2020

Integrating Technology Acceptance Model and Health Belief Model Factors to Better Estimate Intelligent Tutoring System Use for Surge Capacity Public Health Events and Training

Sarah Matthews
University of Central Florida

INTEGRATING TECHNOLOGY ACCEPTANCE MODEL AND HEALTH BELIEF MODEL FACTORS TO BETTER ESTIMATE INTELLIGENT TUTORING SYSTEM USE FOR SURGE CAPACITY PUBLIC HEALTH EVENTS AND TRAINING

by

SARAH D. MATTHEWS

B.S. University of South Florida, 1999

M.P.H., University of South Florida, 2000

M.S., University of Central Florida, 2018

A dissertation submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy
in the School of Modeling, Simulation and Training
in the College of Engineering and Computer Science
at the University of Central Florida
Orlando, Florida

Fall Term

2020

Major Professor: Michael D. Proctor

ABSTRACT

The U.S. public health system is continually challenged by unexpected epidemiological events that pose significant risks to the health of the community and require a commensurate surge in the public health system capacity to stem the spread of the disease. The complexity and even changing nature of funding and surge events drives agencies to innovate in order to maintain and support a competent workforce as well as update, or evolve the knowledge, skills and abilities (KSA) necessary to prevent, mitigate, or even eliminate the health crisis arising from a disease.

This research investigates the capability of an agent-based, online personalized (AOP) intelligent tutoring system (ITS) that adaptively uses aptitude treatment interaction (ATI) to deliver public health training and assure competency. Also, presented is a conceptual model that combines Davis' Technology Acceptance Model (TAM) and the Public Health Service's Health Behavior Model (HBM) concepts to understand actual use of new technology in the public health sector. TAM is used to evaluate the effectiveness and the behavioral intent to use the system. HBM is used to explain and predict the preventative health behavior of actual use of the ITS.

Our findings indicate the use of the ITS increases participant performance while providing a high level of acceptance, ease of use, and competency assurance. Without the determination of casual sequence, the TAM/HBM conceptual model demonstrated the best fit for predicting actual use of an ITS with the constructs of attitude, cues to action, and perceived ease of use showing the most influence. However, discussion of our findings indicates limited potential for an ITS to make a major contribution to adding workforce surge capacity unless members are directed to utilize it and technology barriers in the current public health IT infrastructure overcome.

Keywords: Public Health Training, Intelligent Tutoring Systems (ITS), Technology Acceptance Model (TAM), Health Belief Model (HBM), Surge Capacity, Competencies

I dedicate this to all who believed and supported my abilities to earn a doctorate degree and to my fellow public health professionals, who continue each day to protect the health of our communities.

ACKNOWLEDGEMENT

There are many who helped me along the way on this journey. I want to show my gratitude by thanking them.

First, I wish to thank my dissertation committee for their time, expertise, and guidance. The committee was truly interdisciplinary from Dr. Wan’s excellence in instruction in structural equation modeling, to Dr. Bockelman’s expertise in communication, Dr. Sottilare’s proficiency in intelligent tutoring systems research, Dr. Karwowski’s astuteness in research design and Dr. Proctor, my Chair’s, seasoned academic prowess, all contributing to my success.

To my friends, family, and colleagues; thank you for continuing to support me with physical, mental, and spiritual growth over the 4 years. I am grateful for your patience, commitment and understanding.

Finally, to my husband, Steve, and my daughters Simone and Vidya; your unyielding love, your faith and your fortitude provided me the will to complete this degree. It is now part of our familial legacy. May our accomplishment continue to be meaningful and fruitful for generations to come.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF MEDIA/ABBREVIATIONS/NOMENCLATURE/ ACRONYMS

Adaptive hypermedia systems (AHS)

Affordable Care Act (ACA)

American Public Health Association (APHA)

Aptitude treatment interaction systems (ATI)

Area Health Education Centers (AHEC)

Army Research Laboratory (ARL)

Artificial intelligence (AI)

Association of State and Territorial Health Officials'(ASTHO)

CDC's Epidemic Intelligence Service (EIS)

Centers for Disease Control and Prevention (CDC)

Centers for Public Health training (CPH)

Comparative fit index (CFI)

Computer-aided educational instruction (CAI)

Confirmatory factor analysis (CFA)

Council for State and Territorial Epidemiologists (CSTE)

Direct fluorescent antibody (DFA)

Educational technology (EdTech)

Electronic health records (EHR)

Enzyme-linked immunosorbent assay (ELISA),

Exploratory factor analysis (EFA)

Field Epidemiology Training Program (FETP)

Generalized Intelligent Framework for Tutoring (GIFT)

Goodness of Fit (GOF)

Goodness of fit index (GFI),

Health Belief Model (HBM)

Immunoglobulin G (IgG)

Immunoglobulin M (IgM)

Institute of Medicine (IOM)

Intelligent personal assistants (IPA)

Intelligent tutoring system (ITS)

Knowledge, skills, and abilities (KSA)

Learning management systems (LMS)

National Association of City and County Health Officials (NACCHO)

National Institutes of Health (NIH)

Normed fit index (NFI),

One Health Workforce-Next Generation (OHW-NG)

Reverse transcription polymerase chain reaction (RT-PCR)

Root mean square error of approximation (RMSEA)

Root Mean Square Residual (RMR),

Structural equation modeling (SEM)

The Department of Health and Human Services (DHHS)

The Technology Acceptance Model (TAM)

Theory of Reasoned Action (TRA)

TrainingFinder Real-Time Affiliated Integrated Network (TRAIN)

United States Agency for International Development (USAID)

User management system (UMS)

World Health Organization (WHO)

CHAPTER 1: PUBLIC HEALTH SYSTEM AND TRAINING OF PUBLIC HEALTH PROFESSIONALS

The World Health Organization (WHO) and the American Public Health Association (APHA) defines Public Health as the art and science of promoting health, preventing disease, prolonging life and protecting the health of people and their communities through organized efforts of society (Association, 2018; Organization, 2018). Public health focuses on all aspects of health and well-being by maintaining the functions of encouraging healthy behaviors, conducting scientific research to educate about health, preventing disease through interventions and assuring conditions in which people live, work and play are healthy (Association, 2018). In other words, its mission is to fulfill society's interest in assuring conditions in which people can be healthy (I. o. Medicine, 1988).

Current United States Public Health System

The national public health system in the United States is composed of governmental agencies from federal, state and local government, healthcare providers, public safety agencies, human services and charity organizations, education and youth development organizations, recreation and arts-related organization, economic and philanthropic organizations and environmental agencies and organizations (Prevention, 2017b).

The primary organizations involved in oversight of public health in the United States are the federal Department of Health and Human Services, the state health agencies and local health departments but it also contains representatives within government such as congressional committees, state legislature committees, governor's task forces and county and city officials. Other organizations included are other governmental agencies that operate programs with a public health focus which include education agencies, environmental protection and natural resource agencies, mental health agencies, agencies on aging, health financing agencies, social service agencies, agricultural agencies, housing authorities, military and traffic and highway agencies. Private sector organizations include professional membership associations, universities, the media, consumer organizations, foundations, private health care providers, the insurance industry, nonprofit organizations, and community clinics. These diverse organizations work together to conduct assessment activities, collaborate on setting policies, provide access to personal services, delivery of public health services and emergency response to biological, chemical, radiological, nuclear, manmade and natural disasters within the country and across the globe (I. o. Medicine, 1988). Public health success is dependent on active and effective participation of professionals in medicine, nursing, dentistry, veterinary science, social work, pharmacy, epidemiology, physical therapy, occupational therapy and other health related disciplines within several organizations (Tao, Evashwick, Grivna, & Harrison, 2018).

These professionals touch every sector of community to maintain our lifestyle, thus maintaining sufficient capacity with the appropriate capabilities is critical. The enormous scale and immense diversity of the system makes this task very difficult (Beck, Boulton, & Coronado, 2014; Hilliard & Boulton, 2012; Tao et al., 2018). In addition to size, the composition of the U.S. public health workforce also provides challenges (Beck et al., 2014; Hilliard & Boulton, 2012).

Enumeration methodologies and definitions of public health professionals are frequently problematic (Beck et al., 2014). In 2014, the enumeration estimates of public health professionals in governmental agencies were 290,988 (range=231,464-341-053) with 50% in local, 30% in state and 20% at federal levels. This estimate was composed of administrative or clerical personnel (19%), public health nurses (16%), environmental health workers (8%), public health managers (6%) and laboratory workers (5%). Workers placed in the other/uncategorized public health professional category account for 30% of the workforce with the remaining 16% made up of behavioral health (2%), emergency preparedness (1%), epidemiologists (2%), health educator (2%), nutritionist (2%), public health dental worker (2%), public health informatics specialist (1%), public health physician (3%) and public information specialist (1%). This diverse composition and the lack of a standardized accepted effective method for educating and training adds to the difficulty of recruiting, retaining and maintaining appropriate capabilities in the public health workforce (Evashwick, Begun, & Finnegan Jr, 2013; Hilliard & Boulton, 2012; Tao et al., 2018).

Training of Public Health Professionals

In 1918, John Hopkins University School of Hygiene and Public Health became the first endowed school of public health. Today there are approximately 64 schools of public health, 117 schools with public health programs and 10 standalone baccalaureate programs in public health (Health, 2017). These schools are the primary source for education in public health. Thus, schools are a primary target for recommendations from the Institute of Medicine (IOM) for collaborative partnerships and practice for developing new training opportunities and more extensive approaches to education for the workforce. Partnerships between local health and academic institutes have been a successful route for public health professionals to receive training for preparedness and lifelong learning. Employing methods of distance learning, blending-series, learning management systems (LMS) and web-based programs have also improved access to training and education (Hilliard & Boulton, 2012). E-learning platforms are an attractive method for higher education institutes because of their cost benefits and ability to have a wider reach for learners. In the scientific literature, e-learning has many pedagogical process dimensions such as opportunity for use, quality of knowledge gained and learner's level of acceptance. There is also a variety of studies demonstrating the effectiveness of e-learning on the acquisition of knowledge and the quality of knowledge gained in comparison to traditional learning (Benta, Bologa, Dzitac, & Dzitac, 2015). But even with these educational implementations, there remain substantial gaps between knowledge, skills and abilities (KSA) observed in practice and expectations (Tao et al., 2018).

To help fill the gap, the federal and state governmental health organizations utilize various successful strategies in education and training of the public health workforce in the form of on-the-job training, workshops and conferences (Hilliard & Boulton, 2012). The Public Health Foundation, an organization that receives federal funding for training, created the TrainingFinder Real-Time Affiliated Integrated Network (TRAIN). This platform consists of training courses that build KSA's in multiple subject areas in the form of live events, conferences, blended learning series, webcasts, web stream and self-study web-based training (Foundation, 2018). These e-learning platforms have been well-utilized and have been sustainable with affiliate TRAIN sites adding to much of the domain content and updates.

Additional educational strategies include the use of Area Health Education Centers (AHEC) and the creation of Centers for Public Health training (CPH). AHEC's are traditionally used for continued education credits for many licensed and credentialed public health professionals (e.g. physicians, nurses, dentist, environmental health specialists, nutritionists, etc.). During past periods of federal funding availability, they developed and maintained courses in public health. CPH's also developed courses in public health, many of which correlated to practice, with the availability of federal funds. With budgetary cuts to training and workforce development initiatives, these centers closed or transitioned to more e-learning course delivery (Workforce, 2018).

TRAIN, the self-regulated platform, utilizes several educational techniques to ascertain knowledge gains. The development and sustainment of courses in the educational centers provide a plethora of educational resources. The drawback to these resources is there is no standardization or proficiency testing to assure the learner is gaining the knowledge, skills and abilities (KSA's) that are required to be competent for a surge capacity event (Lederberg, 2000).

Competency Framework

The formal path for a career in public health is by obtaining a degree from a school of public health. However, most careers in public health begin from diverse educational paths with no formal training in public health (2011; I. o. Medicine, 1988). The Department of Health and Human Services (DHHS), Health Resources and Services Administration Bureau of Health Professions estimates that only 20% of the current public health professionals have the education and training needed to be effective at their jobs and the other 80% lacking formal education or training in the field (Hilliard & Boulton, 2012). Even with a formal degree, students are not fully prepared for practice and must utilize on-the-job training and education (2011; Evashwick et al., 2013; Tao et al., 2018). The surge capacity events tend to occur sporadically and the need for continuous training and preparation is necessary.

To ensure the training and education are aligned with the practice, a variety of competency frameworks are employed. The framework most utilized in the U.S. was developed by The Council on Linkage Between Academia and Public Health Practice (Council on Linkages) and contains the core competencies for public health professionals (Core Competencies) (Foundation, 2014; Tao et al., 2018). The Core Competencies are categorized into 8 domains and are defined by the 10 Essential Public Health Services to reflect the most desirable skills for professionals in the practice, education, and research of public health. The 8 domains include: Analytical/Assessment Skills, Policy Development/Program Planning Skills, Communication Skills, Cultural Competency Skills, Community Dimension of Practice Skills, Public Health Science Skills, Financial Planning and Management Skills and Leadership and Systems Thinking Skills (Foundation, 2014).

Figure 1: Core Competencies for Public Health Professionals (Foundation, 2014)

The 10 Essential Public Health Services include: Monitor health status to identify and solve community health problems, Diagnose and investigate health problems and health hazards in the community, Inform, educate and empower people about health issues, Mobilize community partnerships and action to identify and solve health problems, Develop policies and plans that support individual and community health efforts, Enforce laws and regulations that protect health and ensure safety, Link people to needed personal health services and assure the provision of health care when otherwise unavailable, Assure competent public and personal health care workforce, Evaluate effectiveness, accessibility and quality of personal and population-based health services and Research for new insights and innovative solutions to health problems (Prevention, 2017b). These criteria set a framework for education and training and are frequently used for on-the-job training. However, the retention of competent staff to perform on-the-job training is another contributing factor to the problem of maintaining appropriate capabilities in competence (Hilliard & Boulton, 2012; Tao et al., 2018).

Figure 2: The 10 Essential Public Health Services (Prevention, 2017b)

The Challenge of Public Health Workforce Shortfall

Workforce shortages of skilled experienced public health practitioners has plagued the system for several years. According to a recent study published in the *American Journal of Preventive Medicine*, the most recent estimates to the public health workforce (federal, state and local) demonstrate a steady drop in capacity from 500,000 (220/100,000 population) in 1980 to 448,000 (158/100,000) in 2000, and 291,000 (93/100,000) in 2014. The study suggests that one-quarter of the workforce will leave due to budgetary limitation and retirement from 2016-2020. This ranges from 65,000-100,000 practitioners that are currently employed at the state or local level health departments (Leider, Coronado, Beck, & Harper, 2018).   The National Institutes of Health Forum on Emerging Infections Workshop also found that there is a significant deficiency of public health professionals trained in epidemiology and surveillance, two areas of expertise required for outbreak management (Hilliard & Boulton, 2012; Lederberg, 2000).   The factors that contribute to this shortage are attributed to inadequate salaries, staff development, resources, academic partners and the lack of appropriate curriculum as well as the lack of multiyear grants which inhibit state and local health departments from investing in personnel (Lederberg, 2000). The American Public Health Association also reports a 10% decrease in workforce in the public health laboratories, another area of expertise required in outbreaks, in 2009 (Association, 2011; Lederberg, 2000).

Adding to this challenge is the perception that outbreaks, and epidemics of infectious diseases have been successfully prevented and controlled, thus are not health threats to the U.S. This supports the misconception that the current system is sufficient (Lederberg, 2000). These misconceptions have led to an unsustainable and fragmented system leading to less service delivery. These losses are making the health of the community vulnerable as daily tasks and commitment to training become more abbreviated to accommodate workload (2011; Tao et al., 2018).

The Institute of Medicine (IOM) addressed these issues in their publication, *The Future of the Public's Health in the 21st Century* wherein they called for workforce development and strengthening of infrastructure through training, research and collaboration (I. o. Medicine, 2002). Association of State and Territorial Health Officials'(ASTHO) Public Health Workforce Position Statement proposed the building of infrastructure to develop public health leaders by exploring methods of developing knowledge, skills and attitudes to build capacity of the future workforce as well as strengthen partnerships between public health and clinical practice (ASTHO, 2013). The National Institutes of Health (NIH) Forum on Emerging Infections also called for investment of human capital by funding sustainable careers, developing targeted public health training programs and promoting linkages among academic, the medical community and the public health sector (Lederberg, 2000). An example for collaborative partnership is research in education of the public health workforce.

The research on the pedagogy for educating public health students and future workforce is minimal in the scientific literature (Tao et al., 2018). Additionally, the published literature on evidence-based principles for delivery of education has much homogeneity in its study populations which is composed of licensed staff in either medical, dental and nursing neglecting other non-licensed staff (Tao et al., 2018). In the 2014 enumeration of the governmental public health workforce, these licensed staff only accounted for 20% of the workforce while the remaining 80% are classified as other public health professionals (Beck et al., 2014). Thus, focusing on the licensed staff population when studying training outcomes creates limitations when extrapolating correlation in the real workforce.

While the homogeneity in the populations in the published literature might not be ideal, the innovative methods for education and training provide fodder for thought. These methods could be used for training the workforce for surge capacity events that may require deployment of public health services such as emergency responses to chemical, biological, radiological, and natural disasters.

Training Public Health Professionals for Outbreaks in the USA

Training and capacity building for research, response, and daily operations in public health for emerging infectious disease or outbreaks is a multifaceted complex task. Outbreaks are more frequently associated with biological agents (e.g. bacteria, virus, parasite, prion) that cause disease, but they can also be caused by physical forces (e.g. earthquake, car crash) or chemical agents (gaseous, liquid, solid which is inhaled, ingested, absorbed or injected). Once the potential of an outbreak is determined, a multi-step process known as an outbreak investigation is initiated. This process is used to understand and determine the dynamics of the outbreak and implement appropriate control and prevention measures to control the situation. The investigation is a 13-step process that requires competence in diplomacy, logical thinking, problem solving, quantitative skills, epidemiological skills, and judgement. To hone these skills requires practice and experience which is usually acquired by on-the-job training by a seasoned epidemiologist paired with a novice. In the table below the steps are presented in conceptual order, however in practice the steps can be completed in a different order or simultaneously (2012).

Epidemiologic Steps of an Outbreak Investigation

1. Prepare for field work
2. Establish the existence of an outbreak
3. Verify the diagnosis
4. Construct a working case definition
5. Find cases systematically and record information
6. Perform descriptive epidemiology
7. Develop hypotheses
8. Evaluate hypotheses epidemiologically
9. As necessary, reconsider, refine, and re-evaluate hypotheses
10. Compare and reconcile with laboratory and/or environmental studies
11. Implement control and prevention measures
12. Initiate or maintain surveillance
13. Communicate findings

Prior to deployment for field investigations, online training resources offered by the CDC, the Public Health Foundation via TRAIN or state and local health departments can be assessed. Face to face facilitated trainings are also offered by CDC and state and local health departments when training funds are available. One example is the Field Epidemiology Training Program (FETP) which focuses on training the global public health workforce. The program is modeled on CDC's Epidemic Intelligence Service (EIS) program, another program for training for outbreak response in the U.S. and is owned by the countries and their ministry of health for implementation and sustainment. The program is successful in that it has been implemented in 70 countries and has trained over 10,000 graduates (2018). However, they heavily rely on existing staff to mentor and teach which may cause more burden to the system. Additionally, the reach of both programs is limited and does not adequately provide trained personnel to the state and local health departments, the agencies that are frequently the front line of outbreak investigations (Hilliard & Boulton, 2012; Lederberg, 2000).

The American Public Health Association reported that budgets allocated for workforce training and development decreased by 57% in 2009 and continuous learning or in-service training also was less common in local health departments.   Despite the need there continue to be fewer training opportunities (2011). To combat this the Affordable Care Act (ACA) implemented five provisions that intended to support training and education for public health disciplines. These include Public Health Workforce Loan Repayment Program, Preventive Medicine and Public Health Training Grants, Fellowship Training in Public Health, and the creation of U.S. Public Health Sciences Track. The ACA also added provisions to increase training for clinical health care providers. This action also demonstrated the training needs in workforce. However, the funds that were appropriated have suffered significant cuts up to 80% throughout the years (Yeager, 2018). In addition, the workforce development activities were expansions of the existing educational strategies with little innovation or evidence-based research utilized for novel approaches.

By contrast, research in healthcare receives more federal funding support than public health (Beck & Boulton, 2012). Thus, innovative training delivery methods in healthcare run the gambit from e-learning platforms, mannequin and procedural simulators, the use of virtual standardized patients and the use of gaming for various medical and clinical topics (Romero, Ventura, Gibaja, Hervás, & Romero, 2006). Incorporating these innovative methods in public health training and education might be a sustainable route for education if funding were available, which is doubtful. This paper would study one method enables economies of scale when deployed over the internet, the use of adaptive computer-based intelligent tutoring system (ITS).

ITS have demonstrated to be as effective as an expert human tutor which makes it ideal when human tutors are unavailable (VanLehn, 2011). Thus, the question emerges, can online ITS provide public health training? If so, do what degree of competency? Will public health professional accept ITS? What public health applications are most pressing or important for an ITS to be applied?

CHAPTER 2: ADAPTIVE INSTRUCTIONAL SYSTEMS AND ASSESSMENT METHODOGIES

Intelligent Agents

There are many types of Artificial Intelligence (A.I) of which intelligent agents are among. A.I. is a "human produced ability, as opposed to a naturally occurring ability to learn, sense (i.e. take in information and judge), think abstractly, and apply knowledge and skills to favorably manipulate its environment in an effort to achieve its goals"(Van Lent, 2019)

Intelligent agents are a combination of artificial intelligence (AI), databases and computer human interfaces, which may be used to mimic human behavior (Woolf, 2010). Intelligent agents are characterized by their ability to learn from previous experience, reason, adapt and respond to the environment. An intelligent agent has some level of autonomy, may be goal oriented and may communicate and provide feedback to a humans and other agents (Laboratory, 2018). Intelligent agents may be classified by their capabilities and the degree of perceived intelligence. Classifications include simple reflex agents, model-based reflex agents, goal-based agents, utility-based agents and learning agents (Today, 2018).

Intelligent agents serving as personal assistants (IPA) use AI technology to transform data into actions such as answering questions or performing simple tasks for a client. IPA utilize AI to develop virtual identities that can converse and interact with the user. IPA interact with humans by mimicking human behaviors and adapting and learning after that interaction (Techopedia, 2018). These systems may integrate, manage, organize, and maintain multiple sources for information (including inputs from the user). IPA may predict actions needed to perform the task by using learning techniques such as neural networks, probabilistic models or machine learning (Czibula, Guran, Czibula, & Cojocar, 2009).

One example of an IPA is Cortana, a digital assistant created by Microsoft which uses machine learning. It first gathers raw data from several sources. Then it utilizes its intelligence suite to perform transformations, analytics, and machine learning to provide some action to people, an application, or automated systems. Cortana can receive inputs from text or spoken. If given access to your Microsoft account, she incorporates your demographic information, your location information and learns from all the activity that is conducted on your computer (Microsoft, 2015). One limitation of Microsoft's machine learning approach is the degree to which it can adapt to changing needs. For Cortana experts are required to upgrade the system knowledge-base and retrain it for additional applications.   Another limitation is that system learning is not instantaneous which requires more computing time for the system to adapt and can slow up the response rate (Microsoft, 2015).

Intelligent Tutoring Systems (ITS)

Computer-aided educational instruction (CAI) has been used since the 1950's. With the introduction of artificial intelligence (AI) into these systems, it became known as Intelligent CAI (ICAI).   In the 1980's Sleeman and Brown coined the term ITS, which is now the more frequently used term for intelligent systems that adapt to provide customized immediate feedback or instruction to a learner for the best learning results (Fischetti & Gisolfi, 1990). In 2012, most environments that focused on competency-based education utilized an adaptive learning technology as a targeted study aid or a resource for remediation or supplemental instruction. With the generation of new use cases the application of adaptive learning technology has expanded. This allowed for products that support authentic forms of assessment to measure real world knowledge and skills and better assess competency (Partners, 2016).

