Chapter 14
Training for Better Transfer in an Online Competency-Based Higher Education Program:
Technology's Role in Preparing the Next Generation Workforce

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ABSTRACT

Virtual reality simulations represent a much-needed effort to move beyond the shortcomings of traditional form-based assessments. Within VR, we assess competency and problem-solving skills versus the content memorization typically supported by conventional measures. This chapter explores an innovative VR simulation recently deployed at Western Governors University. The authors explored the utility of a VR simulation as an assessment tool when students engaged in more inclusive, immersive, and interactive experiences compared to conventional methods. The authors investigated students' summative assessment scores across a 2D (desktop) and 3D VR (headset) version and how additional factors like motion sickness, cognitive workload, and system usability impacted their scores. The results showed that students in the Desktop version outperformed those in the VR version on the summative assessment while feeling equally immersed in the simulation. Implications for future research are discussed, especially for optimizing learning experiences in an online competency-based higher education program.

DOI: 10.4018/978-1-6684-7644-4.ch014

INTRODUCTION

Somewhere at the intersection between competency-based instruction and workforce demand exists an opportunity to apply what we currently know about how students learn to build competency-based credentials supported by practice scholarship. Science supports learning that builds from and inextricably links to the environment, the situations, and the working culture in which students will eventually find themselves (Schumacher, Englander, and Carpaccio, 2013). Within online competency-based higher education (OCBHE), learning is no longer viewed as a process of transmitting knowledge from instructor to student (e.g., sitting passively, listening to a lecture, taking notes, and applying concepts) but as an active process acquired through a variety of instructional and media types. As a result, students' capacity to develop a particular domain's competency and then transfer that knowledge to future job performance improves.

At a fundamental level, the term *transfer* refers to the influence of prior learning on later activity (Holding, 1991). Initial research began in the early 20th century, when Woodrow (1927) claimed, for example, that "improvement resulting from almost any sort of practice yields, as a rule, some transference" (p. 159). He suggested that *any* practice on a given task produces improvement (i.e., positive transfer) in several related functions. Today, OCBHE programs' criticality in training the next generation's workforce has become evident now that employers focus on identifying, recruiting, and retaining employers with transferable skills. Particularly in times of economic challenge, employers need a skilled, adaptable, creative, and equipped workforce for success in the global marketplace.

To meet this demand, institutions of higher learning are beginning to realize the importance of real-world, performance-based measures like virtual reality (VR) simulations, where performance demonstrations are crucial to success. Central to the development of VR simulations is the need for high-fidelity demonstrations of learner aptitudes and competencies that include a significant emphasis on cognitive abilities (i.e., knowing what) and the performance of those abilities (i.e., demonstrating how). The most important advantage of this testing mode is the real-world relevance that can be incorporated into the assessment, and technological innovations continue to expand these opportunities.

This chapter explores some fundamental principles currently being incorporated into the science of teaching at Western Governors University (WGU) and examines their effectiveness in an OCBHE program. These basic principles are summarized below:

- *Skill acquisition is specific to the conditions practiced during training, and many training programs are only effective to the extent that training will transfer to new situations.* Inefficiently developed training programs can interfere with developing flexible solutions to problem-solving. Programs that train students using a variety of technologies must also evaluate students using those technologies if they want to maximize training transfer.
- *Training that promotes attention flexibility improves learning.* Lessons from dual-task studies suggest that compared to learning single tasks alone, when tasks are practiced together, the cognitive system can coordinate task performance and minimize interference, thus, maximizing learning.
- *Learning complex tasks requires variability in training to maximize learning.* The most robust learning is likely to result from a combination of many experiences that allows students to engage in multiple attention processes when planning and executing solutions from memory.

A key element to each of these principles is that reviewing the same materials at different times and using reorganized contexts from other objectives and perspectives is essential for attaining advanced knowledge acquisition goals. The knowledge that will eventually be used in many ways must be represented, organized, and assessed in many ways. The alternative is knowledge only usable in situations where learners acquired the skill.

It is worth noting that less than a decade ago, terms like learning, memory, and cognition were hardly uttered within competency-based circles. Those less versed in learning theory and cognitive science found phrases like *training for better transfer*, *skill acquisition*, and *memory processing components* rather jargon-laced and somewhat confusing in the context of OCBHEs purpose. Moreover, understanding the instructional means involved in online learning was contextually different and unrelated to institutions' primary goal of educating and graduating students. Since then, seminal publications like *Make it Stick* by Brown, Roedigner, and McDaniels (2014) on successful learning science have altered this view. They provided everyday examples with straightforward explanations about why learning science principles work in an asynchronous environment.

This chapter's remaining sections examine some fundamental learning science principles supporting technology-based learning. We were particularly interested in exploring the utility of a VR simulation as an assessment tool when students engage in more inclusive, collective, and interactive experiences compared to conventional methods in the traditional sense. We investigated students' summative assessment scores across a 2D (desktop) and 3D VR (headset) version and how additional factors like motion sickness, cognitive workload, and system usability impacted their scores. Our results showed that students in the *Desktop* version outperformed the *VR* version on the summative assessment while feeling equally *immersed* in the simulation. Finally, implications for future research are discussed, especially for optimizing learning experiences in an OCBHE program.

Project Background

In 2020, the College of Health Professions at WGU offered two new innovative skills certificate programs designed to upskill healthcare professionals in Chronic and Behavioral Health Care Coordination. The programs were unique to WGU because students were required to pass a summative scenario-based VR simulation to earn a skills certificate; no other programs at WGU require passing a simulation-based assessment delivered in virtual reality. The programs were used as continuing education, employer-required professional development, or as part of employer onboarding for new employees and others leading care delivery transformation.

The skills certificates offered accessible career pathways for new and existing healthcare professionals in career development, career advancement, and mid-career support. They also expanded access by increasing relevancy in health care because the skills and competencies mapped directly to high-demand jobs. Additionally, the certificates provided a pathway for students into the WGU Bachelor of Science in Health Services Coordination (BSHSC) program for students choosing to continue their education. Program certificates, badges, and a skills transcript were awarded to students completing a certificate program.

