through the use of standards, to ensure they are recognized by the industry as a high quality educational institution (AABI, 2017). Currently, AABI's evaluations are mostly focused on the performance-outcome approach and not a competency based approach (AABI, 2018). Since most collegiate aviation schools fall under the AABI accreditation, it is inferred that most of them are

still in a performance-outcome approach. Regardless of these regulations and accreditations, there has been some progress in the implementation of CBE programs in the industry.

Current State of CBE in Aviation

CBE in the aviation industry is still in its first stage of implementation as it has not garnered much support from corporations, institutions, and governments in the aviation industry (Kearns, Mavin, & Hodge, 2016). In fact, the International Civil Aviation Organization (ICAO), which is a UN specialized agency that governs and administers the aviation industry worldwide, has promoted the use of competency-based approaches and methodologies for at least the last decade (Kearns et al., 2016). ICAO has promoted the CBE approaches through its Standards and Recommended Practices (SARPs) and training packages (Huan, 2016), which are both available for any country and its corresponding regulatory body to use and implement (ICAO: About Us, n.d.). Furthermore, in 2013 ICAO changed the criterion in its Civil Aviation Training Policy to include that training courses will be recognized by ICAO according to the Training Development Guide, Competency-Based Training Methodology document" (ICAO, 2013).

Regardless of the support from ICAO, there is still not enough CBE programs in the aviation industry. Kearns et al. (2016) state that of the four major groups in the aviation industry, Air Traffic Control (ATC), pilots, cabin crew, and maintenance engineers, only a handful implementations of CBE approaches can be found between all the groups. In fact, from their book and a search of the literature, CBE approaches in the aviation industry are mostly found in air traffic control and cabin crew training.

One study that implemented a CBE approach in ATC training was conducted in the Netherlands (Oprins, Burggraaff, & van Weerdenburg, 2006). In this study, the Netherlands

ATC implemented a CBT program to train incoming controllers. After two years of implementation, the program showed positive results as it was able to provide incoming controllers more specific feedback on their discrepancies and lack of mastery in certain competencies. In addition, the organization was able to have better focus on each individual trainee and personalize their training, reducing some costs (Oprins et al., 2006). Although this is just one example, a few other CBE approaches in ATC training can be found in Australia and New Zeleand (Kearns et al., 2016).

For training cabin crew with CBE approaches, there is still more work to be done (Kearns et al., 2016). To build a case for CBE programs in cabin crew training a few studies have been completed in the last few years. One study, conducted in Thailand, flight attendants participated in a competency-based training (CBT) program to improve their English comprehension skills (Dibakanaka & Hiranburana, 2012). Another study, conducted in the United States, related flight attendant's performance to customer service (Gibbs, Slevitch, & Washburn, 2017). From these two studies, the results demonstrated positive correlations to the CBT programs and meeting the competencies of either English skills or customer service.

Lastly, according to Kearns et al. (2016) CBE approaches in pilot and maintenance engineers training needs more support. There is minimal support at the time as pilots using CBE approaches are mostly in the airline industry, since regulations mandate a CBE training approach, and maintenance engineers are still using traditional training approaches (Kearns et al., 2016). The implementation of CBE programs for maintenance engineers has been slow and hard, but there has been some support from the International Air Transport Association (IATA). This organization has developed a CBT program that is available for purchase by any airline maintenance department that is interested in implementing a CBT program (IATA, 2019).

From the few studies found implementing a CBE approach, it can be inferred that the aviation industry needs to have more discussions on the topic to determine if the benefits of CBE are worth the cost of implementation. It can be noted though that the aviation industry is placing importance on the knowledge, skills, and abilities (KSAs) of aviation personnel. A study conducted by Watkins et al. (2016) demonstrates that industry values experience as the "teacher" for acquiring the desired KSAs on graduates entering the workforce. Although this article didn't mention CBE or CBT, its focus on KSAs and the level of competency desired by industry fits well with the CBE definition. Therefore, the aviation industry is slowly moving towards CBE programs as the norm for aviation education.

Conclusion

As this literature review proposed, a CBE program could be used by aviation education contexts to prepare students for the industry. At the current time, although CBE is supported by the governing body ICAO (ICAO, 2013), CBE programs in aviation education are scarce. Although the benefits of CBE draw other industries into using CBE approaches for learning, there seems to be some restraint on implementing CBE into the aviation education context, based on the lack of research articles found for this literature review. Further study could focus on the lack of progress in the aviation industry in implementing a CBE program.

In addition, another area that requires further study for CBE programs in the aviation industry is the alignment of the CBE program outcomes to the standards set forth by ICAO. As Kulyk and Suslove (2014) state, ICAO's objectives for personnel training are standards that training institutions should follow for high performing employees and/or individuals entering the workforce. As CBE is still being developed, aviation education institutions could use ICAO's standards to help create competencies for their students and determine if in fact the CBE

program is able to meet them. This research could provide information on whether CBE is

beneficial or not for the aviation industry.

Third, accreditation is another aspect that requires further study to ensure CBE programs

become more widespread and recognized by various industries. Since various industries and

contexts require different competencies, creating an evaluation rubric to validate CBE programs

can be a challenge. Although this literature review touched on this topic, there is still very little

research on how accreditation bodies can successfully evaluate CBE programs (Cunningham,

Key, & Capron 2016). In fact, without proper guidance from the accreditation bodies, institutions

wanting to implement CBE programs would be left to their own. One example that accrediting

bodies can use is the framework that was published by the Council of Regional Accrediting

Commission (C-RAC) to evaluate CBE programs (C-RAC, 2015). With this framework as

guidance, a Midwestern University was able to implement a CBE program for their aviation

management major (Mott et al., 2019).

Lastly, aside from guidance from accrediting bodies, institutions interested in

incorporating a CBE program, must also have guidance on assessments. McClarty and Gaertner

(2015) state that for employers to accept the credibility of the CBE programs, aside from

accreditation, is through the quality and reliability of assessments. Although this is an important

aspect to CBE programs' success, there is very little research done on how to assess

competencies in CBE programs (Cunningham, Key, & Capron, 2016). Although there are

various methods used by institutions that currently employ CBE programs, both McClarty &

Gaertner (2015) and Cunningham, Key, & Capron (2016) state that more consensus between

industries and institutions on creating and evaluating assessments must be done.

Given that CBE programs are still growing in popularity and more research needs to be done to understand this approach to learning, current institutions can ask for guidance from various sources to implement a CBE program. The aviation industry could benefit from this guidance and potentially have more CBE programs that expand from just air traffic controllers and flight attendants.

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