Intelligent tutoring systems (ITS) are computer based instructional systems that mimics the teacher student interaction by modeling the state of a student learner to provide individualized instruction (Ma, Adesope, Nesbit, & Liu, 2014). ITS may utilize aptitude treatment interaction systems (ATI) which are used to adapt learning strategies to specific student characteristics (aptitude) in combination with micro-adaptive systems (i.e. modules),which analyzes user needs and provides the appropriate instruction (Nguyen & Do, 2008). ITS are created to help the learner gain domain specific, cognitive, and metacognitive knowledge and have demonstrated to be an effective tool for learning. Research in intelligent tutors has shown that learning from the ITS is associated with higher outcome scores regardless of the learner's level of schooling, research setting, research instruments, procedural or declarative knowledge content or other conditions (Ma et al., 2014).

An ITS is generally composed of 4 basic modules: an expert or domain module which contains the knowledge about the topic being taught; a student or learner module which manages the student's understanding of the domain; a teaching expert or tutor module/pedagogical module that analyzes and executes the appropriate tutoring strategies, and the user interface which deals with the form of knowledge communication (Fischetti & Gisolfi, 1990). Initial inputs of learner states and traits are received in the learner module which is processed. The data acquired in the process is then used to derive learner states that is then inputted into the pedagogical module. The pedagogical module processes the information and selects the instructional strategies and techniques that would be most beneficial to the learner. The data from this module is then processed and inputted into the domain module. The domain module assesses performance and provides feedback into the learner module and to the interface to present to the learner. This interaction of a learner with an ITS is depicted in Figure 3 below:

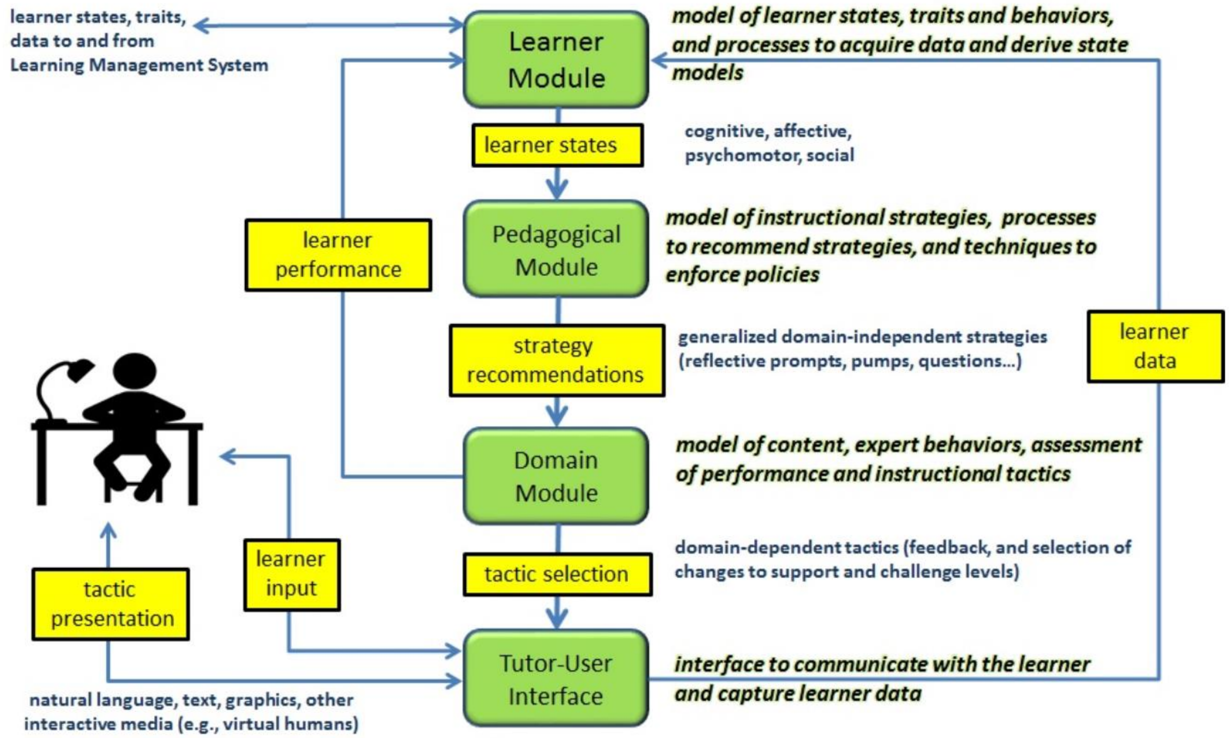


Figure 3: Interactions with an Intelligent Tutoring System (Robert Sottilare, April 6, 2018)

Fundamentally, there are two types of adaptation: rule-based and algorithm-based. The rule-based adaptation uses predetermined fixed branching architecture via a series of if-then functions. When a learner is asked a question and their response is correct, they move to the next selected activity. If the response is incorrect, they are given a hint, chance to repeat, or additional content to assist them. This type of system can gain in complexity or difficulty depending on the branching determination and the responses the learner inputs to the system. It is a simpler system for understanding and has clarity around its functionalities. Rule-based adaptation systems have a greater ease of use when creating content because it does not rely on the use of statistician, a cognitive scientist or significant administrative support. However, it does not have the computational power as compared to the algorithm based. They are limited in that they are predetermined and have a finite number of paths a learner can take to mastery the concept. This limits the extent they can adapt (Oxman & Wong, 2014).

The algorithm-based adaptation is more complex. They use mathematical functions to analyze student performance and or content performance to determine the next activity. Systems can utilize machine learning, Bayesian inference networks, knowledge tracing, Markov chain analysis or item response theory to adapt the system. In machine learning for example, the system learns more about the learner and the content at each interaction and becomes smarter and more efficient in the next decision (Oxman & Wong, 2014).

Intelligent tutors have certain AI features that are not present in frame-oriented instructional systems. Few systems contain all these features, and more research is needed to truly achieve them all. These features include generativity, student modeling, expert modeling, mixed initiative, interactive learning, instructional modeling and self-improving. Generativity is the ability to generate appropriate problems, hints and help that is customized to the learner. Student modeling is the ability to represent and reason about a learner's current knowledge and learning needs and to respond with appropriate instruction. Expert modeling is a way to reason about expert performance in the domain and the ability to respond by providing instruction. Mixed initiative is the ability to initiate interactions with a learner including interpreting and responding usefully to the student interactions. Interactive learning is learning activities that require student engagement that are appropriately contextualized and relevant to the domain. Instructional modeling is the ability to change teaching modes based on inferences about a learner. Self-improving is the system's ability to improve its teaching performance based on previous experience by monitoring and evaluating (Woolf, 2010). With all these features and the current inability to achieve them all in one system leads to the production of adaptive tools.

Adaptive learning tools are categorized into products that are developed to launch a whole course or supplement a course. The whole course category is further categorized into off-the-shelf platforms or authoring platforms. The off-the-shelf platforms have pre-built content by the supplier and are mostly launched as a course. The authoring platforms allow for instructors to create or import content into the system (Partners, 2016).

Some advantages of ITS is that they can encompass both the domain and tutoring knowledge of expert human tutors. The system can make educational decisions based on the learner's inputs and can anticipate misconceptions that the learner may possess. This provision of real-time data analysis can be utilized to assess performance, motivation, engagement, and learning. Once these systems are developed, they can be used by many learners (Fischetti & Gisolfi, 1990). The system then becomes a more cost-effective method when compared to traditional learning by increasing accessibility (Gurunath, Ravi, & Srivatsa, 2012; Ruiz, Mintzer, & Leipzig, 2006). Less time is required to access learning materials, the learner can access the information at any time and at any location and the system is not limited by classroom capacity (Gurunath et al., 2012). The learning management system built into an ITS allows of tracking and monitoring of a learner's KSA's. It also allows for a more standardized course content and delivery (Ruiz et al., 2006).

Some disadvantages are they are difficult to modify, and the authoring tools and processes are not efficient. The rigidity and the increased cost of proprietary packages are also a barrier to use (Benta et al., 2015). ITS are often not cost-effective in building the system and maintaining it because it requires lots of resources (Fischetti & Gisolfi, 1990). Even though open source software can provide flexibility and can combine languages, scripts, learning objects and lesson plans the ability to reuse it is limited (Benta et al., 2015; R. Sottilare, Graesser, Hu, &

Goldberg, 2014). The software might only include one teaching strategy in the code which might not align with the learner's needs or it may not make effective instructional decisions to meet those needs (R. A. Sottilare, 2018). Another challenge is content management. Appropriate content must be selected to meet the learning objectives and must be presented to the learner at the right time. This challenge requires knowledgeable domain experts, instructional designers and course developers to reduce redundancies and create relevant content (Gurunath et al., 2012). There are some challenges in proprietary products and software licensing as well as system integration and implementation. A major barrier to ITS use is the same with all technology using A.I in that assurance that A.I is fair in assessment and credible in its adaptions (VanLehn, 2011). Rapport building and engagement with learners also represents a barrier when utilizing ITS (R. A. Sottilare, 2018). But one of the major barriers to implementation is the faculty skepticism with the concerns surrounding the complexity of use and additional workload for using the products (Partners, 2016).

Learning Theories in a Tutor

The objective of ITS research is not to replace human tutors with computers as there are too many components in teaching that move beyond information processing. As such, the ITS needs to execute the appropriate instructional strategies at the appropriate time while being cognizant of the learner's needs. The system must be able to keep the learner involved, engaged and active. This will not only assist in learning but also improves motivation ultimately minimizing training time and costs (R. Sottilare et al., 2014). Utilizing the appropriate learning theories to provide an authentic and challenging learning environment is important in the ITS. There are 3 main types of learning theories used in teaching environments that are embraces by developers on online learning and incorporated in ITS; behaviorism, cognitive science and constructivism (Woolf, 2010).

Behaviorism is based on the theory that learning is a process of memorizing, demonstrating, and imitating. This implies that the learner must be presented with explicit and planned stimuli. This translates in computer instruction as presentation of text and graphics in which are planned, arranged, and controlled by the computer. Learning strategies using this theory employ memory tasks and recall (Woolf, 2010).

Cognitive science maintains that learning is influenced unobservable and internal constructs such as memory, motivation, perception, attention, and metacognitive skills. The computer instruction for this theory considers the effect of attention and perception and is based on the learning need. Thus, the screen design and interactions that the learner shares with the computer are the focus resulting in active learning, transfer of learning, comprehension and metacognitive skills with the teacher as a coach, facilitator and partner (Woolf, 2010).

Constructivism maintains that learning is an individual process and that individuals interpret and construct the world in their own personalized way. The implication for learning is to focus on the learner and his actions not the teaching or the teacher. This theory is the most difficult to implement in the classroom or on a computer but has the greatest potential to influence and enhance learning (Chi et al., 2018; Woolf, 2010).

Suppliers of Adaptive Technology

Adaptivity in educational technology (EdTech) is the goal for companies that are in traditional education sectors. Adaptive learning systems are being fully implemented at higher learning institutions as online courses, supplements for online course and blended series. They are also being implemented in K-12 grades. According to the U.S. Department of Education, 48 states and the District of Columbia currently support online or virtual learning. These programs run the gambit for supplementing classroom instruction for a blended learning experience to full-time programs utilizing adaptive learning systems (Education, 2018). There were two systems that gained the most popularity for use in elementary and secondary education and are stilled used today. These are the Carnegie Learning's Cognitive Tutor which emerged from research at Carnegie Mellon University and ALEKS which emerged from research at UC-Irvine and New York University. Initially, both systems utilized cognitive theories and were built specifically to enhance math skills. Now the systems have expanded their topics and are utilized in higher education. Both companies boast about the number of learners using their systems and their research reflects the improvement in performance in math skills (Oxman & Wong, 2014).

But adaptive learning is not just used in the formal educational system, it can also be used in corporate settings. Corporate settings are ideal for adaptive learning systems because the concepts to be taught are focused. This makes the content management narrower and therefore, easier to input into an ITS. Additionally, ITS allows for flexibility in training as it is geared toward self-study. This allows for greater time efficiency which results in better return on investment (Oxman & Wong, 2014). With much to gain from the use of an adaptive learning system, how do you begin to find the right system for an organization?

In 2012, the Tyton Partners, an investment banking, and a strategic consulting firm, evaluated 70 companies and organizations that produced adaptive products for institutional adoption. In that study, Tyton Partners highlighted 10 that best represented the state of the market at that time and published it in a series entitled "Learning to Adapt". They repeated the study again in 2015 and evaluated the top 20 companies in the supplier landscape while developing 5 learning themes facing adaptive learning today. The themes encompasses technology adoption and the uncertainty of broader implementation of the technology, the understanding that applications for adaptive learning technology is expanding, the understanding that the role that faculty and educators is changing with the emergence of adaptive teaching, that adaptive learning is an option for competency based education and that adaptive products are being enhanced by new features in response to institutional demand (Partners, 2016). The evolution of this technology space is rapid. In 2014, Forbes Magazine named the big 6 companies leading the way in educational technology (EdTech) are Knewton, TutorGroup, 2U, Blackboard, General Assembly and Coursera (Hendricks, 2014). In the Tyton Partners, 2015 study only one of these 6 companies were highlighted, Knewton.

As previously mentioned, it is difficult for any system to contain all ITS features without further research, as such, the Tyton Partners analysis took the top 20 companies and compared their platforms with their capabilities. Companies that offer off-the-shelf platforms available in whole course instruction coverage include LearnSmart, Fulcrum Lab, Open Learning Initiative, Lumen, Flat World Learn On and ALEKS. Carnegie Learning and Sherpath offer off-the-shelf but for both whole course and supplemental instruction. Companies that offer authoring platforms for whole course include Snapwiz, Fishtree, Difference Engine, Acrobatiq and Loud Cloud. Realize It, BrightSpace, Smart Sparrow and Knewton are companies that have authoring platforms for whole course and supplemental. Cog Books has both off-the shelf and authoring platform for whole course. Drillster and Cerego are authoring platforms that are used for supplemental. All the platforms had high or medium adaptivity (Partners, 2016).

The learner profiles were accessed by the inputs that influence adaptive capabilities: learner confidence level/self-assessment, time to complete learning exercises, performance on questions with the learning objective, learning style preference, mastery of prior learning objective(s), past performance of students with a similar learner profile, elapsed time since last interaction with relevant content, other-specific strategies or choices made in the steps of a multi-step problem (e.g. hints are responsive to the approach taken by the student) and other-error diagnosis and just-in-time feedback for common errors (Partners, 2016).

The faculty customization were accessed by the following parameters: faculty can add content/question from outside the courseware, faculty can set/override the courseware's grading scale/scores, faculty can override the courseware's gatekeeping, faculty can assign individual students different assignments, other-faculty or institute can add, remove, or sequence topics within the curriculum, with warnings on missing prerequisites or topics that are presented in an illogical order and can automatically sequence courses to correct problems and other-faculty can add both pre-tests, which can be prescriptive, and post-tests (Partners, 2016).

Of the 20 companies, none met all the criteria but 5 met all but 1. The one exception was in the learner profile section. The inputs in the learner profile influence the adaptive capabilities, which were all identified as high even with the 1 deficiency. CogBooks a product launched in 2005, has an authoring platform and off-the shelf courseware saw their deficiency in learner profile in the learning style preference. Fishtree, a product launched in 2012 offers an authoring platform for whole course instruction was in elapsed time since last interaction with relevant content. Knewton, a product launched in 2008 and offered full course or supplemental instruction coverage on their authoring platform saw their learner profile deficiency in learner confidence level/self-assessment. Flat World Learn On product launched in 2015 covers whole course, competency, certificate, or full academic program in their off the shelf courseware found their learner profile deficiency in past performance of students with a similar learner profile.

This platform had a medium frequency of adaptivity.   Loud Cloud product launched in 2014 that offered whole course instruction coverage on its authoring platform was the only product to meet all the learner profile criteria which allowed a high frequency of adaptivity. Its deficiencies were in faculty customization in the ability for faculty to override the courseware's gatekeeping and for the faculty to assign individual student different assignments (Partners, 2016). Mathia, by Carnegie Learning, was launched in 1998 and offers math focused courses for grades 6-12 offered as supplemental coverage on their authoring platform. RealizeIT product launched in 2011 offers whole course or supplemental traditional or competency-based instruction coverage saw their learner profile deficiency in learner confidence level/self-assessment (Partners, 2016). RealizeIT is the adaptive learning software used by UCF faculty as instructional technology under the direction of the University's Center for Distributed Learning.   UCF adopted this platform because online and blended courses accounts for the majority of UCF enrollment growth each academic year. The platform was adopted at UCF in 2014 and now hosts 25 courses within the disciplines of psychology, pathophysiology, nursing and algebra all of which are supported by the university's distributed learning student fees (Dziuban et al., 2018; Learning, n.d.).

The Generalized Intelligent Framework for Tutoring (GIFT)

While the fore mentioned commercially available adaptive learning systems have significant attributes that would lend to a comprehensive research in the field, the platform that will be utilized in this study is the Generalized Intelligent Framework for Tutoring (GIFT). Although UCF has RealizeIt available to the faculty, it was not chosen because the university currently only supports use within its student population and no other study populations. The use of RealizeIT for this study would require obtaining the platform commercially to use with public health professionals and is outside the study budget. GIFT provided a no-cost highly configurable framework with a wide range of applications, inclusive of adding sensors for tracking human physiology state and adapting accordingly, that make it ideal for research.

The Generalized Intelligent Framework for Tutoring (GIFT) is an open source modular service-oriented architecture for authoring, managing, and adapting instruction and analyzing and evaluating intelligent tutoring systems technologies. GIFT is developed by the Army Research Laboratory (ARL) as a research prototype with three general goals associated with its functions and components: 1. lowering the skills and time to author in an ITS 2. provide effective adaptive instruction customized to the needs of the learner and 3. provide tools and methods to evaluate the effectiveness of ITS and support research to improve instructional best practices (R. A. Sottilare, 2018).

GIFT's authoring tools include user models, graphical user interfaces, domain specific knowledge configuration tools, instructional strategy developmental tools and a compiler to generate executable ITS utilizing a variety of formats (e.g. PC, IPAD, Android) (R. Sottilare, Graesser, Hu, & Holden, 2013).   Its instructional management function is based on learning theory, tutoring theory, and motivational theory. It's evaluation function contains experimentation tools to evaluate the effectiveness of ITSs (R. A. Sottilare, 2018).

The GIFT ITS platform allows for on demand personalized tutoring that can assess and tutor individuals and teams. GIFT's modular framework and standards allow the ability to author content with lower skills and less time, enhance reuse, allows the set up adaptive surveys based on learner performance and attributes which may significantly improve learning outcomes for many health professionals ultimately improving the quality of response and delivery of care.

GIFT, like all ITS, is composed of 4 modules: the domain module, learner module, pedagogical module, and the tutor-user interface. The tutor-user interface is expanded and contains a sensor module (R. Sottilare et al., 2014). This sensor module is primarily used to read and filter sensor data to determine learner states. Sensor data is collected by a variety of physical hardware sensors. GIFT's integrated sensors include EEG (Emotiv), Electro Dermal Activity (QSensor), Palm temperature and humidity (via instrumental mouse), Zephyr-Technology BioHarness, Inertial Labs Weapon Orientation Module (WOM), USC/ICT Multisense and Microsoft Kinect. The sensor data is sent to the learner module and becomes part of the learner state and can be used by the pedagogical module (R. A. Sottilare, 2018). While still a work in progress, adaptive personalization of an ITS, through agent-based adaption of instructional strategies according to classification of individual student KSA and affect has demonstrated improvement in motivation (Robert Sottilare et al., 2014; Robert Sottilare & Proctor, 2012).

Sensor data will not be used in this study. Additional modules contained in the platform are a user management system (UMS) module, learning management system (LMS) module and a gateway module. The UMS is used to manage a user session, the LMS is used to keep track of a learner or team's instructional experience and achievements and the gateway module is for interfacing with external environments (R. A. Sottilare, 2018).

Learner attributes are intrinsic to the way each individual process and assimilates information presented. The ability of a tutor to perceive learner attributes either by observation or by assessment and formulate content delivery or medium based on these perceived attributes can greatly enhance learner engagement and improve learner outcomes. According to Sottilare et al., GIFT is based on a learner-centric approach that seeks to improve linkages in the adaptive tutoring learning effect chain illustrated in Figure 4 below:

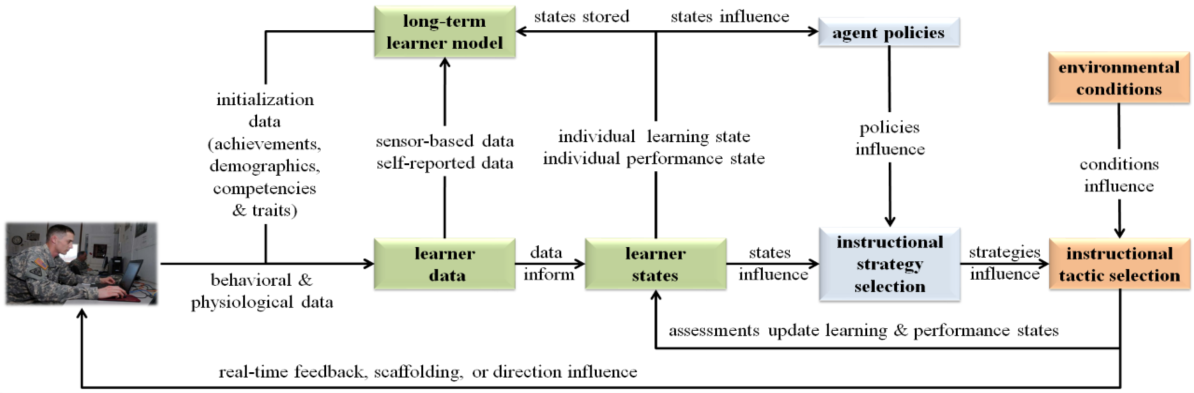


Figure 4: Adaptive Tutoring Learning Effect Model (LEM) for individual learners: GIFT learner module (green boxes); GIFT pedagogical module (light blue boxes); GIFT domain module (orange boxes) (R. A. Sottilare et al., 2018)

GIFT also contains an evaluation function that was created to allow researchers to experimentally assess and evaluate ITS technologies. The evaluation function supports manipulation of the learner model, instructional strategies, and domain specific knowledge within GIFT. It can also be used to evaluate variables in the adaptive tutoring learning effect model (R. A. Sottilare, 2018).

Authoring a course using GIFT faces the challenge of the level of adaptation sufficient for a diverse training audience. In the fore mentioned area of public healthcare sector training, surge events by their very nature draw on upon members with huge differences in training and experience. Thus, the challenge of a tutor for febrile rash illness surge event training is to provide refresher training on an as needed basis to the individuals who may not have collected these clinical samples in the recent past. Therefore, the ability to assess prior knowledge and deliver content as needed prevents redundant training while identifying and tutoring only those individuals who need additional support.

Assessing the Suitability of ITS for Public Health Information Dissemination and Education for Disease Outbreak

The gold standard for competency training for outbreaks in public health is the face-to-face, expert to novice on-the-job training. However, there are several barriers preventing this type of training from occurring. Adaptive computer aided instruction provided by ITS have shown to be on par with expert human tutors and could provide a viable solution for an alternative training method (VanLehn, 2011). ITS have been shown to help a learner understand complex issues and improve decision making (Wolfe et al., 2015).

Theoretically an online ITS would help public health training as scalability accommodates small and large groups. Additionally, ITS allows for flexibility in training as it is geared toward self-study (Oxman & Wong, 2014). This allows for greater time efficiency which results in better return on investment (Oxman & Wong, 2014; Romero et al., 2006). It also allows for an expansion of the experiential learning processes that are most utilized in the public health workforce today.