Competency-Based Education

Competency-based credentials have become another way to demonstrate the flexibility and talent required to learn and grow in an evolving labor market. Consider the differences between traditional higher education and OCBHE programs' approach to learning. In the conventional system, students are awarded credit hours per *seat time* of instruction, and the transmission of knowledge is passed from teacher to student through some lecture or discourse (Johnston, 2011). As participants in this system, all students are taught the same materials simultaneously, resulting in inefficient use of students' and teachers' time. Students who need to learn more quickly fail rather than being allowed to succeed at their own pace, leading some to argue that learning in higher education is one of the least sophisticated aspects of the teaching and learning process (James, 2003).

In contrast, OCBHE programs strive to balance various learning approaches requiring students to master critical concepts before graduating. Students learn at their own pace and earn degrees by demonstrating knowledge and skill in required subject areas through carefully designed competency-based assessments (Gyll & Ragland, 2018). As the popularity of OCBHE programs continues to rise, they will be scrutinized by students and employers alike, and their credibility depends mainly on the quality of the assessments being used (McClarty & Gaertner, 2015).

Within OCBHE programs, assessments associated with traditional linear-based methods are no longer a sufficient means of evaluation. Program designers must now develop learning tasks that represent skilled "competency" based performance, especially those designed to transfer to the world of work. Thus, "competent for (doing) what?" is essential to any competence definition. Successful businesses are looking for employees who can adapt to changing needs, juggle multiple responsibilities, and independently make decisions. Competencies can be acquired through experience, from relevant contextual situations, or influenced by training or other external interventions. For OCBHE institutions to confirm that learners have developed the knowledge, skills, abilities, attitudes, and dispositions to demonstrate successful performance on the job, the definition of competence requires shifting from the conceptual paradigm of an evaluative stance to assuming responsibility for measuring future performance. Forces that might aid this conceptual transformation include the growing acceptance of *high-fidelity, performance-based measures*, which are quickly becoming a way of life in many occupations and professions.

Once student competence has been concretely defined in ways that hinge on quantifiable student achievement, it can be measured and operationalized. Put somewhat differently, and despite the current lack of consensus regarding the definition of competence, it is justifiable and productive to furnish an operational, albeit limited and contestable, definition of competence validated via sound design principles and empirical data. In doing so, institutions have a tool that will increase the likelihood that they will successfully graduate competent students of a particular type than they would otherwise be able to do sans the validated assessment.

For this chapter, competence is defined as "an outcome-based approach to education that incorporates modes of instructional delivery and assessment efforts designed to evaluate mastery of learning by students through their demonstration of the knowledge, attitudes, values, skills, and behaviors required for the degree sought" (Gervais, 2016, p. 99). This definition was chosen because it highlights the importance of student *demonstrations* of knowledge, skills, and abilities (KSAs) throughout the learning process. Demonstrating those KSAs within a competency-based framework is the first step toward ensuring the validity of educational programs and the utility of their outcomes. As such, an evaluation of competence should foretell a student's effectiveness in prospective job situations in a manner that will be fully explored throughout the remainder of this chapter.

Designing for Learning

Compared to traditional instructor-led methods, research suggests that competency-based skills are improved when learning is integrated into the educational experience rather than delivered in a compartmentalized fashion (Ford & Gopher, 2015; Hoogveld, 2003; Van Merrienboer & Kirschner, 2013; Merril, 2002). Furthermore, when content and learning strategies meet accepted education standards, technology increases mastery and helps better prepare students (Penuel & Cohen, 1999). While the literature has produced a sizable amount of evidence in this regard, more is needed to be dedicated to learning science, especially as it applies to training for better transfer in an asynchronous environment. The theories mentioned here represent a few early and more recent ones, and their discussion is not meant to be comprehensive. Instead, the intent is to provide an overview of the selected theoretical issues supporting this chapter's purpose.

Skill Acquisition

In general, skill acquisition follows a predictable pattern, which begins with very slow and effortful problem-solving that leads to fast and automatic problem-solving. Fitts (1964), for example, proposed that skill acquisition progresses through three stages. During the early and intermediate stages, problem-solving is slow and effortful as learners acquire general rules about a task. Then, over time, and after repeated practice, problem-solving in the late stage becomes faster and more automatic as they begin to proceduralize prior learning into action. It is at this point that learners become *expert* problem solvers.

Another skill acquisition model, Adaptive Control of Thought (ACT-R), also suggests that cognitive skill acquisition follows a sequence of learning activities that eventually leads to the automization of the skill (Anderson, 1993). In this theory, all knowledge begins in declarative form (i.e., learning what rather than knowing how). During the initial stages, the learner commits to memory a declarative representation of how rules work. Like Fitts's model, the early acquisition of a skill is slow and effortful, as the learner still needs to achieve an efficient means for solving problems. Instead, learners apply declarative rules that help them solve a problem. Then, through repeated practice, the learner develops a procedural understanding of how rules work. This occurs because knowledge for solving problems is read from the declarative and written to procedural memory. At this point, problem-solving becomes very fast, requires little attention, and can be accomplished while the learner is engaged in other mental activities.

These theories promote a general skill acquisition process, from slow and effortful to faster and more routine. As skills become proceduralized, they lend themselves to faster processing, and the learner is more likely to apply that information to solve complex problems. This is important for guiding our understanding of the effectiveness and utility of a VR simulation because assessing for competency in VR may require standardized procedures that gradually introduce users to its functionality while increasing their situational awareness within the environment.

Learning and Transfer: Lessons From Dual-Task Studies

OCBHE aims to develop students' capacity to acquire competency or mastery of a domain and then transfer that knowledge to new conditions (e.g., solving problems on the job). One method for demonstrating transfer was derived from dual-task studies, which suggest that when tasks are practiced together, learners have more opportunities to minimize interference between tasks and interlace them into a single flow of operations (Kramer, Larish, & Strayer, 1995). In a conventional dual-task, learners work simultaneously on two different tasks, for example, working on a math problem while simultaneously working within a spreadsheet. In general, these studies suggest that compared to learning single tasks alone, when they are practiced together, the cognitive system can coordinate task performance and minimize interference between them, thus, maximizing learning.

According to Brown and Carr (1989), three general methods for acquiring dual-task skills are *restructuring*, *intratask automaticity*, and *task-combination strategies*. The latter of these methods, task-combination strategies, considers dual-task learning and decreases in cognitive interference in the changing relations between two tasks (e.g., solving a math problem while entering the formula into a spreadsheet). Although the functions are performed independently, they can be combined into one processing sequence by interlacing their separate components into a single flow of mental operations. This is important within the context of VR because users are often required to combine bits and pieces of information from overlapping information sources and incorporate them into a single problem-solving activity when called upon to apply that information.

Variability Training

Research in variability training also proposes that irregularity during training may improve learning. For instance, Johnston, Strayer, and Vecera (1998) suggest that narrow-minded practice leads to an overspecialized network that performs well under specific conditions but transfers poorly to new environments. Broad-minded networks (i.e., ones trained on various task components), on the other hand, adapt better to new learning patterns under changed conditions. The learning mechanism responsible for the effectiveness of variability training is significant for understanding training in VR because it provides evidence to suggest that flexibility in attention strategies increases performance on different tasks:

"It appears that systematically altering practice to encourage additional, or at least different, information processing activities can degrade performance during practice, but can at the same time have the effect of generating greater performance capabilities in retention on transfer tests" (p. 215).

Although the principles involving dual-task studies and flexibility training differ from the situated learning in VR, the methods responsible for their effectiveness are noteworthy; it suggests that *integration* during the learning process may increase the application of those skills under changed (i.e., transfer) conditions. Support for these techniques rests in the proposition that flexibility within the cognitive system solves the flexibility dilemma (Johnston et al., 1998). Chiefly, that flexibility within training promotes lasting relationships that allow information to be used in many ways during the skill transfer (Spiro, Feltovich, Jacobson, & Coulson, 1991), like in VR environments.

Constructivist Theory of Learning and Instruction

Education research has also looked at the training dilemma in learning. For example, according to the constructivist theory of learning and instruction (also referred to in their article as cognitive flexibility theory), Spiro et al. (1991) propose that:

"The remedy for learning deficiencies related to domain complexity and irregularity requires the inculcation of learning processes that afford greater cognitive flexibility: This includes the ability to represent knowledge from different conceptual and case perspectives and then, when the knowledge must later be used, the ability to construct from those different conceptual and case representations a knowledge ensemble tailored to the needs of the understanding or problem-solving situations at hand" (p. 24).

A key element to this theory is that reviewing the same materials at different times and using reorganized contexts from other objectives and perspectives is essential for attaining advanced knowledge acquisition goals. The knowledge that will eventually be used in many ways must be represented, organized, and used in many ways during training. The alternative is knowledge only usable in situations where learners acquired the skill.

Designing for Learning in VR Environments

Since the development of VR technology, modern VR applications have been transformed into rich learning experiences leading to an increase in published educational applications. In recent years, collaborative VR applications for learning (Greenwald, 2017), studies on the impact of VR in exposure treatment (Bouchard, 2016), as well as surveys for human-social interactions (Pan, 2018) have all shown the potential of VR as a training tool. Additionally, methodologies for designing learning experiences in VR have evolved. For example, one study examined the impact of a VR Head-Mounted Display (HMD) on high school students' science self-efficacy (Huang, 2022). Hamilton (2021) also discussed VR as a pedagogical tool and proposed maintaining an explicit curriculum in VR space. While still in the early phases, these approaches define the steps required to utilize VR as a pedagogical tool while illustrating the steps needed for completing action-based scenarios within a VR environment.

For the rapid creation of training in VR environments, authoring tools accelerate content creation and provide the platform and assets required by the educational curriculum. For this project, we used MAGES SDK (Zikas, 2022). This platform enables rapid prototyping of any VR simulation in a fraction of the time and cost it typically takes to create VR scenarios. Additionally, we extended MAGES's main capabilities to support the cognitive requirements for this project's needs.

Designing for Learning at WGU

At WGU, students learn at their own pace. All course content is organized, so students navigate different competencies and lectures throughout the learning process. While students are paired with a course instructor, they only receive individualized help from their instructor when needed. Instead, students access the content within the learning management system and navigate freely throughout the course with suggested learning pathways. All WGU courses incorporate the following design principles:

- Learning modules are delivered in short blocks, and the content is practiced at a varied pace rather than one skill at a time.
- Formative questions provide prescriptive feedback and allow learners to return to course materials when needed. The formative questions are varied in type (e.g., multiple-choice, multiple-select, fill-in-the-blank, and drag and drop) and also varied in style (e.g., scenarios, reading checks, and "apply what you know" activities). When students grow accustomed to one type of question, they start to digest content with a particular lens toward that question instead of developing a more well-rounded perspective.
- The content is paired with visual anchors throughout the course. For example, especially in digital environments, the images provide visual cues to the content, which helps improve knowledge retrieval.
- Finally, well-produced videos are integrated into the learning experience.

A recent Gyll and Hayes (2023) study supported these principles. Researchers investigated two different technology methods and their effect on learning outcomes: (1) *traditional* online instruction, whereby students accessed the content through a mix of video lectures supplemented with learning resource materials, and (2) *enhanced* online instruction, whereby students accessed the content through a variety of innovative technology types. They demonstrated that the instructional method in an OCBHE program was an essential factor in the learning process of a student's education; methods that were more innovative, flexible, and based on cognitive science contributed to higher and quicker learning rates than more traditional ones.

The VR Assessment Experience

When training healthcare professionals, both new entrants and those who may be reskilling, an essential measure of competence involves meaningful measures of what students know and can do. For example, for new professionals learning to work with patients and clients to deliver care, information, support, or guidance, the nuances of effective client engagement and psychomotor skills are considered essential entry-level skills. Listening, incorporating, aligning, deciding, and applying knowledge are aspects of these KSAs and can be measured using high-fidelity simulations like those in VR environments.

Hi-fidelity simulations create *presence,* where the assessment is embedded as much as possible in real-time. As a result, the student experiences physical reactions, including heightened attention and awareness. Riva (2019) suggested that presence is more robust when interacting with virtual characters and human avatars than in other mediums. This occurs because the brain creates embodied reproductions of its environment to effectively regulate and control movements, understand concepts and emotions, and make predictions. This is one reason VR simulations continue to receive increased attention from healthcare professionals, accreditors, and state agencies as valid measures of competence.

The Scenario Setting

The goal of the VR assessment was for students to demonstrate competence in the healthcare coordinator's cognitive, psychomotor, and affective domains. The interactions within the assessment occurred in a conference room and private office within various healthcare settings. The Chronic Care Coordinator (CCC) assessment happened over a single client-based scenario. It focused on Emil, a 55-year-old male recently diagnosed with type 2 diabetes complicated by a history of dyslexia and rheumatoid arthritis. The Behavioral Healthcare Coordinator (BHCC) assessment took place over three different scenarios:

1. Scenario A occurred in a long-term care facility.
2. Scenario B occurred in a youth residential treatment center.
3. Scenario C occurred in an outpatient community mental health center.