Despite the technological advances and theoretical benefits for utilizing an ITS, it has few applications in the healthcare space (Crowley & Gryzbicki, 2006; Romero et al., 2006). The educational domains primarily studied are in the fields of mathematics, physics and software programming (R. A. Sottilare, 2018). Though ITS showed early promise to train and educate the medical and public health care workforce (Ruiz, Mintzer, & Leipzig, 2006) subsequent development of intelligent agents largely emphasized modeling and visualization, virtually and through mannequins, of patient conditions to support licensed doctors and nurses (Hackett & Proctor, 2016; M. Proctor & Creech, 2001; M. D. Proctor & Campbell-Wynn, 2014; Woo et al., 2006), not the public health workforce. But even with the few attempts in applying the educational technology they have shown great promise (Ruiz et al., 2006).

With a focus on the lay population, Wolfe et al. used an ITS as an educational tool to test comprehension and knowledge to help make better informed decisions for breast cancer testing (Wolfe et al., 2015). They were able to be demonstrate that an ITS could be utilized as an effective tool to improve knowledge, comprehension, risk assessment and decision making when compared to reading web-based materials (Wolfe et al., 2015).

Inserm, the French National Institute of Health and Medical Research, developed a customized intelligent computer assisted instruction system (CAI) called Consult-EAO, to train rural health workers in developing countries about a myriad of diseases via simulated case studies (Aegerter et al., 1992). The system was designed for learners with at least 2 years of medical education so that there was familiarity with common medical terms. While there were many design improvements that were discussed after their pilot trial of the ITS; the adaptability, versatility and individualized self-paced instruction ability of the system was shown to be advantageous in the highly variable environments associated in developing countries (Aegerter et al., 1992).

Suebnukarn and Haddawy utilized the system COMET, a collaborative tutoring system for medical problem-based learning. The system was able to generate strategies identical to those a human tutor would utilize given the same scenario (Crowley & Gryzbicki, 2006; Suebnukarn & Haddawy, 2007).

Woo et al., used their system CIRCSIM-Tutor to demonstrate the use of natural language processing in the form of natural language dialogue in the ITS to improve learning gains in cardiovascular health. Designed for first year medical students, natural language dialogue is the ability to put ideas into one's own words to learn how to solve problems. The tutor was able to demonstrate significant learning gains when compared to students reading the same text. Additionally, the system was well-received by these highly motivated and highly intelligent students (Crowley & Gryzbicki, 2006; Woo et al., 2006).

Kabanza et al. utilized, TeachMed, a patient simulator that provides feedback to promote clinical reasoning. It demonstrates the pedagogic strategies that incorporate temporal logic. The system has a set of feedback rules matched to the student query. They were able to demonstrate flexibility and guidance in providing appropriate feedback (Crowley & Gryzbicki, 2006; Kabanza, Bisson, Charneau, & Jang, 2006).

Romero et al. incorporates the ITS with adaptive hypermedia systems (AHS) to increase the learner's interactions with the educational system while adapting it to the needs of the student for emergency medicine. They were able to demonstrate improvement in the learner's productivity using an adaptive version of the system when compared to a non-adaptive version (Romero et al., 2006).

Gonzalez, Burguillo and Llamas strategy for utilizing an ITS is to take real life case studies from the health information systems and integrate it into an ITS system provides a more advanced approach to content management. They propose by utilizing this approach would improve the acquisition of skills by the learner interacting with real cases thus improving decision making and therefore having a more accurate transfer of skills (Gonzalez, Burguillo, & Llamas, 2007).

Reviewing the literature on adaptive intelligent training systems in medicine, there is support to utilize an ITS designed to supplement the public health professionals existing knowledge on health-related topics. In this study, the intelligent agent is an adaptive ITS.

Intelligent agents in the form of tutors could provide an innovative solution to educating the public health workforce while providing feedback to assess knowledge gains. In addition, already built tutors could be scalable during emergency responses and surge capacity health events. In addition to educating the governmental public health workforce, the tutor could be utilized for several of public health functions including encouraging healthy behaviors, educating about health, and preventing disease through active learning.

An ITS would be suitable because of the flexibility and scalability of the technology, the increased efficiency and cost effectiveness and the able to be used in variable environmental conditions. During a surge capacity public health event these attributes become increasingly important especially since resources become more limited and the need to respond effectively is critical. The current operational process to accomplish this on-the-job training is the use of a human tutor. ITS have consistently shown their efficacy of improved knowledge and learning gains as compared to a human tutor. Thus, an ITS could be used as an alternative training method prior or during an event. But would the public health workforce be willing to accept this technology by their intent to use it?

Technology Acceptance Model (TAM)

According to the Theory of Reasoned Action (TRA), proposed by Ajzen and Fishbein in 1980, a person's behavior is determined by their intention to perform that behavior. Intention cognitively represents the person's readiness to perform a behavior; it is determined by their attitude toward the behavior, their subjective norms, and their perceived behavioral control (Turner et al., 2010; Twente, February 27, 2017). The Technology Acceptance Model (TAM) is a widely researched and well-established theoretical model introduced by Fred Davis in 1986 that attempts to explain the adoption of information technology (Venkatesh & Davis, 2000). TAM is based on the Theory of Reasoned Action which is constituted on beliefs that the mediating constructs of perceived usefulness (PU) and perceived ease of use (PEOU) will influence attitudes (A) toward use and intention to use (IUSE) which lead to acceptance of the technology (Davis et al., 1989; Gefen, Straub, & Boudreau, 2000; Turner, Kitchenham, Brereton, Charters, & Budgen, 2010)

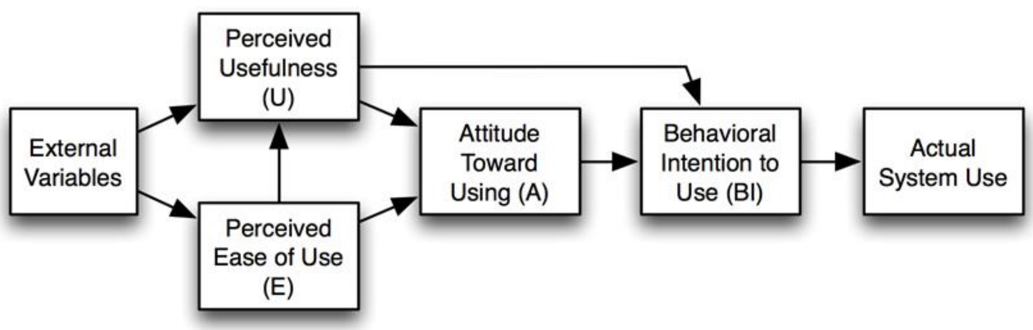


Figure 5: Current version of Technology Acceptance Model (TAM) (Davis et al., 1989)

Davis' research developed and validated the measurement scales for the constructs of perceived usefulness and perceived ease of use as it relates to the behavioral intention to use (F. D. Davis, 1989). In the original TAM, both PU and PEOU are theorized as direct indicators of behavioral intention (IUSE) for use (D. Gefen, D. Straub, & M.-C. Boudreau, 2000). This causal relationship is supported in numerous studies and is confirmed in the context of e-learning studies (Tarhini, Hone, & Liu, 2014). However, Davis postulated that the behavioral intent to use (IUSE) is also determined by the person's attitude (A) toward using the technology and their perceived usefulness (PU) (Davis, Bagozzi, & Warshaw, 1989).

Early TAM research demonstrated that of the concepts presented in TRA, only 3 factors were needed to explain and predict acceptance: PU, PEOU and attitude (F. D. Davis, 1989; Holden & Karsh, 2010). Perceived usefulness (PU) is defined as the degree to which a person believes that the use of an application or system will improve their job performance. Perceived ease of use (PEOU) is defined as the belief that the use of an application or system would be free of effort (F. D. Davis, 1989). In TAM, both PU and PEOU are theorized as mediating indicators of behavioral intention for use (IUSE) and are the determinants for attitude (David Gefen et al., 2000; Holden & Karsh, 2010). Attitude (A) toward the use of the new technology is fundamental of TAM in that the resultant behavior (i.e. actual use) will have some positive effect (F. D. Davis, 1989). The theory in industries outside health care and accounts for 30-40% of IT acceptance (Holden & Karsh, 2010; Legris, Ingham, & Collerette, 2003).

The TAM is usually validated by using measures for behavioral intention to use rather than actual usage (Turner, Kitchenham, Brereton, Charters, & Budgen, 2010). While the research significantly demonstrates that IUSE is correlated with actual usage, the standard is to employ longitudinal studies to gain insight on actual use (Dishaw & Strong, 1999). These types of studies are limited by time and resources for researchers.

One example of a TAM modification is TAM2, which removes the attitude construct and identifies external variables (Holden & Karsh, 2010; Venkatesh & Davis, 2000). Having external variables aids in understanding levels of PU, PEOU, and IUSE. TAM2 proposed by Venkatesh and Davis in 2000 identifies external variables that impact the PU, PEOU, and IUSE variables.   These external variables are highlighted in Figure 6 below (Venkatesh & Davis, 2000).

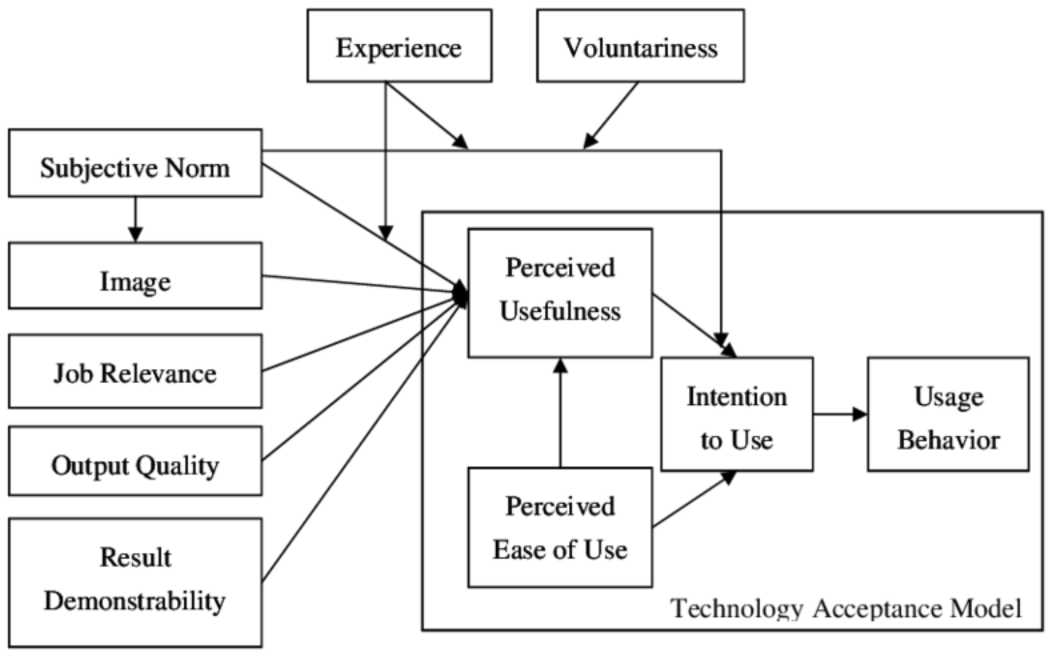


Figure 6: Technology Acceptance Model 2 (Venkatesh & Davis, 2000)

TAM and adaptations of TAM suited to medical applications are the models most utilized in health care and documented in the literature, not TAM2 with its characterization of external variables. TAM in healthcare research has focused on IUSE with modifications to the model placed on IUSE (i.e. Unified Theory of Acceptance and Use of Technology, Theory of Planned Behavior), PU (i.e. TAM2) and PEOU (Holden & Karsh, 2010). TAM is used in healthcare for implementing health information technology (IT) with most of studies focusing on adoption of electronic health records (EHR). It has also been used for telemedicine technology, picture archiving, communications systems and computerized provider order entry (Holden & Karsh, 2010).

In this study, the PU and PEOU constructs were reduced to 5 observed indicators from 6. Thee A maintained its 3 observed indicators. And IUSE increased from 3 to 5 observed indicators. While these measures are previously validated in the literature, this study will re-validate them using confirmatory factor analysis as a part of the SEM process to assure appropriate correlation. The scale items for perceived usefulness include work more quickly, job performance, increase productivity, effectiveness, makes job easier and useful. The scale items for perceived ease of use include easy to learn, controllable, clear and understandable, flexible, easy to become skillful and easy to use (F. D. Davis, 1989). The scale items for attitude include ITS being a good idea, the likability of using an ITS and the use of an ITS being a pleasant experience (Davis et al., 1989). The scale items for intention of use include intent, predict and expected use (David Gefen et al., 2000). These items are contained in Appendix B.

In this study, we focus on estimated use behavior variable by incorporating constructs from the Health Belief Model (HBM). We believe by extending TAM with HBM constructs will allow for a better explanation on the direct effects for the intention of use as well as indirect effects on estimated use behavior of an ITS in public health.

Health Belief Model (HBM)

The Health Belief Model (HBM) has been utilized in healthcare and medicine to explain and predict preventative health behaviors. It was created by the Public Health Service in the 1950’s and 1960’s to engage individuals to comply with prescribed health regime (Rosenstock, 1974b). The model hypothesized that health related-action depends upon three factors occurring simultaneously: 1. The existence of sufficient motivation to make the health issue relevant, 2. The belief that one is susceptible to a serious health problem or the sequelae of that illness or condition (i.e. perceived threat) and 3. That belief that following the health recommendation/regime would be beneficial in reducing the perceived threat (Rosenstock, Strecher, & Becker, 1988; Twente, February 27, 2017). HBM is like TRA in that they are both cognitive theories. In cognitive theories or value-expectancy theories, behavior is a function of the subjective value of an outcome and the subjective probability or expectation that a particular action will achieve that outcome. Consequences of behavior are believed to operate by influencing expectations regarding the situation (Janz, Champion, & Strecher, 2008; Rosenstock et al., 1988).

HBM was initially composed of four main constructs: perceived susceptibility (PS), perceived severity/seriousness/threat (PT), perceived benefits to taking action and perceived barriers to taking action (dPB). These constructs are applied to the individual's cues to action (Rosenstock et al., 1988; Twente, February 27, 2017).

Perceived susceptibility (PS) is an individual's perception of the possibility of experiencing a condition that would adversely affect one's health. Individuals vary widely in this perception from low end that extremely deny the possibility of contracting an adverse condition to individuals to high extreme that perceive there is real danger that they will experience the adverse condition. Individuals can also be categorized as moderate in that they admit to the statistical possibility of disease occurrence (Rosenstock, 1974b).

Perceived seriousness/severity/threat (PT) is the belief that an individual hold that the negative effects of a given adverse condition would have on their own state of affairs. These convictions also vary from person to person and from one condition to the next. This can be interpreted as the adverse condition's medical or clinical consequences (i.e. pain, discomfort, susceptible to future conditions, death) or its impact on emotional or financial burdens (i.e. loss of work time, financial burdens, difficulties with family and relationships) (Rosenstock, 1974b).

Perceive susceptibility and severity have a strong cognitive component which makes them knowledge dependent (Rosenstock, 1974b).

Perceived Benefits of taking action is taking action toward the prevention of the adverse condition or dealing with the illness after accepting one's susceptibility to the disease and recognizing it as serious. The individual's belief about the availability and the effectiveness of the various course of action will determine the course of action.

Barriers to taking action is defined as even though an individual may believe that benefits to taking action are effective, they may not take action because of barriers (i.e. action is inconvenient, expensive, unpleasant, painful, etc.). Barriers to action can arouse conflictive motives of avoidance (Rosenstock, 1974b).

Cues to action (CA) is the individual's perception of the level of susceptibility and seriousness provide the force to act. These cues can be internal (i.e. perception of bodily states) or external (e.g. interpersonal interactions, the impact of media communication, receiving communication from the doctor). Benefits minus barriers provide the path of action (dPB) (Rosenstock, 1974b).

Building on Rosenstock's work, Becker et al. reformulated the HBM (Figure 7) to be used as a predicator of compliance to include general health motivations (GM). The motivation of the individual to undertake the behavior is influenced by the individual's perceptions (e.g. control over the health matter, attitude toward the medical authority), the modifying behavior and the likelihood of the action (LPA). Individual's perception are factors that deal with the importance of health to the individual (e.g. perceived susceptibility and perceived severity).

Modifying behavior include demographic variables, perceived threat, and cues to action. The likelihood of action is the perceived benefits verses the barriers to behavioral change (Becker et al., 1978; Twente, February 27, 2017). The combination of the constructs may cause a response that manifest into action when it is accompanied by a rational course of action.

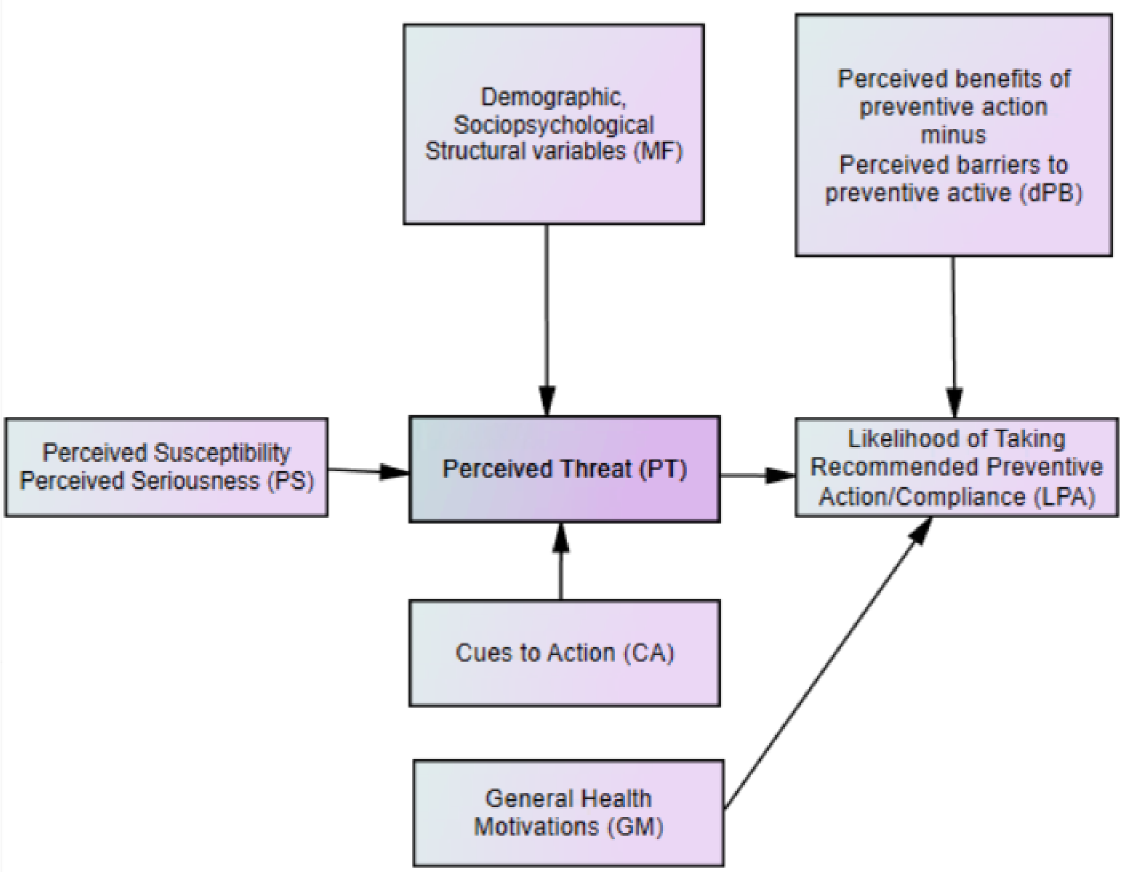


Figure 7: Expanded Health Belief Model (HBM) (Becker et al., 1978; Rosenstock et al., 1988)

HBM has been applied to a broad range of health behaviors and subject populations. Three board areas include preventive health behaviors (i.e. addressing health promoting and health risk behaviors), sick role behaviors (i.e. compliance with recommended medical regimes) and clinic use.

Limitations to HBM is that lack of standardized tools and that factors other than health beliefs heavily influence health behavior practices (e.g. special influences, cultural factors, socioeconomic status and previous experiences) (Janz et al., 2008; Rosenstock, 1974b).

HBM was chosen for this conceptual work because it was created by the U.S. Public Health Service, it is among the most commonly used health behavior theories or models since 1986 to present and because of its similarities with TRA, the theory on which TAM is based.

Purpose and Significance of the Study

As discussed above, the use of intelligent agents in public health practice might be an effective method to support workforce needs in terms of education and skill development while not burdening the system. On interest to this research is the suitability, acceptance and use of the ITS.

Suitability will look at if an ITS could be used to successfully remediate public health professionals for a surge capacity public health event of febrile rash-like illness. This will be determined by knowledge acquisition via a summative assessment on the basic knowledge that governmental public health professionals need to identify and respond to a solitary case of febrile rash illness. Acceptability and use will be determined by evaluating the effectiveness and the behavioral intent to use the system via a comparative analysis of three theoretical models; Davis's technology acceptance model (TAM), the Public Health Services' Health Belief Model

(HBM) and our proposed theoretical extension of TAM with HBM constructs (TAM/HBM). The comparative analysis will utilize structural equation modeling (SEM) analysis to correlate constructs to intention to use (PHIUSE) and estimated use behavior (PHEUB).

The TAM focuses on level of an individual's "intent to use" to use technology (in our case ITS) via the mediating constructs of perceived usefulness and perceived ease of use. TAM contains determinants from the technology perspective. Similarly, HBM focuses on likelihood of compliance (which is again in our case likelihood of using the ITS) via constructs of perceived susceptibility, perceived severity/seriousness, perceived benefits to taking action and perceived barriers to taking action. HBM contains determinants from the individual's perspective.

Integrated TAM/HBM Model

We hypothesize that TAM and HBM should yield equivalent levels of likelihood of using an ITS, though the approach on the assessment is different. By bringing together the best of TAM and HBM into a TAM/HBM integrated model, we hypothesize a TAM/HBM integrated model should lead to better estimate of likelihood of actual use of new technology (ITS in our case study) in public health research.

There have been several efforts to integrate TAM with HBM. Ahadzadeh, Sharif, Ong, and Khong (2015) theorized whereby perceived usefulness of Internet technology and attitude toward the Internet technology for health purposes mediate the relationship between perceived health risks as well as health consciousness and health-related Internet use behavior (Figure 8).

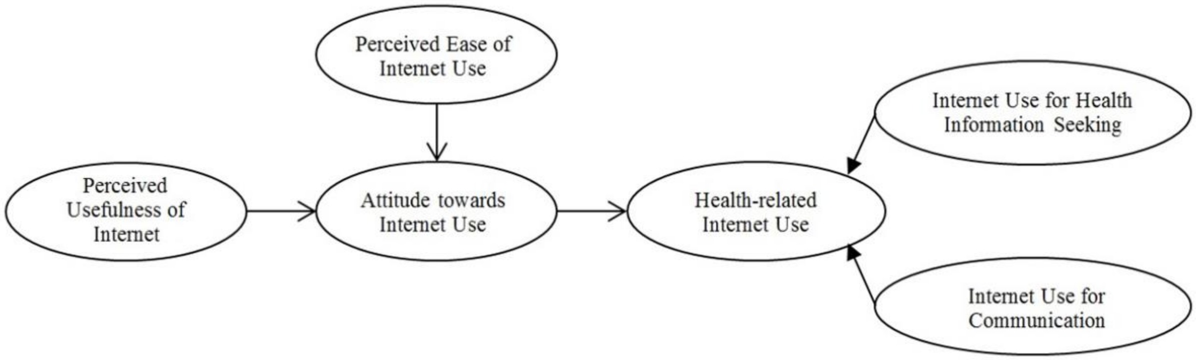


Figure 8: Integrating Health Belief Model and TAM for Health-Related Internet Use (Ahadzadeh et al., 2015)

Ahadzadeh et al found that "Perceived health risk (β=.135, t1999=2.676) and health consciousness (β=.447, t1999=9.168) had a positive influence on health-related Internet use. Moreover, perceived usefulness of the Internet and attitude toward Internet use for health-related purposes partially mediated the influence of health consciousness on health-related Internet use (β=.025, t1999=3.234), whereas the effect of perceived health risk on health-related Internet use was fully mediated by perceived usefulness of the Internet and attitude (β=.029, t1999=3.609). These results suggest the central role of perceived usefulness of the Internet and attitude toward Internet use for health purposes for women who were health conscious and who perceived their health to be at risk."

More recently Wahyuni and Nurbojatmiko (2017) explained acceptance of e-health serves through an extension of TAM and HBM integration (Figure 9).

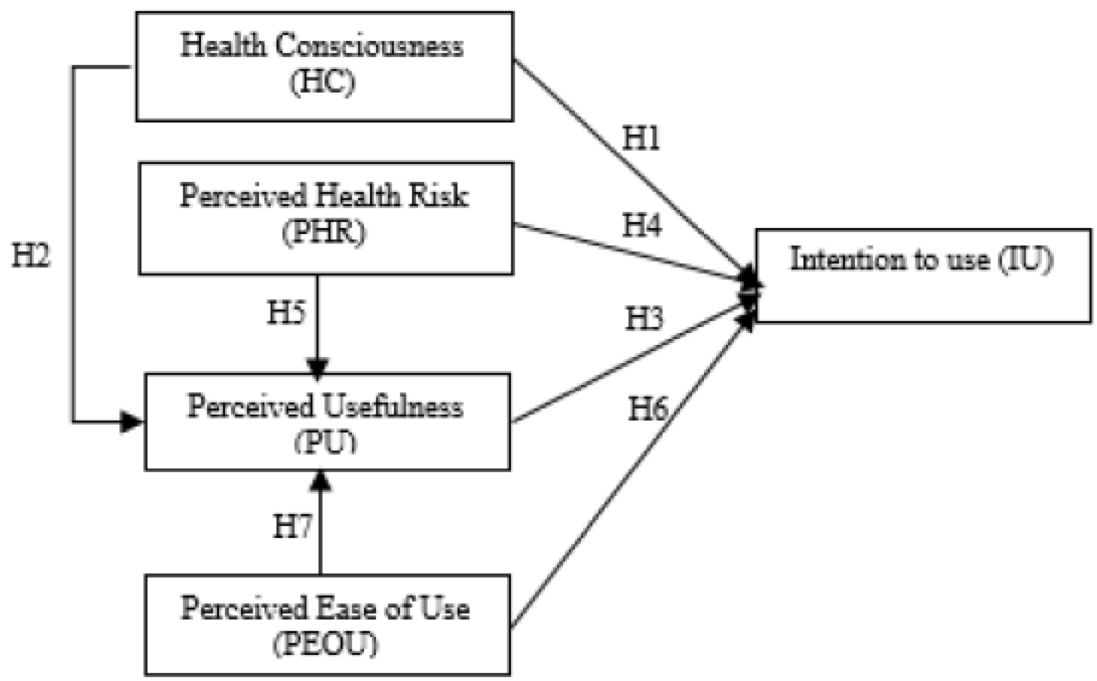


Figure 9: Extension of TAM and Health Belief Model for explaining acceptance of e-health services (Wahyuni & Nurbojatmiko, 2017)

Wahyuni and Nurbojatmiko found "three factors were significant for intention to use e-health service: health consciousness, perceived health risk, and perceived usefulness."

While the three factors identified by Wahyuni and Nurbojatmiko are important, they do not provide the visibility into the underlying technology and the relationship to health benefit factors that make it useful. Ahadzadeh et al identify the importance of Internet technology but again fail to provide sufficient depth in factors pertaining to Internet technology or its specific relationship to underlying factors in health benefit that may compel use.

The conceptual TAM/HBM model considered in this research is depicted in Figure 10 below which contains 7 constructs. We theorize that perceived usefulness (IPU), perceived ease of use (IPEOUS), perceived threat (PHPT), perceived susceptibility (PHPS) and the difference between the perceived benefits and perceived barriers (PHdPB) are significant indicators of actual use of the ITS. For our model, actual use is known as Public Health Estimated Use Behavior (PHEUB). We will be employing the use of structural equation modeling (SEM) to test the direct (i.e. PHIUSE) and indirect effects (i.e. PHEUB) between the constructs. SEM is the preferred analytical method because it allows for both effects to be studied simultaneously without the concern for neglect of the measurement error, a concern most associated with regression analysis methods (Raykov & Marcoulides, 2012).

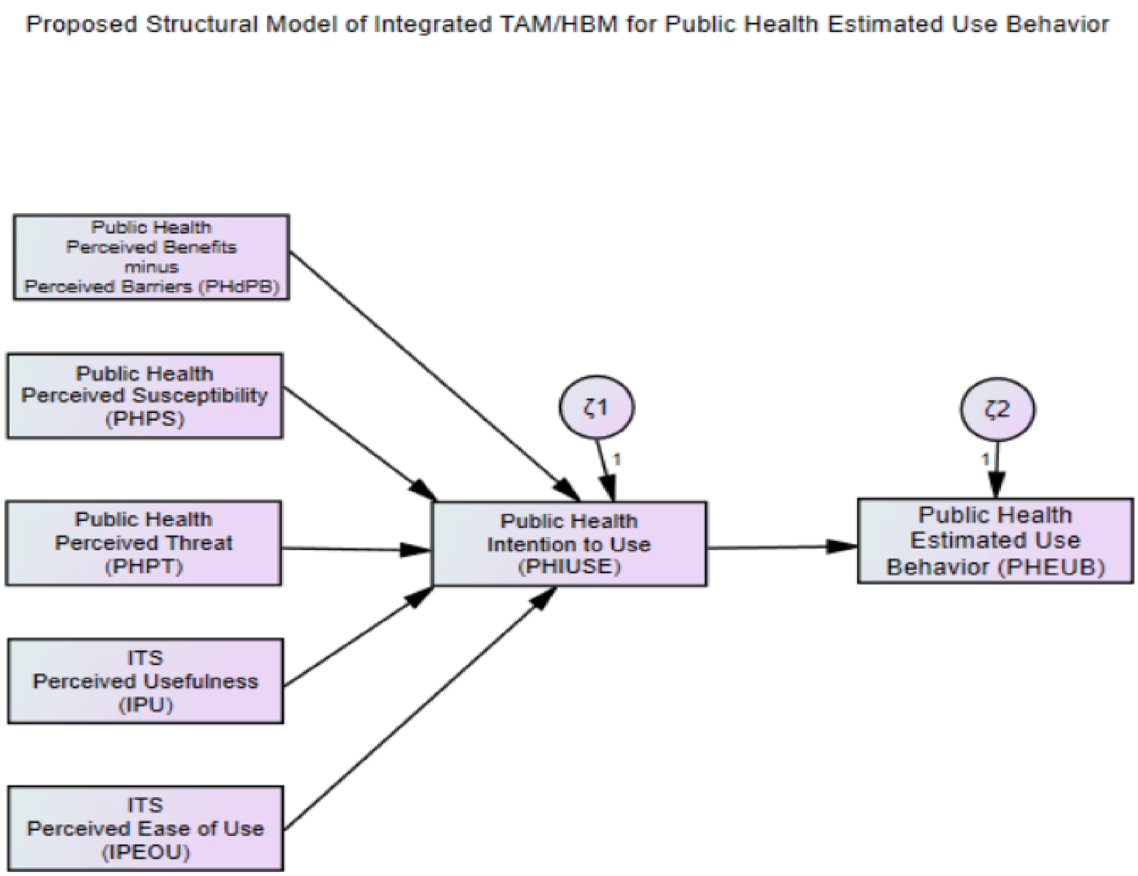


Figure 10: Hypothesized conceptual integrated model for intelligent tutoring system use for surge capacity public health events and training

Additionally, the indicators will provide a temporal sequence for actual use which will assist in strengthen the correlated indirect effects on PHEUB (Wynne, Robert, & Steven, 2008).

The significance of this study is to add to the body of knowledge in the conceptual framework for the acceptance of technology as well as for evidence-based principles for effective design and delivery of education to the public health workforce. This study would seek to understand the level of governmental public health professionals estimated use behavior of a knowledge-based-adaptive Intelligent Tutoring System for education and training functions. It will also serve to assess the degree of knowledge gain that a learner will experience after exposure to the adaptive tutor.

If the study design and results prove to be an effective and efficient method for educating and training, it would align with the 8 core competencies for public health and satisfy 5 of the 10 Essential Services (Diagnose and investigate health problems, inform, educate and empower power people, link people to health services, assure a competent workforce and research for new insights) and could be utilized as an effective method to build individual competency. Additionally, if the hypothesized extended model demonstrates parsimony it can be used to explain or predict the factors associated with accepting and using an Intelligent Tutoring System for public health surge capacity events.

Research Questions

Computer aided instruction is well established in the healthcare sector including public health for education and training of its workers. Combining computer aided instruction with AI in the form of an intelligent agent such as an ITS could provide an innovative approach to ensure a competent workforce as they are utilized to enhance, support and enable human learning by being flexible, interactive and adaptive. The research questions that are posed in this experiment are as follows:

1. What is the level of public health professionals' "estimated use behavior" on a knowledge-based adaptive online ITS (AOP ITS)?
2. Comparatively, would public health professionals' preference to obtain the content knowledge be from the ITS platform, internet search or from a mentor/discussion group?
3. What is the achievement level or learning effectiveness of public health professionals on a knowledge-based adaptive online ITS?
4. How well does Public Health's Health Belief Model concepts of perceived susceptibility, perceived severity, perceived threats, perceived benefits, cues to action and motivation, and the Technology Acceptance Model concepts of perceived usefulness, perceived ease of use, attitude or intention to use explain "estimated use behavior" on a knowledge-based adaptive online ITS?
5. Does Perceived Threats mediate the effects of perceived susceptibility and cues to actions on "estimated use behavior" on a on a knowledge-based adaptive online ITS?
6. Are the factors of perceived susceptibility, perceived severity, perceived threats, perceived benefits, cues to action, motivation, and perceived usefulness, or perceived ease of use independent of each other?

Definitions

Adaptive Learning: Utilizes computers and software as interactive tools focuses on changing content for each learner based on their specific learning needs

ATT: Attitude- Attitude toward the use of the new technology is fundamental of TAM in that the resultant behavior (i.e. actual use) will have some positive effect (F. D. Davis, 1989). Attitude is an intermediate variable in TAM and is measured by 3 items in this study which can be found in Appendix B.

AU: Actual Use- The resultant behavior in TAM and the likelihood of action in HBM. Actual use of the ITS is endogenous variable and is measured by 4 items which may be found in Appendix D

CFA: Confirmatory Factor Analysis is a statistical technique that is used to test pre-specified relationship

CU: Cues to Action is the individual's perception of the level of susceptibility and seriousness provide the force to act. CU is an intermediate variable in HBM which is measured by 4 items which may be found in Appendix D.

Endogenous variables: Variables in SEM that are synonymous with dependent variable.

Exogenous variables: Variables in SEM that are synonymous with independent variables.

GIFT: The Generalized Intelligent Framework for Tutoring (GIFT) is an open source modular service-oriented architecture for authoring, managing, and adapting instruction, and analyzing and evaluating intelligent tutoring systems technologies. GIFT is developed by the Army Research Laboratory (ARL) as a research prototype.

HBM: Health Belief Model (HBM) is a widely researched and well-established theoretical model developed by the Public Health Service in the 1950's and 1960's to engage individuals to comply with prescribed health regime. It is used to explain and predict preventative health behaviors.

IU: Intention to Use- Intention cognitively represents the person's readiness to perform a behavior such as use of the technology. IU is an endogenous variable in TAM and is measured by 5 items in this study. These items may be found in Appendix B.

ITS: Intelligent tutoring systems (ITS) are computer based instructional systems that mimics the teacher student interaction by modeling the psychological state of a learner to provide individualized instruction.

Measurement Model: A model in SEM that illustrates how the hypothetical constructs are measured by observable indicators.

M: Motivations- motivation of the individual to undertake the behavior, the reason for the learner's action. Motivation is an exogenous variable in HBM. It is measured by 6 items in this study, which can be found in Appendix D.

PEOU: Perceived Ease of Use is defined as the belief that the use of an application or system would be free of effort (F. D. Davis, 1989). It is an exogenous variable in TAM and is measured by 7 items in this study. The items may be found in Appendix B.

PB: Perceived Benefits action toward the prevention of the adverse condition or dealing with the illness after accepting one's susceptibility to the disease and recognizing it as serious. PB is and exogenous variable in HBM and is measured by 6 items. The items may be found in Appendix D.

PS: Perceived Susceptibility is an individual's perception of the possibility of experiencing a condition that would adversely affect one's health. PS is an exogenous variable in HBM. It is measured by 5 items which are in Appendix D.

PSV: Perceived Severity is the belief that an individual hold that the negative effects of a given adverse condition would have on their own state of affairs. PSV is an exogenous variable in HBM. In this study it is measured by 5 items which are in Appendix D.

PT: Perceived Threat is the belief that an individual hold that the negative effects of a given adverse condition would have on their own state of affairs. PT is an exogenous variable in HBM. In this study it is measured by 8 items which are in Appendix D.

PU: Perceived Usefulness- is defined as the degree to which a person believes that the use of an application or system will improve their job performance (F. D. Davis, 1989). PU is an exogenous variable in TAM. It is measured by 7 items in this study which are in Appendix B.

SEM: Structural Equation Modeling (SEM) is an analytical technique utilizing the measurement model and structural equation model to understand the statistical interaction and relationship between variables.

Structural Equation Model: A model in SEM that represents the causal relationship among the exogenous and endogenous variables.

TAM: The Technology Acceptance Model (TAM) is a widely researched and well-established theoretical model developed by Fred Davis in 1989 that attempts to explain the adoption of information technology.

CHAPTER 3: METHODOLOGY

Study Design, Hypotheses & Participants

Accurate decision supporting mechanisms must be examined using technology acceptance theories and models in the healthcare domain. However, the frequently utilized theories and models in health care, particularly public health, focus on clinical or community practice guideline recommendations for behavioral health change.

This study is conducted in a cross-sectional experimental study design with the prime purpose of understanding suitability and actual use of intelligent tutoring system technology for the training and education of governmental public health workers. We anticipate that findings in our study will lead to improvement in the research pedagogy for public health professionals instead of extrapolating data from the medical, dental and nursing fields; will provide an innovative solution to address the gap in educational strategies and align with public health practice and provide a viable cost effective method for training with the decrease in expert human mentors. Additionally, our research will attempt to demonstrate that by extending the technology acceptance model with constructs from the health belief model and conducting a comparison analysis this will lead to better understanding of technology acceptance of actual use in the public health domain.

This study will test the suitability and the technology acceptance of an adaptive e-learning system in public health practice based on the Technology Acceptance Model (TAM) and Health Belief Model (HBM). The learning gains will be assessed by summative knowledge-based assessment and knowledge application assessment that is within the ITS. The acceptance of the e-learning technology will be assessed by conducting structural equation modeling analysis (SEM) on the factors associated with TAM and HBM. Confirmatory factor analysis

(CFA) will be used to perform reliability and validity checks. Wilcoxon signed-rank tests will be used to ascertain ambivalence to the technology acceptance model concepts and the health belief model concepts.

The following hypotheses shall be tested:

H_1 - Technology Acceptance Model (TAM): "Are the TAM model constructs of Perceived usefulness (PU), Perceived ease of use (PEOU), Attitude (ATT) and intention to use (IU) significant indicators of actual use (AU) for the intelligent tutoring system for public health education and training?" The null hypothesis is that TAM model constructs will have no effect on actual use (AU).

H_2 - Health Belief Model (HBM): "Are the HBM model constructs of Perceived Susceptibility (PS), Perceived Severity (PSV), Perceived Threat (PT), Perceived Benefits (PB), Cues to Action (CA), and Motivations (M) significant indicators of actual use (AU) of an intelligent agent (tutor) for public health education and training functions?" The null hypothesis is that HBM model constructs will have no effect on the system outcome construct, actual use (AU).

H_3 - Integrated TAM/HBM Model: "Will the conceptual model TAM/HBM Model demonstrate a better prediction of the actual use (AU) of the ITS in public health research as compared to that of the individual models?" The null hypothesis is that the TAM/HBM model will not have a better predicative effect on actual use (AU) when compared to TAM and HBM.

H_4 - "Do public health professionals' prefer an ITS platform, internet search, mentor or discussion group training modality?". The null hypothesis is public health professional are ambivalent about training modality.

H_5 - "Does an AOP ITS that uses ATI improve a public health professionals knowledge level and application of knowledge in an outbreak scenario?" The two-part null hypothesis is that the AOP ITS with ATI will not demonstrate participants improved post-assessment performance level over pre-assessment performance level or competency in applying knowledge in an outbreak scenario assessment.

H_6 - "Does an AOP ITS that uses ATI promote senses of useful, easy to use, positive attitude, and intention to use in public health professional users?" The null hypotheses are that public health professionals will be ambivalent about the usefulness (PU), easy to use (PEOU), attitude (ATT), or intent to use (IU) an AOP ITS with ATI.

H_7 - "Does content in an AOP ITS that uses ATI communicate perceived susceptibility, severity, threat, benefit, cue to action or motivation in public health professional users for the selected outbreak pathogen or prescribed health regime?" The null hypothesis is that public health professionals users of the AOP

ITS with ATI will be ambivalent about the perceive susceptibility (PS), severity (PSV), threat (PT), benefits (PB), cues to action (CA) or motivation (M) toward the selected pathogen or prescribed health regime.

H_8 - “Does an AOP ITS using ATI attract invited public health professionals to receive public health professional’s knowledge and application meet a pathogen outbreak scenario?” The null hypothesis is that public health professional will not voluntarily engage in non-mandatory training for the given pathogen outbreak scenario.

Participants

This study will be conducted in two stages: 1. Procedural Pilot Study and 2. The Study. The intended learner for the ITS is a qualified healthcare professional in governmental public health that already has familiarity with the content presented. Participants will be eligible for participation if they currently or have ever served as a governmental public health professional and if they have any familiarity with surge capacity events involving rash-like illness. Sensitive populations that receive additional protections under the Code of Federal Regulations 45 CFR 46: Subpart B, (i.e. adults unable to consent, individuals under the age of 18, pregnant women and prisoners) will be excluded from the ability to participate in the study. There are no foreseeable risks, discomforts, hazards, or inconveniences anticipated in this research.

Recruitment

procedural pilot study

Recruitment of health professionals that perform public health functions with the Florida Department of Health in the Central Florida area who meet the eligibility criteria above. These professionals are part of the Regional Epidemiology Strike Team. Participation will be elicited by verbal and email communications. After IRB approval and clearance from the University of

Central Florida's IRB Board, recruitment of health professionals that perform public health functions with the government will be elicited.

study

Recruitment of health professionals that perform public health functions, and who meet the eligibility criteria above, with the government will be elicited from professional organizations such as the Council for State and Territorial Epidemiologists (CSTE), National Association of City and County Health Officials (NACCHO) and Association of State and Territorial Health Officials'(ASTHO) and local medical societies, from federal organizations such as the Centers for Disease Control (CDC) and from state organizations such as the state and local health departments.

A recruitment email will be used for the procedural pilot study and the study (Appendix K). At the request of the Florida Department of Health, a flyer will also be used to recruit participants for the procedural pilot study (Appendix L).

Non-participants

A limitation to any experiment study is the non-response or refusal to participate in the study. To evaluate refusal rates in this study, participants will be asked one question upon introduction of the study, "why did you not wish to participate in the study?". The choice for responses will include: No time, Not interested, Invasion of Privacy, Participation not supported by my employer, Previous experience with studies was unpleasant, Information technology barrier (i.e. system compatibility), Waste of time and General Refusal (Menold & Zuell, 2010).

Power Analysis

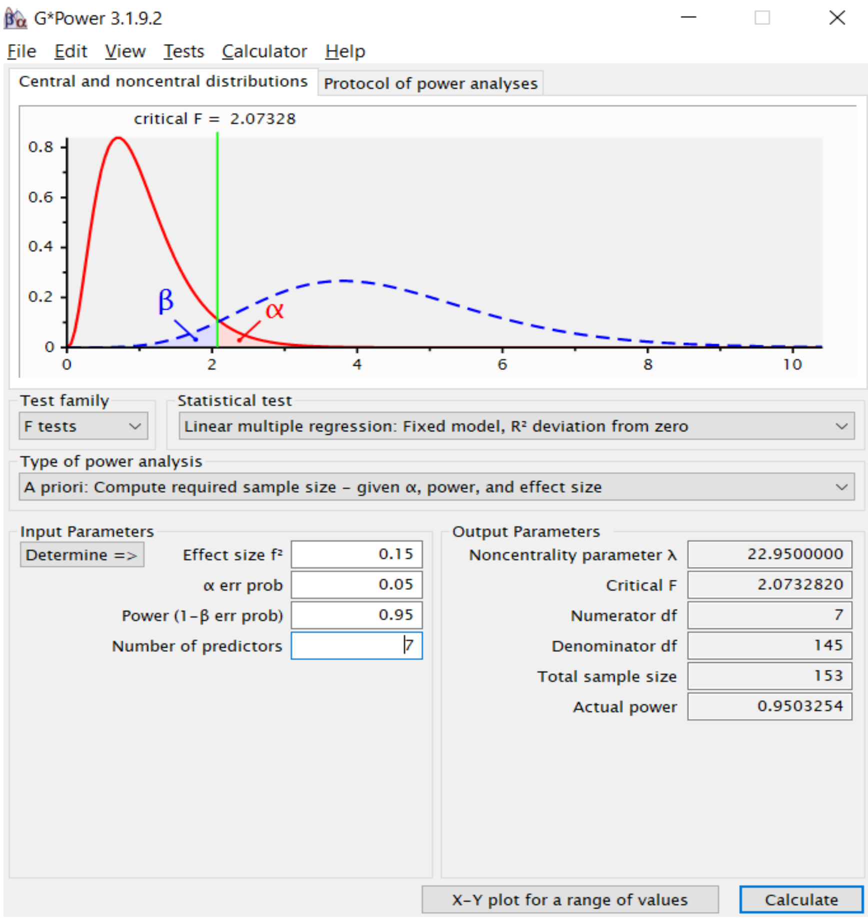


Figure 11: Power Analysis using G Power 3.1.9.2 for Study

The inputs using the G Power 3.1.9.2 application are as follows: Test family is F tests, Statistical test is Linear multiple regression: Fixed model, R^2 deviation from zero, Type of power analysis is A priori: Compute required sample size-given α, power and effect size, input parameters effect size f^2 is 0.15 (this is a medium effect size convention, with .02 being small and .35 being large), α err prob is 0.05, Power (1-β err prob) is 0.95 and Number of predictors is 7 (Cunningham & McCrum-Gardner, 2007; Faul, Erdfelder, Buchner, & Lang, 2009).

The outcomes of this power analysis suggest that 153 participants would be ideal recruitment to account for malingering and unforeseen exclusions. The literature on structural equation modeling considers N=100-150 to be the minimum sample size for conducting this type of analysis.

The anticipated number of subjects for the Procedural Pilot Study is 15. The anticipated number for subjects for the Study is 160.

Setting and Study Timelines

The Procedural Pilot Study will be conducted online on the GIFT platform. The focus group session will be held at a convenient location (e.g., health department conference room) for the focus group members. The subjects for the Procedural Pilot Study will be the members of the Region 4 & 5 Epidemiology Strike Team in Central Florida, who meet the eligibility criteria and accept participation in the study. The duration of an individual subject's participation in the Procedural Pilot Study is anticipated to be 1-2 hours with a maximum of 1 hour on the online platform and a maximum of 1 hour in a post-platform focus group.

The Study will be conducted online on the GIFT platform via a browser. The duration of an individual subject's participation in the study is dependent on the subject's understanding of the content delivered in the course. Anticipated time based on the pilot study results is 1 hour.

Enrollment of the study participants for the Procedural Pilot Study was 1 week. For the Study, it will be 3 weeks (recruitment and participation will occur simultaneously). The Procedural Pilot Study occurred in two session each with a 2-hour duration.

The Procedural Pilot Study began after IRB approval within 4-8 months. The Study will commence the semester after review of the preliminary pilot data and changes are made to the system based on focus group feedback on content delivery. The study is anticipated to take 3 weeks with recruitment and participation occurring simultaneously.