The scenarios utilized allied health and ancillary professionals, like case managers, therapists, psychologists, psychiatrists, pharmacists, nurses, medical assistants, care coordinators, and administrative staff.

During the assessment experience, students assumed the care coordinator role (i.e., the Chronic Care Coordinator or Behavioral Health Care Coordinator). Students were instructed to behave professionally and respectfully as though their situation was "real." The student was responsible for "suspending disbelief" and acting as if the virtual environment was the actual environment.

Theory Meets Practice

Within the VR assessment, assessing for learning is no longer viewed in the traditional sense. There were no *items* in the conventional sense, no *forms* to build; there were no items in the bank. In scoring the VR assessment, the number of points possible for each scenario varied depending on the number of independent tasks or critical actions within the branch. A critical action represented any "measurement opportunity" within the assessment and was akin to a test *item*. For example, a single branching scenario may contain two or more critical actions within the scenario. A student may be required to respond to a multiple-choice question and spend a minimum amount of time reviewing the Electronic Health Record (EHR) to earn points. Each critical action was then scored against the result of a set of scenarios within the branch.

What does this mean for students? Let's consider one. Meet *Janelle*, a student at WGUs Health Professions College. By building a VR assessment with various simulation types, Janelle has multiple opportunities to process and respond to information in new and novel ways. When she engages with her assessment, Janelle finds:

- *Scenario-based branching logic:* Each scenario contains branching logic seated within several errant pathways. Errant paths lead end-users further from a correct response in a computer simulation (Gyll, 2019). There are two types of errant paths: inconclusive and conclusive:

    1. *Inconclusive* (or dead-end) paths allow users to look for or *fish* options but do not provide an opportunity to perform a given task.
    2. *Conclusive* errant paths enable users to navigate options, complete tasks, and see results; however, those results will be incorrect.

Sometimes an incorrect response triggers an errant path, but only occasionally. For example, Scenario A contained five errant paths, Scenario B had four, and Scenario C included three. Suppose an incorrect response triggered an errant path. In that case, the simulation might have branched Janelle back to the same question depending on how she performed within the errant path, allowing her to *self-correct* and answer the question again. If this was the case, she did not receive the total allowable points for her second attempt at the question.

- Distributing the content within her assessment helps Janelle *actively* construct her understanding of the content. Students who participate in active knowledge retrieval can have 6X improvement in outcomes (Dollar & Steif, 2008). This is more than a correlative effect. Frequently testing retrieval is one of the best ways to assess learning and transfer.
- *Varied item types:* Janelle's item types are varied (e.g., multiple-choice, multiple-select, fill-in-the-blank) and also varied in style (e.g., scenarios and "apply what you know" activities). When students grow accustomed to one type of question, they start to digest content with a particular lens toward that question style instead of developing a more well-rounded perspective of the content. These varied item types were also interspersed throughout Janelle's course experience, providing a more exciting and "sticky" learning experience.
- *Chunking:* The content of Janelle's assessment was arranged as distributed scenarios in short blocks, so each took a slightly different amount of time to complete. Each of the three scenarios was designed to take at most 30 minutes to complete, and she could take a break between each scenario. For example, scenario A consisted of 30 assessment questions and actions, Scenario B consisted of 42 questions and actions, and Scenario C consisted of 17 questions and actions. This helped Janelle plan for a steady pace and provided the right-sized blocks to consume in a testing session.
- *Relevance:* To increase Janelle's interest and engagement, well-produced simulation videos integrating real-world experiences were incorporated into the assessment. Short bursts of relevant content helped to maintain attention and motivation.
- *Visual Anchors:* The cognitive system is not built for remembering text. We remember by tagging what we learn to visual imagery. Especially in digital environments, the images provided visual anchors to improve retrieval. Janelle's assessment content was paired with visuals so her brain could tag and connect content.
- *Variable priority:* The assessment content was designed so Janelle could get through some of it quickly, while other sections took much more time. Also known as "interleaving," variable priority means assessing at a varied pace rather than one skill at a time. Think "abc, abc," NOT "aa, bb, cc."

Method

This project aimed to engage students in authentic assessment experiences to test the efficacy of emerging technologies like VR simulations to supplement WGUs assessment practices as a viable alternative to competency-based education. We postulated that we could further advance student learning beyond traditional performance- and linear-based methods by re-creating presence through immersive, simulated assessments. The VR simulation assessment was made available in a 2D (desktop) and 3D (VR headset) version.

Research Questions

1. Do summative 2D (desktop) and VR (3D) assessment scores differ by version?

2. Did the student's cognitive- and task- workload differ by assessment version?
3. Did simulation sickness scores differ by assessment version?
4. Did system usability contribute to student performance on the 2D and VR summative assessments?
5. Does immersion in the 3D version make it more difficult for students to answer questions in the headset?

Participants

Thirty-six students were invited to participate in the research. Students were enrolled in the Chronic Care Coordination (n = 29) and Behavioral Health Care Coordination (n = 7) skills certificate programs during the 2021 and 2022 academic years at WGU. Twelve CCC students and one BHCC student participated in the research. Unfortunately, the BHCC student was excluded from the data analysis, so results are limited to the 12 students in the CCC program. Research participants were awarded a $50 Amazon gift card for their participation.

Apparatus

Students in the *VR* version used HTC Vive Focus 3 VR headsets with controllers. The Vive Focus 3 is a stand-alone VR headset delivering best-in-class graphics and ergonomic comfort. VR and desktop interfaces were projected in world space as 3D objects and accessed with the computer mouse (desktop) or the VR controllers (headset). Students in the *Desktop* version used a Windows PC with an i5-7260 CPU and a GTX1060 GPU. In the *Desktop* version, students navigated to various points of interest by controlling camera angles, for example, zooming in on the tablet or moving to different characters in the scenario. To accomplish this, we implemented an easy-to-use system with clickable buttons to navigate these various points.