Measures

The scales in the measurement tools used in this study were drawn from prior studies related to technology acceptance or knowledge gains assessments. The data collection tools are a combination of self-report and objective assessments. Even though the measures in the tools were previously validated in the literature, this study will re-validate them using confirmatory factor analysis as a part of the SEM process. The questionnaire would be piloted tested with a minimum of 3 subject matter experts to modify and edit the tools prior to the implementation. A 7-point Likert scale would be utilized to reduce the number of uncertain or neutral responses (Matell & Jacoby, 1972).

Learner's knowledge improvement is assessed by evaluation of their pre- and post-performance surveys (Appendix D). The surveys are indicative of the ability of a leaner to learn the topic presented by the ITS. To complete the testing of the hypotheses, learner's perception of the ITS course is recorded by the technology acceptance, comparative evaluation and health belief questionnaires located in Appendix B, C and D, respectively.

ITS Content and Design

The GIFT platform is an authoring tool that allows content to be created and imported into the system. GIFT Experiment capability is located on *cloud.gifttutoring.org*, and participants are not required to provide their name or any personally identifiable information. The data is temporarily stored in a log file on the server for each participant and is mapped to the GIFT experiment containing a participant identifier. The participant identifier is unique per entry into the platform. If a participant leaves the course before completing the course their responses are saved but analyzed as incomplete. The same participant can re-enter the system on the same computer but will be given a new participant identifier. Only a select few with the Army Research Lab have direct access to the server which serves as temporary storage for the data collected during the planned research. Retrieving the data through a browser is secured using HTTPS/SSL. Anonymous data is retrieved from the server for data analysis. This data will be kept on a password protected, computer operating system that only the PI and co-PIs will have access. After data analysis is completed, the data will be saved, stored, and maintained on a password protected hard drive and locked in a secure location in the PI's office. Only the PI's and co-PIs will have access to the password-protected hard drive. Data will be archived for the required minimum of five years (for student researchers). This process is described further below.

Content

Most of content in the tutor is adapted from the Florida Department of Health's Epidemiology and Rash Illness Outbreak Tactics (EPI-RIOT): Combining Epidemiologic Practice with Field Operations course. This course was delivered by Department staff throughout the state to ensure competencies in health professional with public health functions to respond to rash illnesses (Epidemiology, 2009). The content for the course is heavily supplemented by information from the Centers of Disease Control and Prevention. Some of this supplemental information is contained in the tutor.

The course was a full day facilitator led training composed of 5 sections. The content covered 10 different rash illnesses with 8-10 learning concepts for from their signs and symptoms to management of outbreaks. To reduce the time in the experiment, two of the rash illnesses were selected for the tutor, measles, and varicella. The tutor contains 8 learning concepts for each pathogen (16 total) but the study will focus on 4: Lab Testing for Measles, Specimens and Lab Collection for Measles, Lab Testing for Varicella (Chickenpox), Specimens and Lab Collection for Varicella (Chickenpox).

Measles sample collection

Sample collection procedures during measles response outbreaks require significant understanding of the disease and protocols for collection and processing of samples. The trainee must know the methods to detect measles infection and immunity. Measles virus can be detected from various clinical samples by using cell culture techniques or molecular techniques. Measles identification methods are as follows; Serological assays including Immunoglobulin M (IgM) enzyme-linked immunosorbent assay (ELISA), Virus isolation and Reverse transcription polymerase chain reaction (RT-PCR). Throat (Oropharyngeal), nasal or NP (nasopharyngeal) swabs are the preferred samples for virus isolation or detection of measles RNA by RT–PCR. Synthetic swabs are recommended. Urine samples may also contain virus and when feasible to do so, collection of both samples can increase the likelihood of detecting the virus. Collect samples as soon after rash as possible or at the first contact with the suspected case. To assess for measles immunity in contacts, the serological assays are utilized to test for IgM and IgG.

Varicella Sample Collection

Skin lesions are the preferred specimen for laboratory confirmation of Varicella disease. The swab is taken from the base of a wet lesion. Two filled in dime sized circles should be made on a plain glass slide and allowed to air dry. Two slides are collected from each patient. Serum specimens are preferred to test for immunity (IgG). IgM testing maybe performed on unimmunized subjects or on subjects with unknown immunity status. Blood specimens are collected using a vacutainer with a red stopper or serum separator tube.

Several methods including the isolation of varicella virus from a clinical specimen, direct fluorescent antibody (DFA), polymerase chain reaction (PCR) or detection of significant raise in serum Varicella IgG by any standard assay meets the laboratory criteria for diagnosis. Specimens and the manner of collection for each these varies, and the health profession needs to follow the exact procedure to safely and reliably collect and ship specimens. Additionally, demographic information about the subject and the sample needs to be appropriately recorded on the label.

Supplemental content

Information on collection of the specimens are contained in the overview slides for each pathogen and is presented to all learners in the tutor prior to the knowledge assessments. These slides with supplemental materials are abbreviated and are used in the rule and example phase of the tutor. Other content includes YouTube videos (MedCram on measles (MedCram, 2015); New England Journal of Medicine (N. E. J. o. Medicine, 2009), MSR Educators(Educator, 2011)), website links (CDC measles(Prevention, 2017a), and PDF documents (Prevention, 2010, 2016a, 2016b). These are listed below:

youTube videos:

MedCram. (2015, January). *Measles (rubeola) Explained Clearly by MedCram.com*. Retrieved from UTube: https://www.youtube.com/watch?v=fVgabhJMoQM

MSR Educators. (2011, September). *Clean Catch Urine*. Retrieved from UTube: https://www.youtube.com/watch?v=S49nUD-iA4A

New England Journal of Medicine. (2009, November). *NEJM Procedure: Collection of Nasopharyngeal Specimens with the Swab Technique*. Retrieved from UTube: https://www.youtube.com/watch?v=DVJNWefmHjE&feature=youtu.be

websites:

Centers for Disease Control. (2017, July). *Measles*. Retrieved from CDC: https://www.cdc.gov/measles/lab-tools/rt-pcr.html

PDF documents:

CDC. (2010, July). *Varicella (Chickenpox) and Herpes Zoster (Shingles): Overview of VZV Disease and Vaccination for Healthcare Professionals.* Retrieved from https://www.cdc.gov/vaccines/vpd-vac/shingles/downloads/VZV_clinical_slideset_Jul2010.pdf

Centers for Disease Control. (2016). *Varicella and breakthrough varicella: To test or not to test.* Retrieved from https://www.cdc.gov/chickenpox/downloads/varicella-and-breakthrough-varicella.pdf

Centers of Disease Control. (2016, April). *Measles: It isn't just a little Rash: An Introduction to Measles.* Retrieved from https://www.cdc.gov/measles/downloads/IntroToMeaslesSlideSet.pdf

Surveys

Learner’s knowledge improvement is assessed by evaluation of their pre- and post-performance surveys (Appendix D). The surveys are indicative of the ability of a leaner to learn the subject matter presented by the ITS. To complete the testing of the hypotheses, learner’s perception of the ITS course is recorded by the technology acceptance, comparative evaluation and health belief questionnaires located in Appendix B, C and D, respectively

Tutor Process Overview

Upon entering the system, the learner will be presented with a 2:02 minute video, “Course Navigation” on how to navigate through the platform. The video is followed by and information as text object that contains an informed consent paragraph with language taken directly from the informed consent form (Appendix M). This is followed by two information as text objects that contains the “Course Expectations” and the “Course Objectives.

The first survey is a 12-question self-evaluation to ascertain the basic learner demographics and learner attributes as it relates to Prior knowledge, Grit, Skill, and motivation. The questions are in the free text (2), multiple-choice format (2), 5-Point Scale based on Brenner’s clinical competency scale (3) and Likert 7-point scale from Extremely Confident to Extremely Unconfident (5) (Appendix A).

The Brenner’s Novice to Expert model is composed of domains that differentiates theoretical knowledge from practical knowledge for clinical practice competencies. Although this model was defined for nursing practice they are applied to other types of health professionals (Kak, Burkhalter, & Cooper, 2001). There are 3 questions that utilize the Brenner’s scale, “How would you assess your expertise in dealing with a patient with febrile rash illness?” “How would you assess your expertise in using an intelligent tutoring system?” and “How would you assess your expertise in packaging and shipping clinical specimens?”. The scale includes Novice = Minimal or only textbook knowledge of, Beginner = Some working knowledge of, Competent = Good background knowledge and area of practice, Proficient = Depth of understanding of discipline and area of practice and Expert = Comprehensive and authoritative knowledge of.

The learner completes the learner attribute survey and then is asked to complete a 13-question knowledge assessment (Appendix E). This survey is structured around the four concepts the ITS covers. This pre-test will be used in comparison with the post knowledge assessment to ascertain whether learning occurred. It will also be used to adapt the tutor so that the appropriate content is presented to the learner based on the performance of the learner.

Following the survey administration, is a structured review which contains the participant's responses to the pre-test assessment with corresponding scoring. Regardless of the performance on the pre-test, all learners will be presented with the measles overview video (9:00 minutes) and varicella overview video (13:47 minutes) within the pathogen's Adaptive Courseflow object. These videos contain the information on the four concepts and are set in the Rule Phase of the Adaptive Course flow objects for each pathogen. The Adaptive Courseflow on Varicella will not commence until the participant has successfully demonstrated competence in measles. The Adaptive Courseflow process is described below.

The Adaptive Courseflow for Measles covers the concepts of lab testing for measles and specimens and lab collection for measles. The Rule Content files include 2 PowerPoint presentations (Measles Lab Specimens, Measles Lab Surveillance, and Interpretation) and 1 PDF document (Intro to Measles slide set). The Example Content File contains 4 files: 3 videos (NEJM Procedure Collection of Nasopharyngeal Specimens with the Swab Technique, Measles Diagnosis MedCram, Clean Catch Urine) and 1 website (CDC Measles). The Check on Learning Phase is pulled from the Course Question Bank. The rule is to present the learner with an Easy, Medium, and Hard question for the Lab Testing for Measles concept and 1 Easy question for specimens and Lab Collection for Measles. The participant will only advance to the Adaptative Courseflow for Varicella until he demonstrates competence in measles via a 4-question assessment.

A schematic of the course flow is shown in the Figure 12 below.

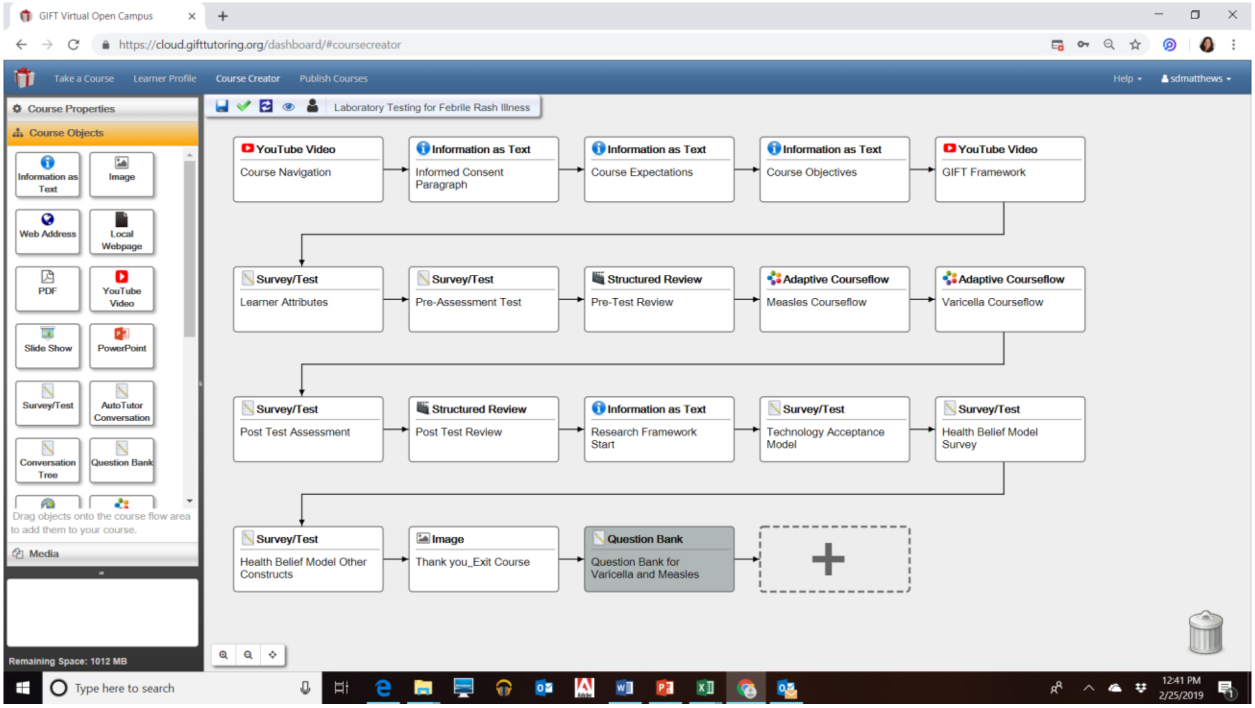


Figure 12: Laboratory Testing for Febrile Rash Illness Course Flow

If the learner is scored on the 4-question assessment as a Novice or Journeyman in the measles section, he will be presented with content from the Example Phase which includes Overview PowerPoints on Measles and Varicella and 3 pieces of Media on each topic. If the learner scores as an Expert, after viewing the Measles video, he will go immediately to the Check on Learning for Measles (Structured Review) and then go into the Varicella video contained in the Adaptive Courseflow object "Varicella Courseflow". If the Check on learning criteria is not met, the learner will be presented with the rule content again and have the option to select the media content to review. This will occur until the learner can successfully demonstrate understanding from the assessment surveys.

The Adaptive Courseflow for Varicella covers the concepts of lab testing for Varicella (Chickenpox) and specimens and lab collection for Varicella (Chickenpox). The Rule Content files include 2 PowerPoint presentations (Varicella Lab Specimens, Varicella Lab Surveillance, and Interpretation). The Example Content File contains 3 files, 2 PDFs (VZV Clinical slide set from CDC, Varicella and Breakthrough Varicella) and 1 PowerPoint (Varicella). The Check on Learning Phase is pulled from the Course Question Bank. The rule is to present the learner with an Easy, Medium, and Hard question for the Lab Testing for Varicella concept and 1 Easy question for specimens and Lab Collection for Varicella. The participant will only advance to the Post Test Assessment Survey until he demonstrates competence in measles via a 4-question assessment or until he has exhausted the content three times.

Once the learner has completed reviewing the tutor content, he will be asked to complete a 13-question post knowledge assessment (Appendix E). This assessment is a duplicate of the pre-assessment. A structured review of the posttest assessment is presented to the participant. The participant is then presented with an information as text object that announced the “Research Framework Start”.

The TAM survey contains 18-survey questions composed on a 7-point Likert Scale questions that range from Strongly Agree to Strongly Disagree and 3 comparison evaluation questions with a Yes or No response (Appendices B & C). The purpose of the TAM survey is to receive feedback from the participant on usefulness (6) and the ease of use (6), intention of use (3) and attitude (3) toward the system (F. D. Davis, 1989). This comparison evaluation survey serves to gather information preference on comparing the ITS to an internet search, speaking with a knowledgeable mentor, or participating in a discussion group to glean the same information.

The final HBM survey is separated into two survey objects. The first section contains 16-questions, 14 of which are composed on a 7-point Likert Scale from Extremely unlikely to Extremely likely with the latter 2 questions with Yes or No responses. The second section contains 31 questions with a measurement scale on a 7-point Likert scale from Strongly Disagree to Strongly Agree. These questions evaluate the constructs of perceived threats (6), perceived benefits (11), cues to action (4), motivations (8) and actual use behavior (3).

The Question Bank consists of 42 questions of which 30 address the 4 concepts used in the study. The other 12 questions are correlated with the other concepts and are formatted as True/False and classified as Easy. The 30 questions are multiple choice (16), matrix/matching (2) and True/False (12) and are classified as Easy (9), Medium (14) and Hard (7). Screenshots of the course flow are presented in Appendix D.

The course concludes with an image that thanks the participants for their time and participation in the study.

Content Design

The guiding principle in the design of the current version of the ITS system was to test the research hypotheses. As a first step the key concepts were identified as, Lab testing for Measles, Specimen and Lab Collection for Measles, Lab testing for Varicella (Chickenpox) and Specimen and Lab Collection for Varicella (Chickenpox). These concepts lend themselves to testing and assessment based on the principles in component display theory. We collated content and developed presentation paradigms for the expository rule and example phase. A decision was made to limit the current iteration to these four concepts and test the system before incorporating any additional concepts. Each of these concepts has content and media files associated with it that were collated from material that is generally made available to health care professionals.

The system was authored to provide all the necessary background information when needed based on the leaners performance. Screen shots of the creation of the tutor are presented in Appendix G.

Survey test design

The intake survey, “Learner Attribute”, was designed to assess the learner’s attributes and prior knowledge. The adaptive course flow combines the rule and the example phase with the inquisitory recall and practice phase. For this tutor we identified questions for the recall phase but did not include the practice phase as we were primarily interested in testing the ability of learner to demonstrate retention and ability to apply key concepts that are covered in the expository phases.

Data Analysis

The data collection tools are a combination of self-report and objective assessments. Even though the measures in the tools were previously validated in the literature, this study will re-validate them using confirmatory factor analysis as a part of the Structural Equation Modeling (SEM) process. The questionnaire was piloted tested with a minimum 3 subject matter experts to modify and edit the tools prior to the implementation. A 7-point Likert scale would be utilized to reduce the number of uncertain or neutral responses (Matell & Jacoby, 1972).

A description of the data will be performed by examination of the dataset utilizing IBM SPSS Statistics 27 software package ("IBM SPSS Software," 2018).

Structural Equation Modeling (SEM)

Structural equation modeling (SEM) with latent constructs consists of two parts, the measurement model, and the structural relations. The measurement model illustrates how the hypothetical constructs are measured by observable indicators and the structural equation model represents the causal relationship among the exogenous and endogenous variables.

This method was developed by Karl Joreskog can be considered a combination of regression methods (Wan, 2002). SEM is utilized in the data analysis portion of this study in the causalities among all parameters constructed in the models. SEM is an ideal analytical technique for this study as it allows for multiple paths to be modeled in one analysis. It can also estimate the strength of each observed indicator on the loading on the correlated construct (David Gefen et al., 2000).

Confirmatory factor analysis (CFA)

CFA is a statistical technique that is used to test pre-specified relationship. It allows a postulated relationship between observed variables (indicators) and their latent constructs (factors) to be tested for existence as well as to determine how well the measured variables represent the constructs (i.e. which variables load onto which factors). CFA relies on several statistical tests to determine the fit of the model to the data (Solutions, 2013). It has 3 underlying assumptions:

1. Both the latent and observed variables are measured as deviations from their means
2. The number of observed variables is greater than the number of latent factors
3. The common factors and the unique factors are not correlated (Wan, 2002).

CFA is mainly utilized in 4 areas: psychometric evaluation of measures, construct validation, testing method effects and testing measurement invariance across groups or populations (Harrington, 2008). CFA is based on factor analysis. Exploratory factor analysis (EFA) is used for data reduction, to investigate interrelationships among variables and to create a new set of variables that demonstrate commonality among the original set of variables (Wan, 2002). In other words, exploring relationships to help develop a hypothesis. CFA then takes that hypothesis to validate it.

Confirmatory Factor Analysis is used to investigate the construct validity of the survey instruments used in the study. Using CFA, we will investigate if there needs to be a reduction in the number of observed variables into each latent factor based on the commonalities within the data. This method will also allow for alternatively proposed a priori models at the latent factor level. Each latent factor will be used as a single factor analysis and then a 4-factor analysis will be conducted for TAM and a 6-factor analysis will be done for HBM.

Data analysis will also include descriptive statistics utilizing IBM SPSS Statistics 27 software package (Analytics, 2018). Pearson's Correlation Coefficient will be calculated via a correlation matrix for any interval datasets to analyze the relationships between the variables. The higher the Pearson correlation coefficient the higher strength of linear association between two variables.

IBM SPSS Amos 25 Graphics is a structural equation modeling software that allows models to be built graphically and analyzed with standard multivariate analysis methods (IBM, 2018). Hypothesized models will be first built in Amos Graphics tool and then analysis will be conducted on each model in the Analysis Properties tool. Amos Output will then be reviewed for the regression statistics to modify and revise the model.

This study will examine the relationships among the different constructs within the conceptual model for intent to use by employing a confirmatory factor analysis (CFA). The internal consistency of the constructs will be checked using a Cronbach's alpha.

The squared multiple correlations provide information on how much variance the common factors account for in the observed variables. High variances suggest that these variables do not represent the latent construct well (Albright, 2006). The correlation magnitude will also be considered as high collinearity indicates identical measurements of the same object. High loadings values are interpreted as good indicators for the factors (B. M. Byrne, 2016).

Goodness of Fit (GOF) of the model will be determined using Chi-squared tests, Likelihood ratio, Root Mean Square Residual (RMR), Goodness of fit index (GFI), Normed fit index (NFI), Root mean square error of approximation (RMSEA) and Comparative fit index (CFI) that help measure model validity (Solutions, 2013).

Absolute fit measures

Absolute fit measures determine the degree to which the overall model predicts the observed covariance or correlation matrix. These measures include the chi-square statistic, GFI and RMSEA. The Chi-squared (χ^2) value of a well-fitted model approximates the degrees of freedom and the probability level is >0.05 which indicates it is statistically significant and reflects that the estimated sample variance/covariance matrix is no different from the population variance/covariance matrix. It is ideal to achieve smaller Chi-squared values and show a p value that is greater or equal to 0.05. A model p value that is smaller than 0.05 suggests the model could be improved. Evaluating the fit based on the Likelihood ratio indicates that the closer the value is to 1 and not exceeding 3 the better the fit of the model. GFI index must exceed 0.80.

RMSEA values of 0.05 or less are considered a close fit, RMSEA values should not be greater than 0.1 (B. M. Byrne, 2016).

Incremental fit measures

Incremental fit measures compare the proposed model to the baseline model. The indices of these measures are the NFI and the CFI (Pai & Huang, 2011). Normed Fit Index (NFI) and Comparative Fit Index (CFI), values of >.95 are considered representative of a well-fitted model (B. M. Byrne, 2016).

Wilcoxon Signed Ranks Test

The Wilcoxon signed-ranks test is a non-parametric equivalent of the paired t-test. It does not assume normality in the data and is used to compare paired observations by testing difference in mean or median. There are 3 assumptions that must be met to use the Wilcoxon Signed Ranks Test. The first assumption is that your dependent variable is measured at the ordinal or continuous level. Our data utilizes 7-point Likert items. The second assumption is that the dependent variable should consist of two categorical related groups or matched pairs. We utilize the same study participants for the pre and post assessment evaluations. The third assumption is that the distribution of the differences between the two related groups needs to be symmetrical in shape (AERD, 2018; InfluentialPoints).

Procedural Pilot Study

A Procedural Pilot Study was conducted as explanatory research to explore the use of ITS with public health professionals to examine if the possibility of undertaking this research study was feasible and realistic. The Pilot Study was conducted in two face to face focus group sessions in November 2018 utilizing a Debrief Guide (Appendix O) facilitated by an investigator. The study participants (N=17) were public health professionals with varied experienced in surge events whose daily workforce areas included environmental health, epidemiology and disease intervention in HIV, tuberculosis, and STD prevention programs. Self-disclosed level of expertise in responding to febrile rash surge event ranged from novice to expert.

The first session was plagued by network connections and hardware functionality issues which did not allow for data to be harnessed for any further analysis. The second session had lesser issues and participant data (N=5) was able to be analyzed. This data is presented below. The analysis contributed to creating and updating the prosed analysis methodology as well as assuring that this research would likely provide a significant contribution to the public health research body of knowledge.

Description of Data

A sample of 17 public health professionals from a single organization was selected for this pilot study. Data respecting the Procedural Pilot was obtained from the Procedural Pilot Debrief Guide (Appendix O) and a facilitated led discussion. Data for 5 of the professionals were obtained from the Learner Attributes Survey (Appendix A), the Pre/Post Test Summative Assessment (Appendix E), the Comparison Evaluation Questions (Appendix C) contained in the Technology Acceptance Model (TAM) Survey, TAM Survey (Appendix B) and the HBM Survey (Appendix D).

Participants found the instructions to access the course understandable, clear and "simple to the point". They found the platform easy to navigate, user-friendly and the "design was easy to figure out". The instructions provided "communicated easily and effectively". The "course expectations were very well laid out". Most of the participants found the platform informative, useful, and thought that idea of using for just in time training and public health professionals working in the field was a good idea.

The average age of the participants is 37.8 years (range 27-59 years). The average years of experience is 6.3 years (range 1-20 years). The participant population was 60% Male. Sixty percent (60%) of the participant population self-identified has having prior experience dealing with a febrile rash illness.

When asked about expertise having prior knowledge and skill with of dealing with a patient with febrile rash illness was 40% of participants self-identified as novice, 40% as competent and 20% as proficient. Expertise in using an intelligent tutoring system was self-identified as competent (40%) and 20% in the categories of novice, beginner, and proficient. Expertise in packing and shipping clinical specimens self-identified as novice (20%), beginner (40%) and expert (40%).

The learner attribute survey contained 5 questions that assessed self-identified confidence. The first two questions were written to assess participants' prior knowledge and grit. In the first questions, participants were asked about their confidence on knowledge of the rule out diagnostic process for febrile rash illness to which 40% responded with a degree of unconfident (extremely and quite), 20% was slightly confident and 40% were quite confident. The second question evaluated confidence in ordering and following the appropriate laboratory procedures for febrile rash illness to which participants responded with 20% extremely unconfident, 20% quite unconfident and 60% quite confident. The latter 3 questions evaluated the participants' grit and motivation for using an ITS for learning, completing the course and willingness to return to the ITS platform. Responses to these 3 questions were all with the categories of quite confident and extremely confident.

The comparison evaluation questions sought to determine if the participants would have preferred to obtain the content from the ITS in the form of an internet search, a mentor, or a discussion group. Most responses were negative for utilizing the internet (100%), mentor (80%) or discussion group (80%) over the use of the ITS platform, demonstrating a favorable response to the utilization of the technology.

The summative assessment process executed in this research illustrated that 80% of study participants demonstrated a positive change in knowledge acquisition when compared to their baseline test scores at the beginning of the course.

Table 1: Pre/Post Test Score Comparisons for November 2018 Pilot Study (22 total points)

Participant	Pre-Test	Post-test	Percent Change
1	20	17	-0.15
2	15	21	+0.40
3	21	22	+0.05
4	14	20	+0.43
5	11	17	+0.55

In the Technology Acceptance Survey participants' responses to perceived usefulness of the system was unanimously favorable with responses from somewhat agree to strongly agree on all 6 of the perceived usefulness questions. Unanimous favorability was also demonstrated in the responses for perceived ease of use. Agreement was also demonstrated for intention of use construction except for one participant's neutral response when asked if would predict use for training now that she had access. Unanimous agreement was also demonstrated on the attitude constructs.

The HBM Survey responses to Perceived Susceptibility and Perceived Benefits ran the gambit for responses for both self and the community. Perceived severity responses demonstrated that most participants believe that a febrile rash illness to themselves or to their community would not be so severe. Perceived threat to the self and community responses highly demonstrated disagreement.

The HBM Survey responses for the Cues to Action, Motivation and Actual Use demonstrated high agreement among these categories. Cues to Action responses were all in agreement (Somewhat agree to Strongly Agree). Motivation category demonstrated agreement among all questions with only one neutral response with following medical orders due to benefit to the community. The Actual Use Behavior responses demonstrated unanimous agreement for use of the ITS.

Findings

Based on the responses from each of the surveys, the study population can be described as highly motivated participants. Their responses showed favorability to utilizing an ITS system for training on a febrile-rash illness. They did not feel that self or their community had a significant threat or severity of illness from a febrile rash illness.

To fully gain more understanding of the correlation of these constructs, it is our proposal that they be analyzed utilizing SEM for the full study.

Prospects for Proposal Submission Summary

There is demand for this research in the health care community. Specifically, recent Pivot search of grant funding availability resulted in identification of a Centers for Disease Control and Prevention (CDC) announcement for Collaboration with Academia to Strengthen Public Health Workforce Capacity and a United States Agency for International Development (USAID) announcement for One Health Workforce-Next Generation (OHW-NG) (USHHS, 2019) (USAID, 2019). Both funding opportunities address the need to strengthen public health workforce capacities. The former solicits this capacity building in the United States around immunization practices content and the latter in Africa and Southeast Asia around infectious disease threats content. While each funding opportunities have significant differences in educational content and applicant criteria, the one underlying theme is the need for training and educational offerings to align with core competencies and technical skills. Though I decided to pursue this research on a self-funded basis, our research address the fore mentioned needs from a more theoretical research perspective.

Overview

Traditional educational strategies may not be enough to overcome the challenge of maintaining a competent and effective public health workforce capable of responding to a surge event on organizations with limited resources and questionable surge capabilities. The use of intelligent agents in public health practice might be an effective method to support workforce needs in terms of education and skill development while not burdening the system. Intelligent agents are a combination of artificial intelligence (AI), databases and computer human interfaces used to mimic human behavior (Woolf, 2010). They are characterized by their ability to learn from previous experience, reason to adapt and respond to the environment. The intelligent agent has autonomy, is goal oriented and can communicate and provide feedback to the user (Laboratory, 2018). Inherent to any online system, it is flexible, scalable, and accessible. Our proposed research introduces an agent-based, online, personalized, intelligent tutoring system to deliver surge event personalized training accessible by individuals in organizations nationwide. The system intends to not only strengthen employee skills and competencies, but also build capacity of local public health to respond to surge capacity events.

Intellectual Merit

Utilizing a research prototype developed by the Army Research Laboratory (ARL), our research would not only improve the research pedagogy for public health, but it would also provide an innovative platform to decrease the gap in training the workforce to become more align with practice and allow for limited subject matter experts to reach a plethora of learners regardless of location. Additionally, our research proposal seeks to understand actual use of technology by the public health workforce by measures of the learner's perceived ease of use, perceived usefulness, attitude, motivation, and health beliefs. Our methodology includes a hypothesized conceptual model built on the extension of the Technology Acceptance Model with Health Belief Model constructs.

Boarder Impact

The use of ITS technology to advance public health practice can make a significant impact on preparing the workforce to detect, prevent and respond to public health surge capacity events. It can support training with subject matter experts in remote areas. It can assess competency prior to deployment of human resource.

CHAPTER 4: FINDINGS

Course Data and Non-Participation

The study was conducted from September 20, 2019 to November 12, 2019. Participant invitations were sent to 940 potential participants via email with a response of 179 (19%) making a course attempt. Forty-eight (48) did not make a course attempt but did respond to the invitation. Of the 48, 6 respondents left the survey blank, 40.48% (17) indicated “no time”, 28.57% (12) indicated a “information technology barrier (i.e. system compatibility)”, 14.29% (6) indicated a “general refusal”, 11.90% (5) indicated “no interest”, 2.38% (1) indicated “waste of time”, 2.38% (1) indicated “participation not supported by my employer”. Figure 66 and Table 25 in Appendix Q display the data for persons responding to the invitation without a course attempt.

Of the 179 course attempts, 164 respondents completed the introduction and 15 ended at this page. 129 participants were able to continue and to view the informed consent paragraph and the course expectations slide. 123 participants were able to continue and viewed the course objectives slide. 104 participants completed the learner attributes survey, 97 completed the pre-test assessment, 73 completed the application scenario question, 72 completed the post-test assessment and 69 completed the technology acceptance model survey which contained the three comparison survey questions and 69 respondents completed the health belief model survey. Data analysis for this 69-participant cohort is provided at the end of this chapter.

Study Population Demographics

The study population profile mirrored the results of other public health workforce studies (Jones, Banks, Plotkin, Chanthavongsa, & Walker, 2015). The findings of the study show that our study population is composed of 78% female with an average age of 44.8 years of age and an average of 16.67 years of experience as a health professional. Seventy-five percent (75%) had experience dealing with febrile rash illness. Although the majority had experience dealing with a patient with febrile rash illness, their level of expertise had the most range within the Brenner's scale of competency. On the expertise with using an ITS, the study population identified with a 59% majority as novice. When we combined novice with beginner competency this rose to 86%, demonstrating that using an ITS is on the lower end of the Brenner scale of competence. In expertise in packaging and shipping of clinical specimens for febrile rash illness, the study population majority was 34% novice. When novice was combined with beginner competency this rose to 61%, demonstrating that expertise in packaging and shipping is on the lower end of the Brenner scale of competence.

Our study population showed that 84% were highly motivated with grit about their willingness to learn about rule-out diagnosis process on an ITS, 87% were motivated to complete the entire course on the ITS and 74% were willing to return to the platform for a refresher course. Fifty-six percent (56%) of respondents were confident about their prior knowledge about the rule-out diagnosis process for febrile-rash illness, but this question also saw the highest level of unconfident responses at 37%. Respondents' confidence in executing the correct procedures for rash and fever was divided with 51% confident in their current ability and 41% unconfident.

Time Session

The GIFT platform records the total time a participant is within a course. The total time is calculated from the start of the course until the close domain session is requested. However, if the participant does not elect to close the domain session (i.e. close the browser in which the platform is running) the time continues to run. Extreme values at each session event were removed as outliers in the descriptive analysis.

The descriptive statistics for each session are displayed in Table 32 in Appendix Q. The 15 participants that ended at the introduction page of the course each had a “Course is Ending” message, 10 of the attempts were made on the same Saturday (10/19/2019) at different times throughout the day. The other 5 were withing 2 days over a weekend (10/26/2019-10/28/2019). Inquiry to the GIFT technology team, did not reveal any platform issues or maintenance on those days. One reason for this error was participants had problems starting or loading the course leading to a session with no useful events.

It took participants a mean of 2.8 minutes (N=29) to complete the introduction, informed consent, and course expectations. The next course event was the course objectives which added 0.2 minutes for a mean of 3.0 minutes spent in the tutor to complete up to this session. To complete the learner attributes session was a mean of 5.2 minutes. At this event, 1 participant received the “Course is Ending” message and their session was terminated. To complete the Pre-test took a mean of 17 minutes. Participants reached a mean of 26 minutes after completing the scenario application. At this point 24 participants ended their session. The 69 participants that completed the entire course averaged 47.1 minutes with a range of 11-115 minutes.

Learner Profile and Attributes

The first survey ascertained the learner profile and attributes. 104 respondents answered all twelve (12) questions of the survey. Seventy-eight percent (78%) of respondents identified as female (N=81) and 22% as male (N=23).

The age range for respondents was from 24 to 71, with an average age for respondents (N=104) as 44.8 years with a median age of 41.5 years. The age range that consisted of the majority of respondents were with the 25-34 years of age (27%), followed by 35-44 years of age (26%), 55-64 years of age (22%), 45-54 years of age (15%), 65 years and older (8%) and 18-24 years of age (2%).

When asked how many years you have worked in healthcare, the respondents experience ranged from less than 1 year to 46 years. The mean years of experience was 16.67 years.

Age and years of experience in healthcare are the two continuous variables in the experiment. The Kolmogorov-Smirnov (Age: KS=.123 p=.001 Experience: KS: .164 p=.000) and Shapiro-Wilk tests (Age: SW=.939 p=.000 Experience: SW: .918 p=.000) for Normality both showed that the data was not normally distributed.

Seventy-five percent (75%) respondents (N=78) indicated they have experience dealing with febrile rash illness, while 25% (N=26) indicated they had no experience dealing with febrile rash illness.

The survey contained 3 questions that asked about expertise with dealing with a patient with a febrile rash illness, expertise using and ITS and expertise in package and shipping specimens for febrile rash illness. Figure 13 below depicts the expertise levels. The expertise question "How would you assess your expertise in dealing with a patient with febrile rash illness?", respondents were almost evenly distributed in the novice (25% N=26), competent

(28% N=29) and proficient (28% N=29). This was followed by a 14% (N=15) beginner and 5% (N=5) expert identification.

The expertise question, “How would you assess your expertise in using and intelligent tutoring system ITS?”, 59% (N=61) of respondents identified as novice and 27% (N=28) identified as beginner, 10% (N=10) identified as competent, 4% (N=4) as proficient, >1% as expert.

The expertise question, “How would you assess your expertise in packaging and shipping clinical specimens for febrile rash illness?”, 34% (N=35) identified as novice, 27% (N=28) as beginner, 26% (N=27) as competent, 10% (N=11) as proficient and 3% (N=3) as expert.

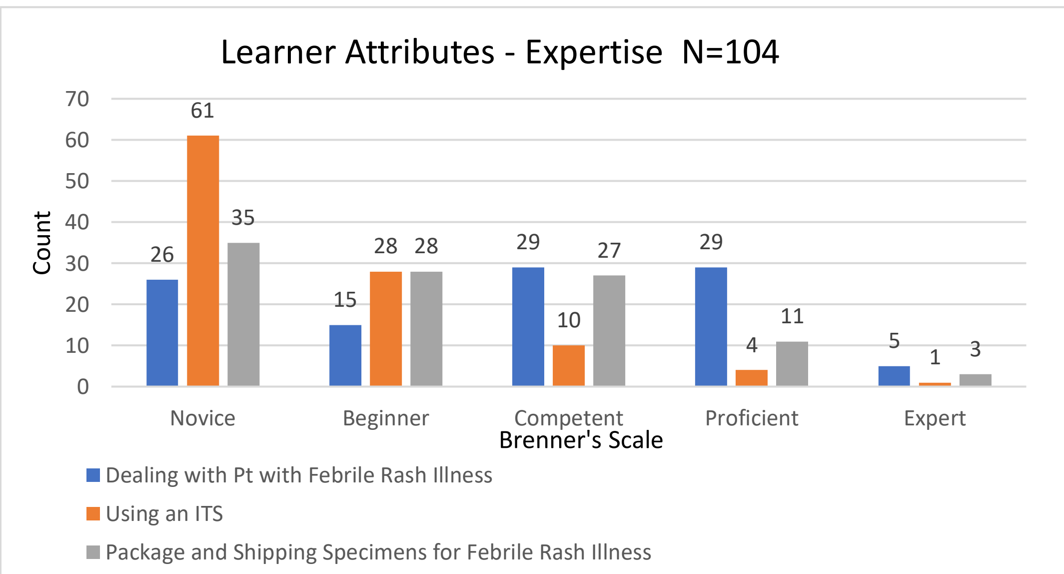


Figure 13: Learner Attributes by Brenner’s Scale of Competency

The learner attribute survey also assessed the self-selected confidence that participants believed of themselves. Figure 14 below illustrates this confidence level. Question 8, “How confident are you in your knowledge about the rule out diagnostic process for febrile rash-like illnesses?", and Question 9, "How confident are you that if a patient walked into your healthcare facility with a rash and fever that you would be able to order the correct laboratory procedures based on clinically and epidemiological evidence?", were asked to ascertain prior knowledge and grit. Questions 10, "How confident are you in your willingness to learn about the rule out diagnostic process for febrile rash-like illnesses on an intelligent tutoring system (ITS) platform?", and 11, "How confident are you that you will complete the entire course in the Intelligent Tutoring System (ITS) format provided?", were asked to ascertain learner attributes of grit and motivation. Question 12, "How confident are you that if you found this learning platform useful (ITS) that you would return to it for a refresher course?", ascertained motivation. Across these five questions, confident was the most frequent response chosen. Respondents felt confident about their willingness to learn about the rule out diagnosis process on an ITS at 46% (N=48). The study population also felt confident to complete the entire course on the ITS at 45% (N=47). Most unconfident responses were demonstrated in the knowledge about rule out diagnosis process for febrile rash illness 17% (N=18) and with executing correct lab procedures for rash and fever 15% (N=16). Returning to the platform for refresher course received most neutral responses 21% (N=22).

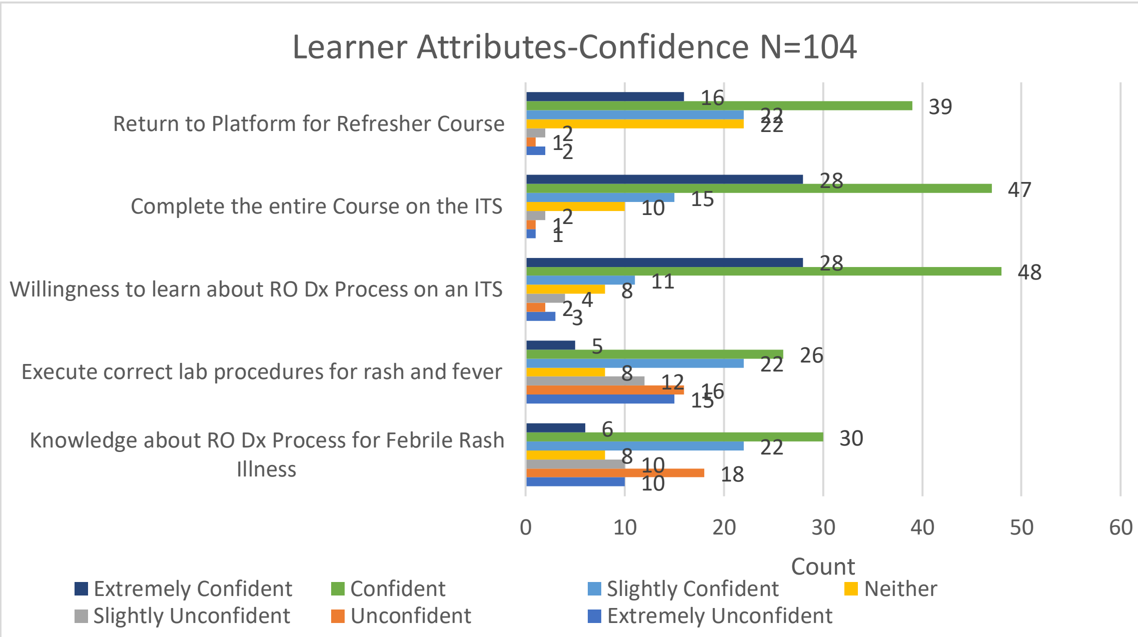


Figure 14: Learner Attributes Confidence in Knowledge of ITS Content, Use of ITS and Return to Platform

To understand the level of motivation, grit and prior knowledge at quick glance the data was summed down to 3 categories from the original 7 which is depicted in the figure below (Figure 15). The visualization shows that respondents are 74% (N=77) more confident that they will return to the platform for a refresher course, 87% (N=90) were more confident that they will complete the entire course on the ITS, and 84% (N=87) more confident that they are willing to learn about rule out diagnosis process on an ITS. There is a 51% (N=53) level of confidence on executing the correct lab procedures for rash and fever and 56% (N=58) level of confidence on respondents' knowledge about rule out diagnosis process for febrile rash illness.

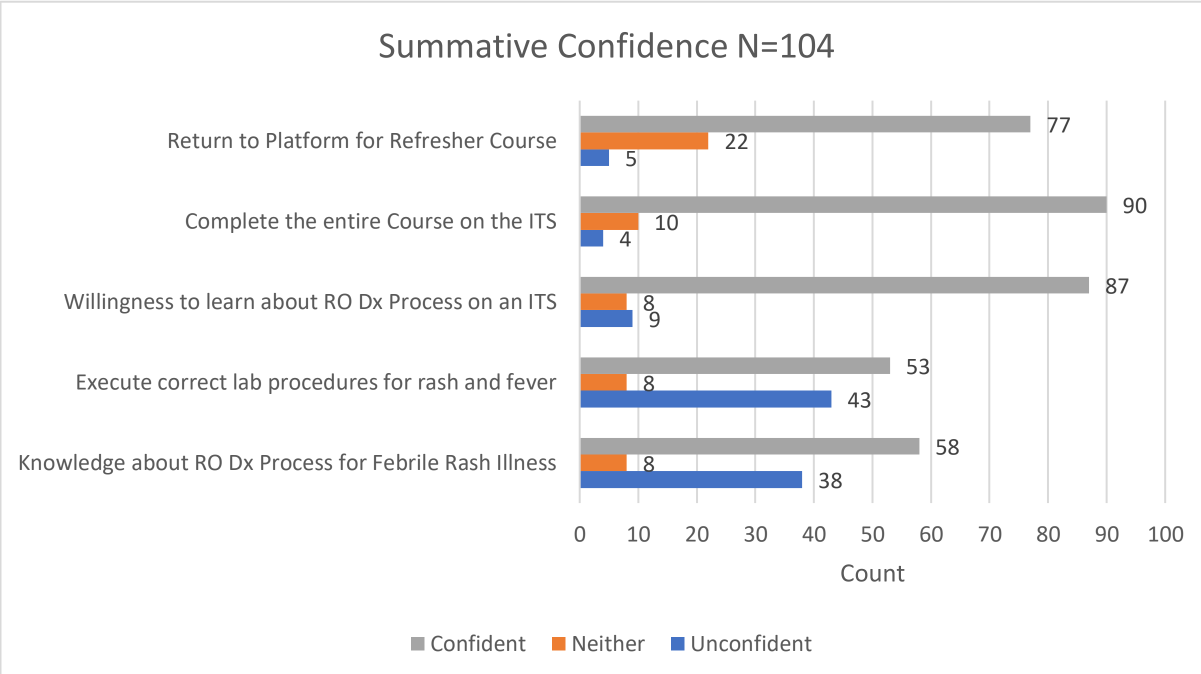


Figure 15: Learner Attributes Summative Confidence in Knowledge of ITS Content, Use of ITS and Return to Platform

Knowledge and Application Based Assessments

To test effectiveness of the tutor, we looked at knowledge acquisition via the knowledge-based assessments (i.e. pre- and post-tests) and knowledge application via application of knowledge in a scenario-based problem.

In the application-based assessment, respondents (N=73) were asked to decide when ruling out the diagnosis of several febrile rash illnesses the most important information to collect would be all the following with one exception. In this assessment, 74% of respondents (N=54) correctly responded to the scenario (i.e. sexual contacts and history). Of the respondents who responded incorrectly (N=19), 84% (N=16) selected the same incorrect response (i.e. patient's allergies). The remaining 3 respondents selected into 3 separate responses (i.e. the patient's demographics, the patient's travel history, the rash progression).

We saw that 97 respondents completed the pre-test assessment of which 72 completed the post-test assessment. A comparison was made between pretest scores and post test scores for respondents. The average test points for pretest was 6.7 points or 67%, the average for the post test was 8.7 points or 87%. A paired samples t-test was conducted at 95% confidence interval to look for a difference between the tests. The p-value was significant at p= .000 which is less than our alpha (0.05) and the t-test was -8.243 demonstrating that we reject the null hypothesis that there is no significant difference in the means of each sample. The correlation coefficient is .499 demonstrating that it is very poor correlation.

We ran a Wilcoxon Signed Ranks Test on the assessment data as this test does not assume normality of the data. The descriptive statistics show that there is an increase in scores from pre to post tests. The 25th percentiles saw an increase of 3 points, the 50th by 1 point and the 75th percentile by 2 points. In the ranks statistics we see that 7 respondents had higher scores in the pre-test when compared to their post test scores. There were 53 respondents that had higher post test scores when compared to their pre-test scores and there were 12 respondents who saw no change in their scores. The test statistics show that the ITS indeed demonstrates learning effectiveness by its statistically significant change in test scores in individuals ($Z=-6.04$, $p=0.00$).

We then ran a one-sample paired t-test for the difference in posttest and pretest for our 72 respondents. With our test value=0 we note that the positive mean difference is 1.806 indicating that the mean of the sample is greater than the hypothesized value. Our $p<0.001$, which indicates that there is a significant difference between the mean score of our sample and what we would expect for the overall population. Figure 16 demonstrates visually the significant change in scores.