Process

Before the Assessment

Before the summative assessment, students in the CCC program completed *Care for Individuals and Families*. The course content and topics covered five competencies and 11 skills validated in the assessment (see Appendix A). Western Governors University uses skills to develop the competencies on which its educational model is based. This skills-based approach to designing content establishes the "skill" as the common denominator for employers, job seekers, and educational institutions, allowing them to communicate in a common language.

Learning taxonomies describe different types of learning behaviors. Some taxonomies distinguish different 'levels' of learning, whereas others categorize learning. As a result, learning taxonomies demonstrate the growth of the learner's acquisition of knowledge, skills, and abilities (KSAs) across a pathway. At the highest level, *Competency* is an individual's measurable, assessable capability that integrates knowledge, skills, abilities, and dispositions required to successfully perform tasks at a determined level in a defined setting. *Skill* is a lower-level contextualized statement describing an individual's foundational applied capabilities and behaviors for a given job, occupation, or need.

During the Assessment: Chronic Care Coordinator Scenario Description

The CCC scenario offered multiple opportunities for care coordination across disciplines, including the care coordinator (and others - primary care provider, nutritionist/dietitian, endocrinologist, diabetic educator, pharmacist), the patient, and the patient's family. The scenario began with an opportunity for the care coordinator to review patient information in the electronic health record (EHR). Next, it built into a conference meeting with the client while ever-increasingly implementing care coordination-specific assessments and interventions. At this point, the care coordinator interacted with members of the interdisciplinary team, and ultimately the care coordinator documented her impressions and care plans.

Specifically, the scenario describes Emil, a 55-year-old Hispanic male with several chronic conditions, including rheumatoid arthritis (RA), dyslexia, and type 2 diabetes. Emil lives alone at home and is employed as a rural mail carrier. He describes work as stressful because he was recently reprimanded for delivering mail to the wrong addresses. He also reports worsening pain and dexterity in his hands due to the RA.

Emil recently visited his primary care provider (PCP) and received a new diagnosis of type 2 diabetes with an HbA1C of 12. The PCP prescribed insulin glargine (ten units daily) and metformin 500 mg (twice daily). In addition, he was asked to keep a daily glucose log and a diary of day-to-day activities and meals. The PCP noted pronounced tension between Emil and his sister, Patricia, regarding how best to manage Emil's medical care. At this point, Patricia is trying to pull back from managing his day-to-day care and is primarily focused on managing his finances. As a result, the PCP referred Emil to the chronic care coordinator.

Emil has had one previous visit with the care coordinator, where he brought his daily glucose, activity, and meal logs to the visit. Unfortunately, he was logging information in the wrong columns and was not tracking the data daily. This issue was addressed at the previous meeting, and the care coordinator arranged for Emil to complete an *electronic* daily activity and glucose log. This has proven successful, and the care team has noticed improved frequency and accuracy of the records.

However, new concerns need to be addressed by the care coordinator and team. For example, Emil is not using his insulin pens appropriately due to dexterity issues; he cannot depress the button when administering the insulin. Additionally, he needs to understand the nutritional guidelines (e.g., he feels that all sugar is bad and should be avoided), and the medical team feels he is at risk for hypoglycemia. Finally, Emil is only willing to administer one injection daily despite having higher insulin requirements because he "does not like the pokes," will not take both long-acting and short-acting insulin, and will not agree to multiple injections for using a glucose correction scale. Therefore, the care coordinator will need to work with the other professionals on the team to establish a plan that provides Emil with prefilled single-dose insulin syringes due to safety-related dexterity and dyslexia concerns.

After the Assessment

Assessments were computer-scored, and students received their results immediately. Students were categorized into one of two groups:

- Competent (pass)
- Approaching competence (fail)

To set the passing score for the assessment, we used a two-stage process developed by WGU psychometricians. It is the same process used for all objective assessments at WGU. Unfortunately, passing standards at WGU are not shared or made public for test security reasons. For a thorough description, please refer to the chapter "Design, Measurement, and Technology Considerations in Virtual-Reality Assessment."

Additionally, students received a coaching report showing their scores for each competency. The coaching report was also made available to their student mentor. We recognized early on that the VR assessment was new, innovative, and prone to planning failures. Likewise, we knew that students were also new to VR and inclined to execution errors. We were all on a steep learning curve, and we prepared for this. Therefore, if a student did not pass after their first attempt, they could retake the assessment (either in VR or on the desktop version) or debrief with a student mentor. Debriefing helped them to "think through" the assessment experience and remediate each skill. It was at the student mentor's discretion whether to award additional points for a particular competency based on the debriefing protocol. The debriefing questions were modeled after the PEARLS Debriefing Framework (Eppich & Cheng, 2015) and included the following questions:

- Provide a summary of the case.
- How are you feeling after completing the simulation?
- What aspects of the simulation do you think went well?
- What are some key takeaways you have from this simulation?
- What would you do differently next time if you were to do the simulation again?

After the debrief, the student's assessment was rescored, and a final pass/fail decision was made.

Variables

Subjective Measures

- *Cognitive workload* was modeled after the NASA Task Load Index (2005): The NASA task load index (TLX) measures subjective mental and physical workload. The TLX rates performance across six dimensions to determine an overall workload rating. We modified the TLX to a 4-point ordinal scale (0 = No effort, 1 = A little effort, 2 = Some effort, and 3 = A lot of effort). Total scores ranged from 0 to 18, with higher scores indicating higher workload levels. The six dimensions were:
  - Mental demand - the amount of thinking, deciding or calculating required to perform the task.
  - Physical demand - the amount and intensity of physical activity required to complete the task.
  - Temporal demand - the amount of time pressure involved in completing the task.
  - Annoyance/frustration - how annoyed/frustrated the participant felt during the task.
  - Stress - how stressed the participant felt during the task.
  - Difficulty - the overall difficulty in completing the task.

- *Simulation sickness* was modeled after the Simulator Sickness Questionnaire (SSQ, 1993): The SSQ measures users' level of simulator sickness in VR research. We used a modified 13-item *SSQ*. Participants rated the severity of each symptom on a 4-point ordinal scale (0 = None, 1 = Slight, 2 = Moderate, and 3 = Severe). Total scores ranged from 0 to 39, with higher scores indicating higher simulation sickness levels. The 13 symptoms were:
  - Fatigue, headache, eyestrain, focus, sweating, nausea, concentration, blurred vision, dizziness (eyes open/closed/vertigo), upset stomach, and burping.
- *System usability* was modeled after the System Usability Scale (SUS, 2006). The SUS is a widely used tool allowing users to evaluate various products and services, including hardware, software, mobile devices, websites, and applications. We used a modified 7-item scale. Participants rated the severity of each symptom on a 3-point ordinal scale (0 = Poor, 1 = Acceptable, 2 = Good). Total scores ranged from 0 to 14, with higher scores indicating higher system usability levels. The seven categories were:
  - Text resolution, image resolution, virtual setting/location, characters/avatars, realistic movement/actions, vocals/speech volume, and pronunciation.
- *Immersion and presence* were measured by asking students to describe their sense of "being" in the office space and working with patients while taking the assessment. Students rated their level of agreement to five questions using a 3-point ordinal scale (0 = Not all, 1 = Somewhat, 2 = A lot). Total scores ranged from 0 - 10, with higher scores indicating higher levels of agreement. The five questions were:
  - The office space feels realistic.
  - The office space seemed like someplace I had visited before.
  - I felt a sense of being in the office space.
  - I thought I was standing in the office space.
  - I felt like I was interacting with an actual patient.

Objective Measures

- *Summative Assessment - VR* (3D) Version
  a. Students were scored on their total assessment score rather than on a pass/fail basis per scenario. The total score was based on a weighted composite of the number of "critical actions" within the assessment. There were 500 total possible points. See Appendix B.
- *Summative Assessment - Desktop* (2D) Version
  a. Scoring in the Desktop version worked the same as in the VR version.

Analysis and Results

Our goal was to test hypotheses related to the effectiveness and utility of VR simulations as a viable alternative to assessment in an OCBHE program. However, the limited number of respondents (n = 12), and thus the small sample size, precluded any statistical inferences from being drawn. Therefore, our results are descriptive and exploratory.

Demographics

There were ten female and two male respondents across five ethnicities (see Appendix C). The majority (50%) were between 35 - 44 years old, and many (42%) held at least a 4-year college degree. All respondents worked in *Health Care and Social Assistance*, and their years of employment varied between 3 - 20. Most (83%) had *No* prior experience with virtual reality simulations or equipment.

Study Variables

The grand mean (M) and standard deviation (SD) values for each study variable are in Table 1. On average, students in the *Desktop* version scored five percentage points higher on the summative assessment (M = 43% correct) than those in the *VR* version (M = 38% correct). In addition, students in the *Desktop* version reported lower *Task Load* and *Simulation Sickness* scores than those in the *VR* version. However, differences in *System Usability* and *Immersion* scores were not notably different between the two versions. It can be reasoned that students in the *Desktop* version not only outperformed students in the *VR* version on the summative assessment but also felt equally *immersed* in the simulation while experiencing similar *quality*.

Table 1. Comparison of Study Variables for VR versus Desktop Versions

Assessment Version	% Correct Score	Task Load	Simulation Sickness	System Usability	Immersion
VR	M = 38%, SD = 10%	M = 11.8, SD = 4.26	M = 6.2, SD = 5.07	M = 8.8, SD = 4.44	M = 4.8, SD = 5.02
Desktop	M = 43%, SD = 8%	M = 7.42, SD = 5.0	M = 3.7, SD = 2.69	M = 7.57, SD = 5.47	M = 5.14, SD = 3.93

DISCUSSION

The focus on ensuring that degrees correlate with careers is a promising development in online competency-based higher education. Nearly every academic discipline and job require some skills transference from college to career. As we work toward the development of alternatives to *practice hours* and challenge and reform outdated norms about *hours being the measure of competency* in higher education, new and innovative methods like VR simulations are demonstrating their effectiveness and utility as a valid measure of competency. In addition, learning theory suggests that programs that practice a blend of assessment approaches may improve training transfer when integrated into the learning experience compared to those learned in the traditional format (Gyll et al., 2023). While it would be too strong to say that science is uniting a new learning theory, there is convergence in the essential attributes of a successful model when technology and instructional methods meet.

Today's economy values broad knowledge and skills, flexibility, cross-training, multi-tasking, teaming, problem-solving, and project-based work. Learning in an environment that optimizes and aligns explicit and implicit curricula is critical to achieving a new paradigm's desired outcome. Janelle does not just need a degree; she needs the ability to apply the knowledge and skills she has built earning that degree. The principles discussed here support learning that is flexible, variable, and integrated, creating learning experiences that bear a close similarity to the contexts in which the learning results will be applied. As a result, students are more engaged in the learning process, more interested in the content, and better prepared to enter the workforce with the generalizable skills employers expect.

Limitations

The apparent quasi-experimental nature of our research is worth noting. Our study included variables that did not use random assignment to create the comparisons from which statistical inferences were gathered. Instead, our comparisons depended on the nonequivalent groups that differed in many ways other than the presence of a treatment whose effects were being compared. Especially in a field setting as complex as higher education, we recognize the inherent threats to valid causal inference that non-random assignment brings to the process. Yet, we must deal with those threats in some meaningful way. After all, designing experimental research in an applied educational setting is seldom done well, as day-to-day operations allow little to *design experiments*. As a result, a convenience sample provided the only means to draw somewhat meaningful conclusions without the afforded capability of manipulating variables in an operational setting.

Additionally, although the sample size was small, it is worth noting that even small samples can be impressive. What makes some research seem important is not their magnitude but rather the studies' methodologies that produced them. Lacking any statistical process control or research design methodology (there were no manipulations of the IV), our findings supported the learning science principles described throughout this chapter.

Stated somewhat differently, researchers adopt a tremendous variety of experimental approaches, including computer simulations, longitudinal studies, psychometric assessments, content analyses, meta-analyses, citation assessments, and biographical data. The research units can be as small as single discoveries and as large as whole generations. The sample sizes can vary from single-case studies to inquiries with thousands of records. Since our research did not employ a strong causal design, I suspect that a future study could be designed to maximize its power and statistical strength with sufficient ingenuity. As Einstein and Infeld (1938) once concurred, in a different context:

"The formulation of a problem is often more essential than its solution, which may be merely a matter of mathematical or experimental skill. To raise new questions, new problems, to regard old problems from a new angle, requires creative imagination and marks real advances in science" (p. 95).