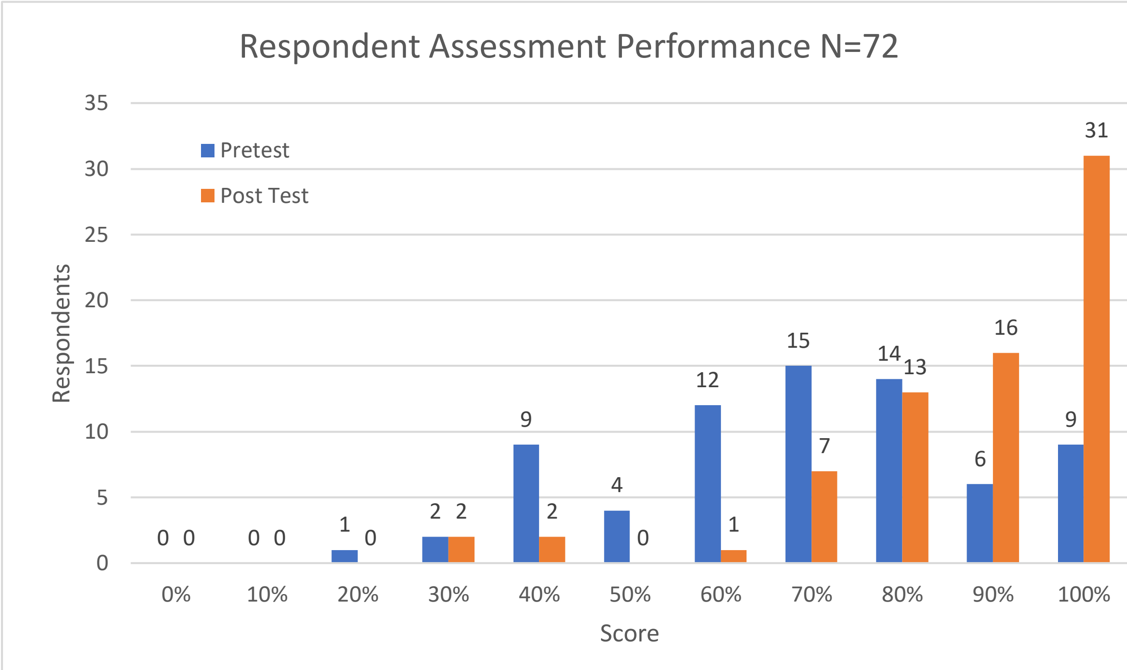


Figure 16: Respondent Assessment Performance

Overall, there was 244% increase for the number of respondents who received all 10 points and a 220% increase for respondents who receive 9 points when compared to their pretest assessment. When we looked compared individual scores, 19% of respondents improved their post test scores by 2 points, 19% by 3 points, 18% by 1 point, 10% by 4 points, 4% by 5 points, 1% by 6 points, and 1% by 7 points. Seventeen 17% percent of respondents did not show any increase or decrease in points when comparing their pretest to their post test scores. Seven 7% of respondents showed a decrease of 1 point and 3% a decrease of 2 points.

Table 2: Frequency Table of Test Scores and Point Difference

Frequency of Test Scores and Point Difference					
Scores/ Points	**Pretest**	**Pretest (72)**	**Post Test**	**Frequency for Change in Points**	**% for Change in Points**
10	10	9	31	0	0%
9	7	6	16	0	0%
8	17	14	13	0	0%
7	20	15	7	1	1%
6	18	12	1	1	1%
5	7	4	0	3	4%
4	12	9	2	7	10%
3	4	2	2	14	19%
2	2	1	0	14	19%
1	0	0	0	13	18%
0	0	0	0	12	17%
-1	N/A	N/A	N/A	5	7%
-2	N/A	N/A	N/A	2	3%
Total	**97**	**72**	**72**	**72**	**100%**
Mean	6.7	6.9	8.7	N/A	N/A
Median	7	7	9	N/A	N/A

We then compared the frequency of assessment scores by respondents' self-identified competency level on their expertise in dealing with a patient with febrile rash illness, expertise in packaging and shipping clinical specimens for febrile rash illness and expertise in using an ITS. Across all competency levels within the 3 expertise questions, improvers were at 51%, non-improvers at 37.5% and no change at 11.5%. Respondents who identified as Novice saw the greatest percentage of improvers across the 3 expertise questions when compared to the other competency levels. Respondents who identify as Novice, Beginner or Competent across all three expertise questions saw the greatest percentage of overall improvers.

When asked about expertise in dealing with a patient with febrile rash illness, respondents who identified as Novice, Beginner, Competent and Expert saw greater number of improvers when compared to non-improvers or no change. Proficient respondents had a greater number of non-improvers (37.9%) and no change (27.6%).

When asked about expertise in packaging and shipping clinical specimens for febrile rash illness, respondents who identified as Novice, Beginner and Competent saw greater number of improvers when compared to non-improvers or no change. Respondents who identified as Expert saw an equal distribution between improvers, non-improvers, and no change (33.3%). Respondents who identified as Proficient saw a higher value for non-improvers (54.5%) compared to improvers (36.4%) and no change (9.1%).

When asked about expertise in using an ITS, respondents who identified as Novice, Competent or Proficient saw the higher percentage for improvers. Respondents who identified as Beginner saw a higher value for non-improvers (46.4%) compared to improvers (39.3%) and no change (14.3%). Respondents who identified as Expert also saw a higher value for non-improvers (100%) for this expertise question.

Table 3: Expertise and Assessment Comparisons

Expertise and Assessment Scores										
Expertise Questions	**Competency Level**	**Improvers**	**% Overall Improvers**	**% Improvers by Level**	**Non-improver**	**% Overall Non-improvers**	**% Non-improvers by Level**	**No change**	**% Overall No Change**	**% No Change by Level**
How would you assess your expertise in dealing with a patient with febrile rash illness?										
N=26	**Novice**	17	16.3%	65.4%	8	7.7%	30.8%	1	1.0%	3.8%
N=15	**Beginner**	8	7.7%	53.3%	6	5.8%	40.0%	1	1.0%	6.7%
N=29	**Competent**	15	14.4%	51.7%	12	11.5%	41.4%	2	1.9%	6.9%
N=29	**Proficient**	10	9.6%	34.5%	11	10.6%	37.9%	8	7.7%	27.6%
N=5	**Expert**	3	2.9%	60.0%	2	1.9%	40.0%	0	0.0%	0.0%
N=104	**Total**	53	51.0%		39	37.5%		12	11.5%	
How would you assess your expertise in packaging and shipping clinical specimens for febrile rash illness?										
N=35	**Novice**	20	19.2%	57.1%	11	10.6%	31.4%	4	3.8%	11.4%
N=28	**Beginner**	13	12.5%	46.4%	12	11.5%	42.9%	3	2.9%	10.7%
N=27	**Competent**	15	14.4%	55.6%	9	8.7%	33.3%	3	2.9%	11.1%
N=11	**Proficient**	4	3.8%	36.4%	6	5.8%	54.5%	1	1.0%	9.1%
N=3	**Expert**	1	1.0%	33.3%	1	1.0%	33.3%	1	1.0%	33.3%
N=104	**Total**	53	51.0%		39	37.5%		12	11.5%	
How would you assess your expertise in using an intelligent tutoring system (ITS)?										
N=61	**Novice**	33	31.7%	54.1%	21	20.2%	34.4%	7	6.7%	11.5%
N=28	**Beginner**	11	10.6%	39.3%	13	12.5%	46.4%	4	3.8%	14.3%
N=10	**Competent**	6	5.8%	60.0%	4	3.8%	40.0%	0	0.0%	0.0%
N=4	**Proficient**	3	2.9%	75.0%	0	0.0%	0.0%	1	1.0%	25.0%
N=1	**Expert**	0	0.0%	0.0%	1	1.0%	100.0%	0	0.0%	0.0%
N=104	**Total**	53	51.0%		39	37.5%		12	11.5%	

Comparative Preferences to Obtain Content Knowledge

Study participants were asked instead of the time spent taking the ITS course if their time would have been better spent on the internet researching, talking with a knowledgeable mentor or taking a class with a discussion group so that I could learn about a surge capacity public health event such as a febrile rash illness outbreak. Respondents showed that in all 3 comparisons the

ITS platform was preferred over the internet search (84%), a knowledgeable mentor (64%) and a class with a discussion group (74%).

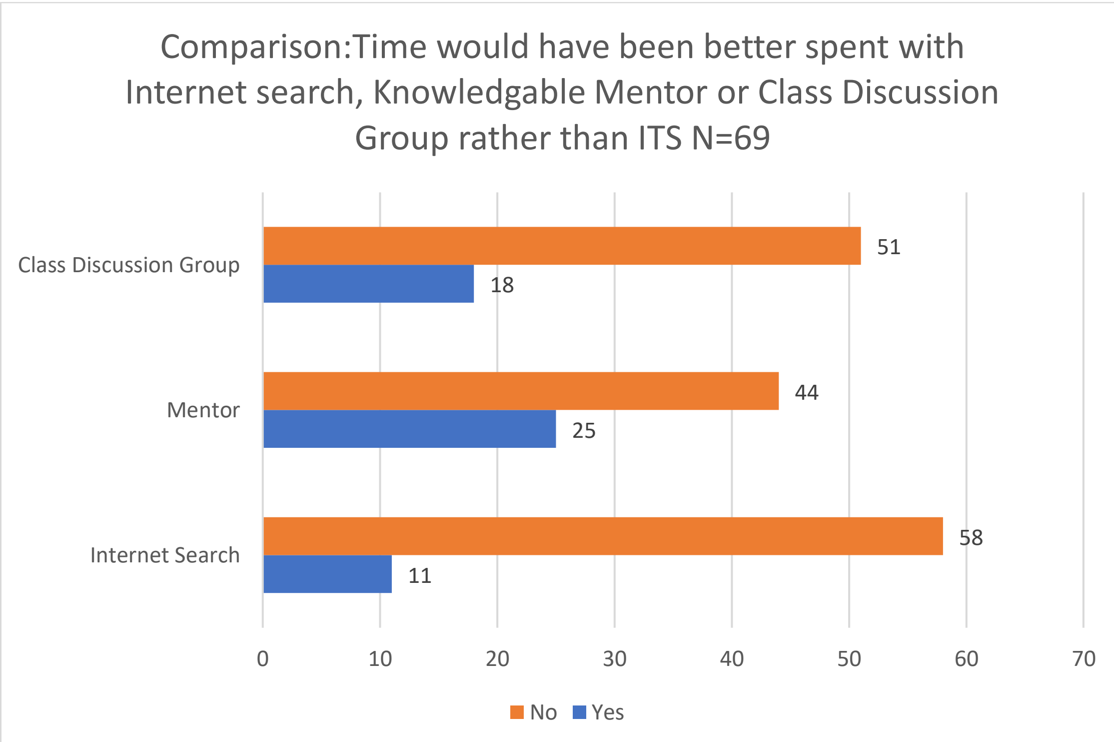


Figure 17: Comparative Preferences to Obtain Content Knowledge

Confirmatory Factor Analysis

Missing Data-Imputation into Model

The surveys for the Technology Acceptance Model and the Health Belief Model each had 69 respondents. A review of survey responses for each of the 69 respondents did not show any unengaged participants (i.e. no respondent answered consistently one choice). There were no outliers identified in the data.

However, in the TAM survey there were 4 respondents (ID 27, 44, 40, 73) that each did not answer one question which resulted in missing data (IU1, PEOU4, PEOU6, PEOU2). In the

HBM survey there were 3 respondents (ID 33, 40, 62) that contributed to missing data in the exogenous variables for perceived benefits (PB1-PB6) and perceive threats (PT1-PT8). The missing data for each survey were within exogenous variables of the model and the missing data was less than 5% per indicator (i.e. the set of participant responses to a given survey question about a given construct), the data may be imputed into the dataset (Nunkoo, Ramkissoon, & Gursoy, 2013)

Imputation of the data requires comparative analysis between the original dataset (N') and the imputed dataset (N). This comparison was conducted on the respondents' demographic variables of years or experience, age, and sex. The tables in Figure 18 show the comparison samples (N & N') for TAM and for HBM. The comparison samples show consistent similarities in the groups but to assure this, parametric tests for paired samples were conducted.

The statistics from the parametric tests show that sample group N has no difference in the means to sample group N' in the TAM survey and in the HBM survey. There is no statistical difference between the means of both sample groups when comparing the years of experience, age, or sex. Thus, the estimated mean can be imputed into the dataset. The chart in the Appendix Q, Table 39 shows the 4 questions on the TAM survey that required imputed data. The average of the responses was taken for the imputation. The chart in the Appendix Q, Table 40 shows the 14 questions on the TAM survey that required imputed data. The average of the responses was taken for the imputation.

Sufficient sample size for CFA and SEM is met. Power analysis assumes there is a linear function of measured parameters (i.e. indicators) to number of observation (i.e. sample size) but most SEM published analysis do not follow this rule. The research to date has not yielded a sample size formula suitable for SEM (Westland, 2010). Theoretically, 50-150 participants are needed for CFA or SEM analysis.

Imputation for Missing Data Comparison TAM Survey

	N	**N'**
N	69	65
Years of Experience Descriptive Statistics		
Range	44	40
Minimum	1	1
Maximum	45	41
Mean	15.67	15.2
Mean Std. Error	1.35	1.34
Std. Deviation	11.217	10.807
Variance	125.814	116.787
Median	12	12
Mode	10	10
Age		
Range	45	45
Minimum	24	24
Maximum	69	69
Mean	43.74	43.17
Mean Std. Error	1.575	1.597
Std. Deviation	13.08	12.879
Variance	171.078	165.862
Median	40	39
Mode	38	38
Sex		
Male	17	17
Female	52	48
Percent Male	24.6	24.6
Percent Female	75.4	69.6

Imputation for Missing Data Comparison HBM Survey

	N	N'
N	69	66
Years of Experience Descriptive Statistics		
Range	44	44
Minimum	1	1
Maximum	45	45
Mean	15.67	15.98
Mean Std. Error	1.35	1.391
Std. Deviation	11.217	11.298
Variance	125.814	127.646
Median	12	12
Mode	10	10
Age		
Range	45	45
Minimum	24	24
Maximum	69	69
Mean	43.74	43.95
Mean Std. Error	1.575	1.63
Std. Deviation	13.08	13.244
Variance	171.078	175.398
Median	40	40.5
Mode	38	38
Sex		
Male	17	16
Female	52	50
Percent Male	24.6	23.2
Percent Female	75.4	72.5

Figure 18: Comparative Analysis for TAM and HBM Imputation of Data

Measurement Models with Confirmatory Factor Analysis (CFA)

The reflective measurement models for each construct (e.g. PU, PEOU, IU, ATT, PS, PSV, PT, PB, CA, M, AU) were evaluated to check loading from each indicator and to check the variance of each indicator. In the CFA analysis for TAM, N=69. The CFA analysis for HBM, N=69. Using IBM SPSS Statistics 27, the Cronbach alpha, Standard deviation, and Mean were calculated for the items prior to import into IBM SPSS Amos 25 Graphics.

Additional data for each construct is in Appendix Q: Data Analysis for Study.

AMOS Analysis Properties selections.

1. Estimation tab: Maximum Likelihood; Fit the saturated and independence model; Estimate means and intercepts (selected when missing values)
2. Output tab: Standardized estimates; Squared multiple correlations; Modification indices (only if no missing values); Covariance of estimates; Correlation of estimates; Threshold for modification indices 4.

Each construct was drawn and evaluated as a “generic” measurement model and subsequently manipulated into what is termed in this dissertation as a “modified” and a “revised” model. All models were normalized by setting the unstandardized regression coefficient estimate with the biggest value to 1. To create the modified model from the generic model, generic model goodness of fit statistics were evaluated and then a modified model was drawn and evaluated based on modification indices. The modification indices that have the highest value and parameter changes are explored individually and stepwise to reduce variance and improve item loading. Similarly, modified model goodness of fit statistics were evaluated and the modification indices reviewed to create a revised model.

Evaluation of each measurement model was conducted to determine the best fit based on the fit statistics described in Chapter 3.

The CFA is used for construct validity and instrument evaluation. Each observed indicator is evaluated based on loadings and concluded to be retain or deleted. When conducting the CFA, at minimum 3 indicators whose errors are uncorrelated with each other must be maintained (B. M. Byrne, 2016). This information is presented in a table for ease of visualization.

The perceived usefulness (PU) construct is used in this chapter to provide an example of the process, analysis, and interpretation methods used to determine the best fit model for each construct considered. For the remaining constructs (PEOU through AU) and for the sake of easy of reading, the process, analysis, and interpretation methods used for those constructs are abbreviated and presented in Appendix Q. The CFA for TAM and HBM are also presented in this chapter.

CFA on Perceived Usefulness (PU)

Evaluation of the measurement models reveal that the revised model has the best model fit statistics for PU (Table 5).

The following process illustrates the steps taken that lead to the selection of the revised model as our predictor model for PU.

The CFA statistics for the revised model are summarized in Table 4. This data reveals that the estimates (factor loadings) are very high in the standardized loadings, their standard errors to be low and their critical ratio to be real, strong evidence of their strong statistical significance. The R^2 range from 0.575-0.871 indicating good correlation of the items to the construct. Therefore, we may retain the 7 observed indicators for construct validity and instrument evaluation.

Table 4: Seven questions that provide input to PU observed variable: Summary of Statistics for Best Model Fit

ITEM-Perceived Usefulness α=0.958, N=69	Label	Mode	CFA Statistics					Retain/ Delete after CFA
			Standardized Regression Weights (>0.65)	Standard Errors	Critical Ratio (≥±1.96)	p-value	R^2	
Using an intelligent agent (tutor) would enable me to accomplish tasks more quickly.	PU1	Agree	**0.923**	0.077	12.594	***	0.852	**Retain**
Using an intelligent agent (tutor) would improve my job performance.	PU2	Agree	**0.904**	0.069	11.96	***	0.817	**Retain**
Using an intelligent agent (tutor) would increase my productivity.	PU3	Agree	**0.899**			-	0.809	**Retain**
Using an intelligent agent (tutor) would enhances my effectiveness on the job.	PU4	Agree	**0.915**	0.069	12.292	***	0.837	**Retain**
Using an intelligent agent (tutor) would make it easier to do my job.	PU5	Agree	**0.87**	0.082	10.878	***	0.756	**Retain**
Overall, I would find the intelligent agent (tutor) system useful in my job.	PU6	Agree	**0.934**	0.09	10.382	***	0.871	**Retain**
Over the last 12 months, I would find using an intelligent agent (tutor) to be useful in my job.	PU7	Agree	**0.758**	0.109	8.25	***	0.575	**Retain**

*** indicated significance smaller than .001, *Statistically significant at <.05, Scale: 1-7 (Extremely Disagree, Disagree, Slightly Disagree, Neither, Slightly Agree, Agree, Extremely Agree)

Perceived Usefulness is an exogenous variable in the TAM model and in the hypothesized model. Indication of PU of the ITS is represented by responses to the 7 questions listed in Table 4. Responses utilize a 7-level measurement scale that indicate level of agreement from Extremely Disagree to Extremely Agree. The frequency data are favored toward agreement on the perceived usefulness of the ITS for all seven indicators (Table 42) with the Mode as Agree. The Cronbach alpha shows excellent reliability among the 7 observed variables at an α=0.958 (Table 44).

Measurement models for PU had 3 variations: generic (Figure 19), modified (Figure 20) and revised (Figure 21). The modified model has one covariance link between d3-d6. The revised measurement model has 2 covariance links (covariance links between d3-d6 and d1-d4) and shows the best model fit statistics when comparing the Chi-squared, likelihood ratio, NFI, CFI, RMSEA, GFI and AGFI (Table 5).

Table 5: Goodness of Fit Statistics for Generic, Modified and Revised Models-Perceived Usefulness

Model Fit	Statistical Range	Generic Model (Figure 19)	Modified Model (Figure20)	Revised Model (Figure 21)
Sample Size	-	69	69	69
Sample Moments	-	28	28	28
Distinct Parameters	-	14	15	16
Degrees of Freedom (df)	-	14	13	12
Chi Squared χ^2	Approximates the df	51.85	31.926	21.386
Probability	≥ 0.05	*0.000*	*0.002*	*0.045*
Likelihood ratio CMIN/DF	1< CMIN/DF <3 Closer to 1 but not to exceed 3	*3.656*	**2.456**	**1.782**
Normed Fit Index NFI	NFI ≥ 0.95	*0.910*	*0.944*	**0.962**
Comparative Fit Index CFI	CFI ≥ 0.95	0.932	**0.965**	**0.983**
RMSEA-Root Mean Square Residual	RMSEA < 0.05 Should not exceed 0.1	*0.198*	*0.146*	*0.107*
Goodness of fit Index GFI	0.80 < GFI < 1	**0.845**	**0.893**	**0.919**
AGFI	0.80 < AGFI < 1	*0.690*	*0.769*	**0.812**

Values that fail the standard are in italics. Values that pass are in BOLD.

The generic model is recursive with a sample size of 69. In the generic model there were 15 variables in the model: the fore mentioned 7 observed variables (PU1-PU7) and 8 unobserved variables (d1-d7, PU). The modified model is also recursive with a sample size of 69. It has 15 variables in the model, the 7 observed and 8 unobserved. The revised model is recursive with a sample size of 69. There are 15 variables in the model; the 7 observed and 8 unobserved.

Figure 19 below depicts the generic measurement model for perceived usefulness. It is composed of 28 distinct sample moments and 14 distinct parameters to be estimated, the difference of which yields 14 degrees of freedom (df). The Chi-squared (χ^2) value is 51.85 and the probability level is 0.000 suggesting that the fit of the model is not entirely adequate (B. Byrne, 2016). When we compare the three models a decrease in Chi-square given an equal number of degrees of freedom will indicate a better fit (Table 5).

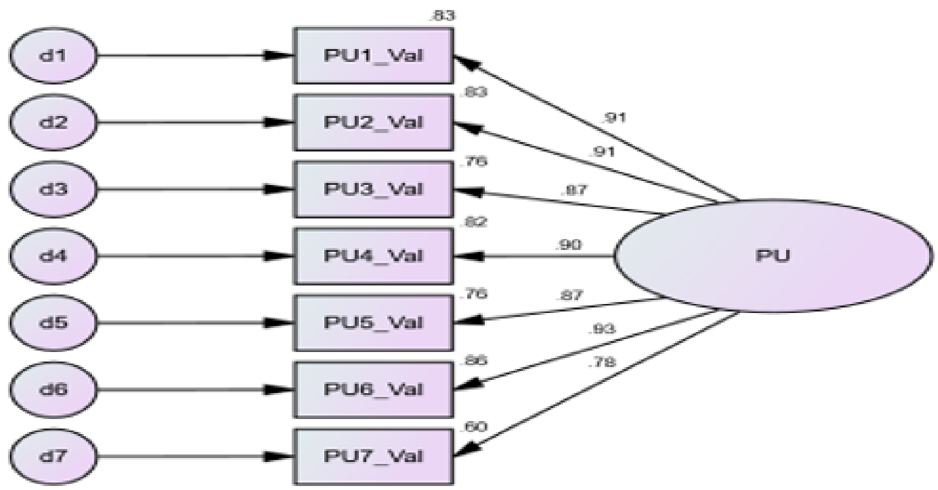


Figure 19: Perceived Usefulness (PU) Generic Model

Most importantly, examination of the regression weights (i.e. factor loadings) reveal the estimates to be reasonable, their standard errors to be low and their critical ratio to be real, strong evidence of their strong statistical significance (Table 45). Our sample size is N=69, thus our sufficient factor loading should be greater than 0.65 to show good correlation. In the PU CFA, each factor loading is >0.7, which demonstrates good convergent validity.

The Likelihood ratio CMIN/df (χ^2/df) is equal to 3.656. Evaluating the fit based on Likelihood ratio indicates that the closer the value is to 1 and not exceeding 3 the better the fit of the model (B. Byrne, 2016). The high value indicates the fit of the data is not adequate.