Nevertheless, students in the *Desktop* version outperformed those in the *VR* version on the summative assessment. They also reported lower *Task Load* and *Simulation Sickness* scores than those in the *VR* version while feeling equally *immersed* in the simulation. While we can only speculate, there are perhaps many factors that contributed to lower summative assessment scores in the *VR* version, not just the *VR* experience. Such as donning the headset (compounded BY), working in 3D, (compounded BY) test anxiety, (compounded BY) prior experience with VR, etc.

During debriefing interviews, students told us they felt wholly immersed and enjoyed the novel, innovative experience. The VR assessment helped them feel like they were taking on the role of a care coordinator. However, using the VR headset seemed to elevate anxiety for some students already anxious about taking a high-stakes assessment. Getting them comfortable and confident is essential long before the assessment starts. For those unable to overcome their anxiety, offering an alternative like the desktop version was necessary.

Next Steps

There is little doubt that OCBHE is here to stay; students benefit from more inclusive, collective, and interactive experiences than traditional learning methods. Which begs the question, what's next? As discussed, much of the focus of conventional learning methods has been on traditional practices, which are necessary, but insufficient for learning transfer. As a result, OCBHE must position itself to advance student achievement through – among other things – identifying and assessing high-performing students and their workforce readiness through a variety of mechanisms. Rationalization within the market will occur among institutions as they learn the effectiveness of OCBHE programs and their ability to graduate high-performing students.

VR Training Platforms

In VR training platforms, a new competency-based approach to learning is beginning to emerge using a blend of artificial intelligence and live human interaction. Musion provides an immersive VR training platform for mastering essential skills such as interpersonal communication, leadership, and emotional intelligence. Using trained professionals who orchestrate the interactions between learners and avatar-based characters, Musion simulations achieve the realism needed to deliver measurable, high-impact results.[1]

Learning and Individual Differences

Our human actions (i.e., individual differences) can limit the precision of a training program's effectiveness, despite our best intentions. Research on individual differences can reinforce and complement inquiry into students' unique learning characteristics. Individual differences are the enduring psychological characteristics that distinguish one person from another (Ackerman, Kyllonen, & Roberts, 1999). Some have argued that student achievement is the byproduct of multiple distinguishable causes. Therefore, it refers to effective instructional practices as an entity or personal attribute that holds steady over time and space. However, as Harris and Sass (2008) point out, the "differences between the age, academic level, and needs of students mean that teaching requires different skills and knowledge in a different context. These multiple contexts underscore that effective teaching is not fixed but reflects the particular organizational environment and student needs" (p. 22). Attempts to differentiate students in a nuanced fashion based solely on the broad learning approaches discussed in this chapter are surely misguided, as students enter their degree program with varying degrees of KSAs and differing learning styles.

Among the dominant trends in the educational literature is characterizing those differences in students' knowledge, experiences, and strategic capabilities. By uncovering those characteristics, educators are more likely to orchestrate learning experiences that serve each student's needs. For example, recent research has demonstrated that students' confidence, experience, and knowledge notably affect study behavior and performance outcomes (Gyll & Hayes, 2021) in an OCBHE program. Specifically, students with a higher understanding of the course content (measured a-priori) performed well despite less studying. In addition, students with higher confidence also performed well. Still, students with high experience with the course struggled more with the course material and demonstrated performance decrements on the summative assessment. In other words, individual differences in learning style can indicate the amount of effort required to succeed in an OCBHE course, but more research is needed.

Aptitude-Based Learner Guidance

Aptitude measures - tests assessing the human potential to be successful in specific areas or occupations - can serve as a helpful complement to traditional interest-only measures by connecting students' interests to their abilities and matching them to career possibilities that may have previously gone overlooked as viable choices. Different occupations require different KSAs, and individuals who show strengths in those KSAs are more likely to succeed and persist in a particular field (Krane & Tirre, 2012). Without educators assisting students in understanding what they have the potential to accomplish, many learners, especially the underserved, could be guided away from high-demand, high-wage careers for which they have a high ability. Knowing one's strengths (such as aptitudes) can be a great starting point.

Research studies have questioned whether conventional endorsements of students' interests predict anything useful regarding educational outcomes at all. For example, student *interest* in STEM careers is more strongly predictive of pursuing a STEM degree than academic achievement or ability (Rothstein, 2015). Additionally, we know that the percentage of college students majoring in engineering has grown markedly from 1% in 1970 to 17% today. This figure indicates fewer than two out of every ten engineering majors (Carnevale, Smith, & Gulish, 2018) and those graduating with Bachelor's degrees are female (Burrelli & Woodin, 2008; Yoder, 2014). Unfortunately, higher-education authorities are rarely trained in research-based strategies and typically remain unaware of the aptitude-based learner guidance literature. So, in lieu of meaningful predictors, career guidance counselors who use interest-only measures are left to their own devices to determine which career choices are most likely to be a good fit for students. In other words, a more holistic and accurate career potential assessment is possible when considering both factors.

Individual Learning Style

Finally, it is undoubtedly critical to appreciate that one's learning style is not uniform or unidimensional from an instructional standpoint. Instead, as educators have frequently attested, individuals can - and do - differ, even for the same instructor, same content, or within the same school (Alexander & Murphy, 1999). Given the distinctive nature of individual learning styles, OCBHE institutions should adopt a robust notion of student attributes and holistic and comprehensive views of every student using prescribed methods. In addition to scientifically validated academic planning tools, supplementary techniques and components such as readiness for self-directed learning, confidence and level of experience with course content, interactions with faculty, behavioral archetypes, and the like should be utilized to as great an extent as the faculty deems necessary and practical. Stated somewhat differently, science should not over-emphasize asynchronous learning as a tool but also include individual difference factors when designing better learning systems. Augmented, extended, simulated, virtual, etc., whatever we call it, is a starting point, not a definitive answer.

CONCLUSION

Looking ahead, several issues hinder the market's functioning as it relates to an agreed-upon set of approaches. These include a lack of research in - the topics mentioned above - for adult learners (especially those transitioning into new careers), agreed-upon definitions of what it means to be "competent," inadequate transparency and portability of employer-backed credentials, and a lack of policy support. Although there are many promising examples and much momentum around competency-based learning, the current marketplace is far from flourishing, and more research is required. Whether creating a data-driven, systematic value chain will be left primarily to competency-based institutions or alternative providers remains to be seen.

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ENDNOTE

1 www.musion.com

APPENDIX A: CARE FOR INDIVIDUAL AND FAMILIES' COMPETENCIES AND SKILLS

Table 2. Care for individuals and families competencies and skills

<table>
<tr><th>Competency Identifier</th><th>Competency</th><th>Skill</th><th>Course Unit</th></tr>
<tr><td rowspan="3">7070.6.1 (Scenario A) (Scenario B)</td><td rowspan="3">Competency 1: Models of Care Delivery: The learner applies care delivery models to navigate individuals and families through a care plan in various healthcare settings.</td><td>995 Care Delivery Models: The learner collaborates with the interdisciplinary team to determine an appropriate care model.</td><td rowspan="3">Unit 1</td></tr>
<tr><td>420 Care Planning: The learner applies comprehensive patient, and family-centered care plans to improve access and health care outcomes.</td></tr>
<tr><td>4034.1 Care Planning: The learner determines if additional resources or potential partners are needed to meet a patient's health needs.</td></tr>
<tr><td rowspan="3">7070.6.2 (Scenario A) (Scenario C)</td><td rowspan="3">Competency 2: Helping Individuals and Families Meet Healthcare Goals: The learner implements care plans to support individuals and families in meeting their healthcare goals.</td><td>376 Care Planning: The learner applies a comprehensive patient and family-centered care plan.</td><td rowspan="3">Unit 2</td></tr>
<tr><td>2213 Care Planning: The learner determines barriers to care and non-compliance.</td></tr>
<tr><td>3852 Care Planning: The learner identifies resources and strategic partners to meet a patient's health care needs.</td></tr>
<tr><td rowspan="2">7070.6.3 (Scenario B)</td><td rowspan="2">Competency 3: Prevention Practices: The learner selects prevention practices to educate the individual and family and support their health care goals.</td><td>2313 Risk Analysis: The learner determines which prevention practices are most appropriate to implement based on patient risk assessment.</td><td rowspan="2">Unit 3</td></tr>
<tr><td>2817 Health Education: The learner educates patients on their condition and treatment plans.</td></tr>
<tr><td rowspan="2">7070.6.4 (Scenario A) (Scenario B) (Scenario C)</td><td rowspan="2">Competency 4: Intervention Strategies: The learner applies intervention strategies to meet the health care needs of the individual and family.</td><td>564 Health Intervention: The learner applies the appropriate intervention(s) for a patient, given the population the patient belongs to.</td><td rowspan="2">Unit 4</td></tr>
<tr><td>3661 Health Intervention: The learner identifies appropriate interventions that promote client-centered care.</td></tr>
<tr><td>7070.6.5 (Scenario A) (Scenario B) (Scenario C)</td><td>Competency 5: Shared Decision-Making: The learner executes shared decision-making strategies to support individuals and families in meeting their healthcare goals.</td><td>5345 Decision Making: The learner creates models to engage and motivate clients and families toward shared decision-making.</td><td>Unit 5</td></tr>
</table>

APPENDIX B: SCORING RUBRIC FOR CHRONIC CARE COORDINATION - EMIL

Figure 1. Scoring rubric for chronic care coordination - Emil

Scenario B - Emil					
Competency	**Skill**	**Unique Critical Actions**	**Calculated Weighted Percentage (from Blueprint)**	**Suggested Points Allotment for Skill - Based on Weighted Percentage (out of 500)**	**Suggested Points Allotment for Each Unique Critical Action Opportunity**
Competency 1: Models of Care Delivery: The learner applies care delivery models to navigate individuals and families through a care plan in a variety of healthcare settings. Note: This is talking about ACOs, Medical Homes. Care delivery models - Staff models (HMO), ACO, PCMH-Patient Centered Medical Homes (primary Phys supported as lead role providing care), Open systems [illegible]	**995 Care Delivery Models: The learner collaborates with the interdisciplinary team to determine an appropriate care model.**	4	0.0939	47	12
	420 Care Planning: The learner applies comprehensive patient and family-centered care plans to improve access and healthcare outcomes.	3	0.1379	69	23
	4034.1 Care Planning: The learner determines if additional resources or potential partners are needed to meet a patient's health needs.	4	0.0575	29	7
Competency 2: Helping Individuals and Families Meet Healthcare Goals: The learner implements care plans to support individuals and families in meeting their healthcare goals.	**376 Care Planning:** The learner applies a comprehensive patient and family-centered care plan.	5	0.1226	61	12
	2213 Care Planning: The learner determines barriers to care and non-compliance.	5	0.0926	46	9
	3852 Care Planning: The learner identifies resources and strategic partners to meet a patient's healthcare needs.	3	0.0805	40	13
Competency 3: Prevention Practices: The learner selects prevention practices to educate the individual and family and support their health care goals.	**2313 Risk Analysis:** The learner determines which prevention practices are most appropriate to implement based on patient risk assessment.	3	0.1207	60	20
	2817 Health Education: The learner educates patients on their condition and treatment plans.	2	0.0766	38	19
Competency 4: Intervention Strategies: The learner applies intervention strategies to meet the healthcare needs of the individual and family.	**564 Health Intervention:** The learner applies the appropriate intervention(s) for a patient given the populations the patient belong to.	3	0.0575	29	10
	3661 Health Intervention: The learner identifies appropriate interventions that promote client-centered care.	6	0.067	34	6
Competency 5: Shared Decision-Making: The learner executes shared decision-making strategies to support individuals and families in meeting their healthcare goals.	**5345 Decision Making:** The learner creates models to engage and motivate clients and families toward shared decision making.	3	0.0939	47	16
	Totals	41	1.00	500	147

APPENDIX C: DEMOGRAPHICS

Table 3. Demographics

Gender	***N***	***%***
Female	10	83.3%
Male	2	16.7%
Age	***N***	***%***
35 to 44	6	50.0%
45 to 54	2	16.7%
Ethnicity	***N***	***%***
African American/Non-Latino	4	33.3%
Asian	3	25.0%
Caucasian/Non-Latino	2	16.7%
Latino	2	16.7%
Western European	1	8.3%
Education	***N***	***%***
2-year college degree	3	25.0%
4-year college degree	5	41.7%
High school	1	8.3%
Post-graduate degree	2	16.7%
Trade/Tech/Vocational School	1	8.3%
Years	***N***	***%***
11 - 15 years	2	16.7%
16 - 20 years	3	25.0%
3 - 5 years	2	16.7%
6 - 10 years	3	25.0%
More than 20 years	2	16.7%