RMSEA values of 0.05 or less are considered a close fit, RMSEA values should not be greater than 0.1. In the model, the RMSEA is slightly greater at 0.198. Normed Fit Index (NFI) and Comparative Fit Index (CFI), values of >.95 are considered representative of a well-fitted model. The NFI (.910) and CFI (.932) are both slightly below the value (B. Byrne, 2016). The Goodness of fit Index (GFI) and the AGFI are both indices that with values close to 1.00 indicate a good fit (Table 5). These two indices are influenced by sample size (B. Byrne, 2016). The GFI is .845 and the AGFI is .690. Examining the modification indices (M.I.), we included a correlated link between d3 and d6 for the modified model as this had the greatest M.I. value and parameter change value. Correlated links are used to reduce the variance in the model and improve impact of one item loading on another (B. M. Byrne, 2016). The recommendation for a correlated link may be a result of randomness or the result of some relationship between the two observed indicators.

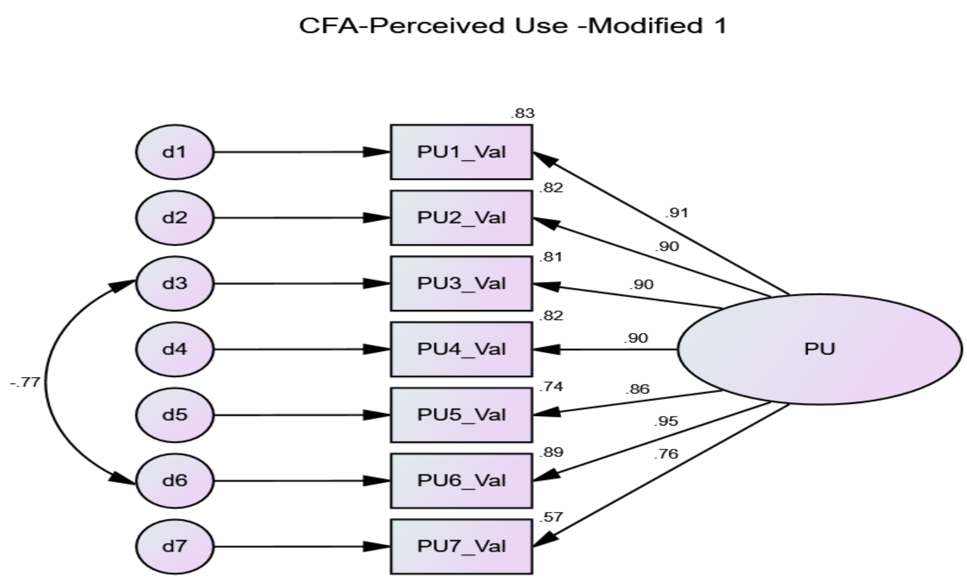


Figure 20: Perceived Usefulness (PU) Modified Model

Figure 20 shows the modified model for PU. The model is recursive with a sample size of 69. It is composed of 28 distinct sample moments and 15 distinct parameters to be estimated, the difference of which yields 13 degrees of freedom (df). The Chi-squared (χ^2) value is 31.926 and the probability level is 0.002 suggesting that the fit of the model is not entirely adequate. Review of the Goodness of Fit Statistics shows improvement. The Likelihood ratio CMIN/df (χ^2/df) is equal to 2.456. RMSEA is 0.146 which is improved but does not show a close fit. Normed Fit Index (NFI) and Comparative Fit Index (CFI), values of >.95 are considered representative of a well-fitted model. The NFI (.944) and CFI (.965) are both improved as well but the NFI is slightly below the >.95 value that we are seeking (B. Byrne, 2016). The GFI is .893 and the AGFI is .769 which also show improvement in the model fit. Examining the modification indices, we included another correlated link between d1 and d4 for the revised model as these had the highest MI and parameter change values.

Figure 21 shows the revised model for PU. This model shows the best fit when compared between the generic and modified models on evaluation of their Goodness of Fit Statistics. The model is recursive with a sample size of 69. It is composed of 28 distinct sample moments and 16 distinct parameters to be estimated, the difference of which yields 12 degrees of freedom (df). The Chi-squared (χ^2) value is 21.386 and the probability level is 0.045 suggesting that the fit of the model is not entirely adequate but improved when compared to the generic and modified models. The Likelihood ratio CMIN/df (χ^2/df) is equal to 1.782. RMSEA is 0.107 which is improved but does not show a close fit. Normed Fit Index (NFI) and Comparative Fit Index (CFI), values of >.95 are considered representative of a well-fitted model. The NFI (.962) and CFI (.983) are both improved (B. Byrne, 2016). The GFI is .919 and the AGFI is .812 which also show improvement in the model fit. Based on the goodness of fit statistics, the RMSEA interprets the model as poor fit, the CFI and NFI as well-fitted and the GFI and AGFI as weak. Therefore, the revised model is interpreted as a weak fitted model.

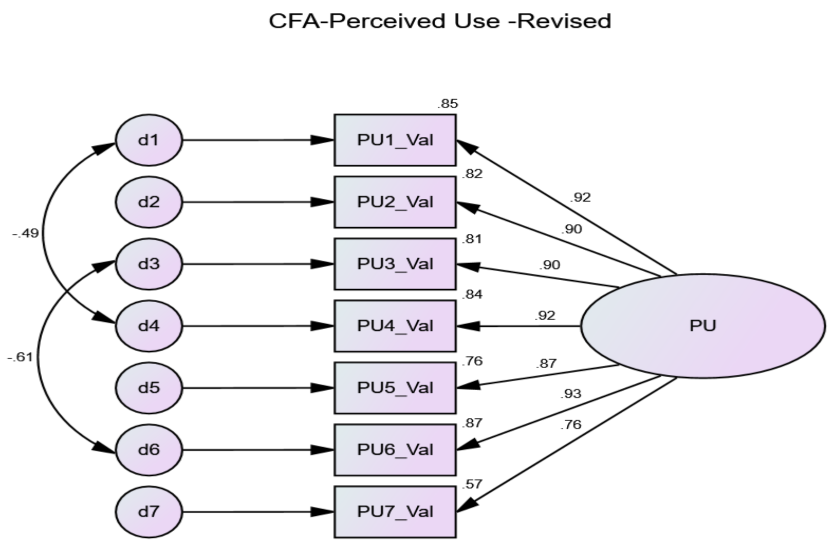


Figure 21: Perceived Usefulness (PU) Revised Model

A table with the revised fit model's regression weights is shown below (Table 6). This data reveals that the estimates (factor loadings) are very high in the standardized loadings, their standard errors to be low and their critical ratio to be real, strong evidence of their strong statistical significance. The regression weights of the generic and modified models are within the appendices but they too show estimates high in the standardized loadings, their standard errors to be low and their critical ratio to be real, which is strong evidence of their strong statistical significance.

Table 6: Regression Weights-PU Revised Model

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
PU1	.923	.970	.077	12.594	***
PU2	.904	.826	.069	11.960	***
PU3	.899	1.000			
PU4	.915	.847	.069	12.292	***
PU5	.870	.888	.082	10.878	***
PU6	.934	.932	.090	10.382	***
PU7	.758	.899	.109	8.250	***
Covariance d6-d3	-.608	-.143	.037	-3.856	***
Covariance d4-d1	-.488	-.099	.031	-3.216	.001

*** indicated significance smaller than .001
*Statistically significant at <.05

We have drawn and interpreted each measurement model and now we compare the three models to evaluate which has a decrease in Chi-square given an equal number of degrees of freedom to indicate a better fit. Reviewing the Chi-square values, we note that the Revised model has a better fit when compared to the Generic or Modified Model, but the degrees of freedom are not equal. Comparison of the other fit measures also conclude that the Revised model has a better fit. Thus, the Revise Model shows that the 7 observed indicators do represent the Perceived Usefulness construct strongly and that there may be some correlation between PU6 and PU3 and PU4 and PU1. Therefore, we may retain the 7 observed indicators for construct validity and instrument evaluation (Table 4).

Summary of CFA for constructs including PU and PEOU to AU found at Appendix Q

CFA's for PU through AU were conducted, and each indictor was evaluated for retention or deletion for the SEM analysis of TAM, HBM and the conceptual TAM/HBM models. The indicators retained were consolidated in the SEM analysis. In general, the generic models are drawn with no covariance links, modified models have a least 1 covariance link and revised have

2 or more covariance links. Correlated links are used to reduce the variance in the model and improve impact of one item loading on another and are determined by the modification indices recommendations that AMOS calculates (B. M. Byrne, 2016). Modification indices are not able to be calculated in AMOS when there are missing values in the dataset. The recommendation for a correlated link may be a result of randomness or the result of some relationship between the two observed indicators. Summary of our analysis for the 11 constructs represented by 22 indicators are presented in Table 7 & Table 8. The "CFA Best Fit" column identifies the model for each construct with the interpretation of the model fit (i.e. Weak, Moderate, Strong) based on 6 Goodness of Fit Statistics and their interpretation (i.e. poor, weak, well, strong).

Table 7: Summary of CFA for TAM Constructs

Construct	CFA Best Fit (Weak, Moderate, Strong)	Fit Indices (Poor, Weak, Well, Strong, N/A=not calculated)	Indicators Retained (Consolidated for SEM)	Indicators Deleted	Reference
Perceived Usefulness (PU)	Revised Model Moderate Fit	RMSEA=poor $\chi2$/df= well NFI=well CFI=well GFI=well AGFI=well	PU1 PU2 PU3 PU4 PU5 PU6 PU7		Table 5
Perceived Ease of Use (PEOU)	Revised Model Strong Fit	RMSEA=strong $\chi2$/df=strong NFI=strong CFI=strong GFI=strong AGFI=strong	PEOU1 PEOU2 PEOU3 PEOU5 PEOU6	PEOU4 PEOU7	Table 53
Intention to Use (IU)	Revised Model Moderate Fit	RMSEA=poor $\chi2$/df= well NFI=strong CFI=strong GFI=strong AGFI=well	IU1 IU2 IU3 IU4 IU5		Table 66
Attitude (ATT)	Generic Model Identified Model	RMSEA=poor $\chi2$/df=N/A NFI=N/A CFI=N/A GFI=N/A AGFI=N/A	ATT1 ATT2 ATT3		Table 79

Table 8: Summary of CFA for HBM Constructs

Construct	CFA Best Fit (Weak, Moderate, Strong)	Fit Indices (Poor, Weak, Well, Strong N/A=not calculated)	Indicators Retained (Consolidated for SEM)	Indicators Deleted	Reference
Perceived Susceptibility (PS)	Modified Model Moderate Fit	RMSEA=well χ2/df=poor NFI=strong CFI=strong GFI=strong AGFI=strong	PS2 PS3 PS5	PS1 PS4	Table 87
Perceived Severity (PSV)	Modified Model Moderate Fit	RMSEA=weak χ2/df=well NFI=well CFI=strong GFI=strong AGFI=well	PSV3 PSV4 PSV5	PSV1 PSV2	Table 99
Perceived Threat (PT)	Revised Model Weak Fit	RMSEA=weak χ2/df=well NFI=poor CFI=weak GFI=well AGFI=well	PT3 PT4 PT5 PT6	PT1 PT2 PT7 PT8	Table 112
Perceived Benefits (PB)	Revised Model Weak Fit	RMSEA=N/A χ2/df=poor NFI=strong CFI=N/A GFI=strong AGFI=strong	PB4 PB5 PB6	PB1 PB2 PB3	Table 128
Cues to Action (CA)	Generic Model Moderate Fit	RMSEA=weak χ2/df= weak NFI=strong CFI=strong GFI=N/A AGFI=N/A	CA1 CA2 CA3 CA4		Table 143
Motivations (M)	Modified Model Weak Fit	RMSEA=N/A χ2/df= poor NFI=well CFI=N/A GFI=N/A AGFI=N/A	M4 M5 M6	M1 M2 M3	Table 154
Actual Use (AU)	Modified Model Weak Fit	RMSEA=poor χ2/df= well NFI=strong CFI=strong GFI=N/A AGFI=N/A	AU1 AU2 AU3 AU4		Table 167

We utilize the individual CFA's from each construct to assist in drawing our measurement models to conduct our CFA's for TAM and HBM.

Measurement model for TAM

The Cronbach alpha shows excellent reliability among the 22 indicators at an α=0.951 (Table 177).

The model is recursive with a sample size of 69. Measurement models for TAM had 3 variations: generic (Figure 129), modified (Figure 130) and revised (Figure 22). The generic model contains 48 variables: 22 observed variables (PU1-PU7, ATT1-ATT3, PEOU1-PEOU7, IU1-IU4) and 26 unobserved variables (d1-22, PU, PEOU, ATT, IU). The modified model contains covariance links between d4-d1, d6-d3, d11-d9, d20-d18 and d21-d22. The revised model removed PEOU7 and contains 8 additional covariances d20-d22, d19-d21, d18-d21, d9-d10, d9-d13, d1-d5, d2-d7 and d3-d7. The model contains 46 variables: 21 observed variables and 25 unobserved variables. Review of modification indices only showed covariances between error terms not on the same factor. Removal of PEOU4 does increase the NFI and GFI by .010 but it increases the RMSEA to .090, so it was not removed in the aggregated dataset for SEM analysis (Table 9).

Table 9: Goodness of Fit Statistics for Generic, Modified and Revised Models for TAM

Model Fit	Statistical Range	Generic Model (Figure 129)	Modified Model (Figure 130)	Revised Model 2 (Figure 22)
Sample Size	-	69	69	69
Sample Moments	-	253	253	231
Distinct Parameters	-	50	55	61
Degrees of Freedom (df)	-	203	198	170
Chi Squared χ^2	Approximates the df	397.947	336.331	241.190
Probability	≥ 0.05	*.000*	*.000*	*.000*
Likelihood ratio CMIN/DF	1< CMIN/DF <3 Closer to 1 but not to exceed 3	**1.960**	**1.699**	**1.419**
Normed Fit Index NFI	NFI > 0.95	*.769*	*.805*	*.854*
Comparative Fit Index CFI	CFI > 0.95	*.870*	*.907*	**.951**
RMSEA-Root Mean Square Residual	RMSEA < 0.05 Should not exceed 0.1	*.119*	*.101*	**.078**
Goodness of fit Index GFI	0.80 < GFI < 1	*.666*	*.703*	*.764*
AGFI	0.80 < AGFI < 1	*.583*	*.621*	*.680*

Values that fail the standard are in italics. Values that pass are in BOLD.

The correlations and standard regression weights were inputted into an online stats tool for CFA's which determined that the revised model had no validity concerns (Table 10).

Table 10: Validity Analysis for TAM Revised Model

	CR	AVE	MSV	MaxR(H)	PU	PEOU	IU	ATT
PU	0.956	0.785	0.684	0.964	**0.886**			
PEOU	0.888	0.580	0.213	0.926				
IU	0.928	0.722	0.691	0.935	0.772	0.462		
ATT	0.910	0.771	0.691	0.919	0.827	0.423	0.831	

This factor loading data reveals that the estimates (factor loadings) are very high in the standardized loadings, their standard errors to be low and their critical ratio to be real, strong evidence of their strong statistical significance. PEOU4 has the lowest factor loading at .445 but all others are above .70 which indicates good correlation and good convergent validity for a sample size of N=69 (Table 11).

Table 11: Regression Weights of TAM Revised Model

Indicators	Squared Multiple Correlations	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value	Retain Delete SEM
PU1	.818	.904	.948	.078	12.148	***	**Retain**
PU2	.812	.901	.820	.068	12.040	***	**Retain**
PU3	.822	.907	1.000				**Retain**
PU4	.817	.904	.833	.069	12.129	***	**Retain**
PU5	.723	.850	.865	.083	10.465	***	**Retain**
PU6	.902	.950	.944	.089	10.587	***	**Retain**
PU7	.633	.796	.938	.122	7.690	***	**Retain**
PEOU1	.504	.710	.598	.111	5.401	***	**Retain**
PEOU2	.530	.728	1.000				**Retain**
PEOU3	.780	.883	.859	.113	7.569	***	**Retain**
PEOU4	.198	.445	.724	.187	3.871	***	*Delete*
PEOU5	.634	.796	.815	.136	5.970	***	**Retain**
PEOU6	.832	.912	.848	.139	6.101	***	**Retain**
ATT1	.739	.860	.780	.074	10.588	***	**Retain**
ATT2	.857	.926	1.000				**Retain**
ATT3	.716	.846	.981	.096	10.217	***	**Retain**
IU1	.730	.855	.921	.125	7.379	***	**Retain**
IU2	.773	.879	1.018	.102	10.025	***	**Retain**
IU3	.826	.909	1.049	.130	8.059	***	**Retain**
IU4	.609	.781	1.000				**Retain**
IU5	.669	.818	1.083	.111	9.763	***	**Retain**

*** indicated significance smaller than .001
*Statistically significant at <.05

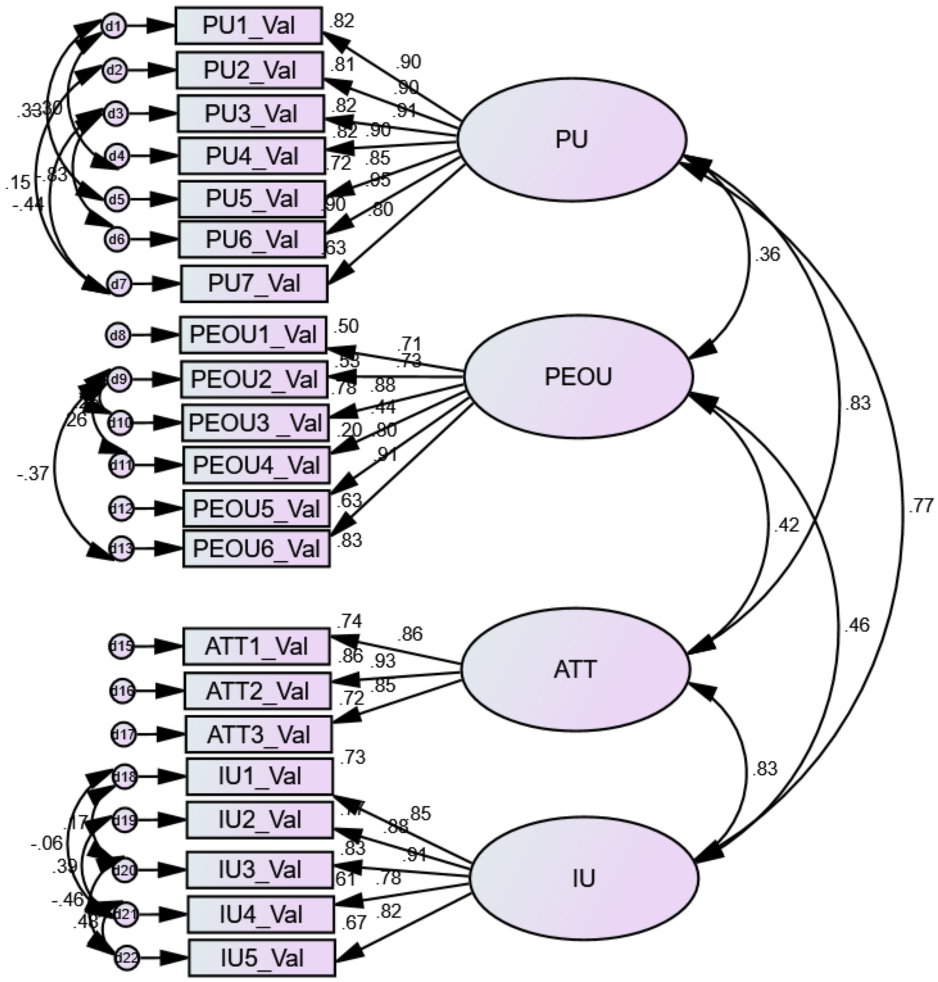


Figure 22: TAM Revised Measurement Model

Measurement model for HBM

The Cronbach alpha shows good reliability among the 21 indicators at an α=0.782 (Table 180).

The model is recursive with a sample size of 69. Measurement models for HBM had 2 variations: generic and modified (Figure 23). The generic model contains 48 variables; 21 observed variables (PS2, PS3,PS5, PSV3, PSV4, PSV5, PT3, PT4, PT5, PT6, PT8, PB4-PB6, M4-M6, CA1-CA4) and 27 unobserved variables (e2, 3,5,e8-e10, e13-16, e18, e22-e28, e32-e34, PS, PSV, PT, PB, M, CA). The modified model removed PT8 and contains covariance links between e9-e8 and e26-e25. There are 46 variables in the model: 20 observed variables and 26 unobserved variables.

Table 12: Goodness of Fit Statistics for Generic and Modified Models for HBM

Model Fit	**Statistical Range**	**HBM Measurement Model (**Figure 23**)**	**Modifications added-Remove PT8**
Sample Size	-	69	69
Sample Moments	-	252	230
Distinct Parameters	-	80	77
Degrees of Freedom (df)	-	172	153
Chi Squared χ^2	Approximates the df	272.718	225.211
Probability	≥ 0.05	*.000*	*.000*
Likelihood ratio CMIN/DF	1< CMIN/DF <3 Closer to 1 but not to exceed 3	**1.586**	**1.472**
Normed Fit Index NFI	NFI > 0.95	*.687*	*.727*
Comparative Fit Index CFI	CFI > 0.95	*.843*	*.882*
RMSEA-Root Mean Square Residual	RMSEA < 0.05 Should not exceed 0.1	*.093*	*.083*

Values that fail the standard are in italics. Values that pass are in BOLD.

The correlations and standard regression weights were inputted into an online stats tool for CFA's which determined that the modified model had validity concerns with convergent validity on PT as the AVE was less than 0.50 which indicates that PT does not have high correlation from its observed variables (Table 13). Review of the loadings and of PT3, 4, 5, 6 and PT3, 4,6 have similar loadings.

Table 13: Validity Analysis for HBM Modified Model

	CR	AVE	MSV	MaxR (H)	PT	CA	M	PS	PSV	PB
PT	0.745	0.434	0.023	0.834	**0.659**					
CA	0.843	0.583	0.147	0.887	0.020	**0.763**				
M	0.878	0.713	0.225	0.937	-0.152					
PS	0.831	0.713	0.338	0.878	-0.142	-0.056	0.474			
PSV	0.880	0.711	0.338	0.913	-0.073	0.103	0.367	0.581		
PB	0.730	0.505	0.147	0.837	0.142	0.384	0.048	0.126	0.113	

This factor loading data reveals that the estimates (factor loadings) are very high in the standardized loadings, their standard errors to be low and their critical ratio to be real, strong evidence of their strong statistical significance for indicators PS2-PS5, PSV3-PSV5, PB5-PB6, M4, M6, CA2-CA4, and PT5. PB4, PT3, PT6, PT4, CA1 and M5 have the lowest factor loadings from .323 to .621 indicating weaker statistical significance and aligns with PT demonstrating unsatisfactory convergent validity (Table 14).

Table 14: Regression Weights-HBM Measurement Model-Modified Model

Indicators	Squared Multiple Correlations	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value	Retain or Delete for SEM
PS5	.567	.753	1.001	.140	7.131	***	**Retain**
PS3	.573	.757	.849	.118	7.184	***	**Retain**
PS2	.855	.924	1.000				**Retain**
PSV5	.875	.936	1.000				**Retain**
PSV4	.667	.817	.863	.129	6.692	***	**Retain**
PSV3	.590	.768	.729	.117	6.251	***	**Retain**
PT4	.358	.598	.732	.208	3.513	***	**Retain**
PT3	.274	.523	1.000				**Retain**
PT6	.323	.568	.986	.290	3.402	***	**Retain**
PB4	.104	.323	.679	.277	2.452	.014	**Retain**
PB5	.652	.808	1.000				**Retain**
PB6	.758	.871	1.020	.232	4.393	***	**Retain**
M4	.871	.933	.901	.085	10.561	***	**Retain**
M5	.386	.621	.587	.101	5.796	***	**Retain**
CA3	.666	.816	1.000				**Retain**
CA4	.616	.785	.802	.116	6.939	***	**Retain**
CA1	.251	.501	.703	.187	3.763	***	**Retain**
M6	.881	.939	1.000				**Retain**
CA2	.797	.893	.963	.128	7.501	***	**Retain**
PT5	.783	.885	.938	.252	3.726	***	**Retain**

*** indicated significance smaller than .001

*Statistically significant at <.05

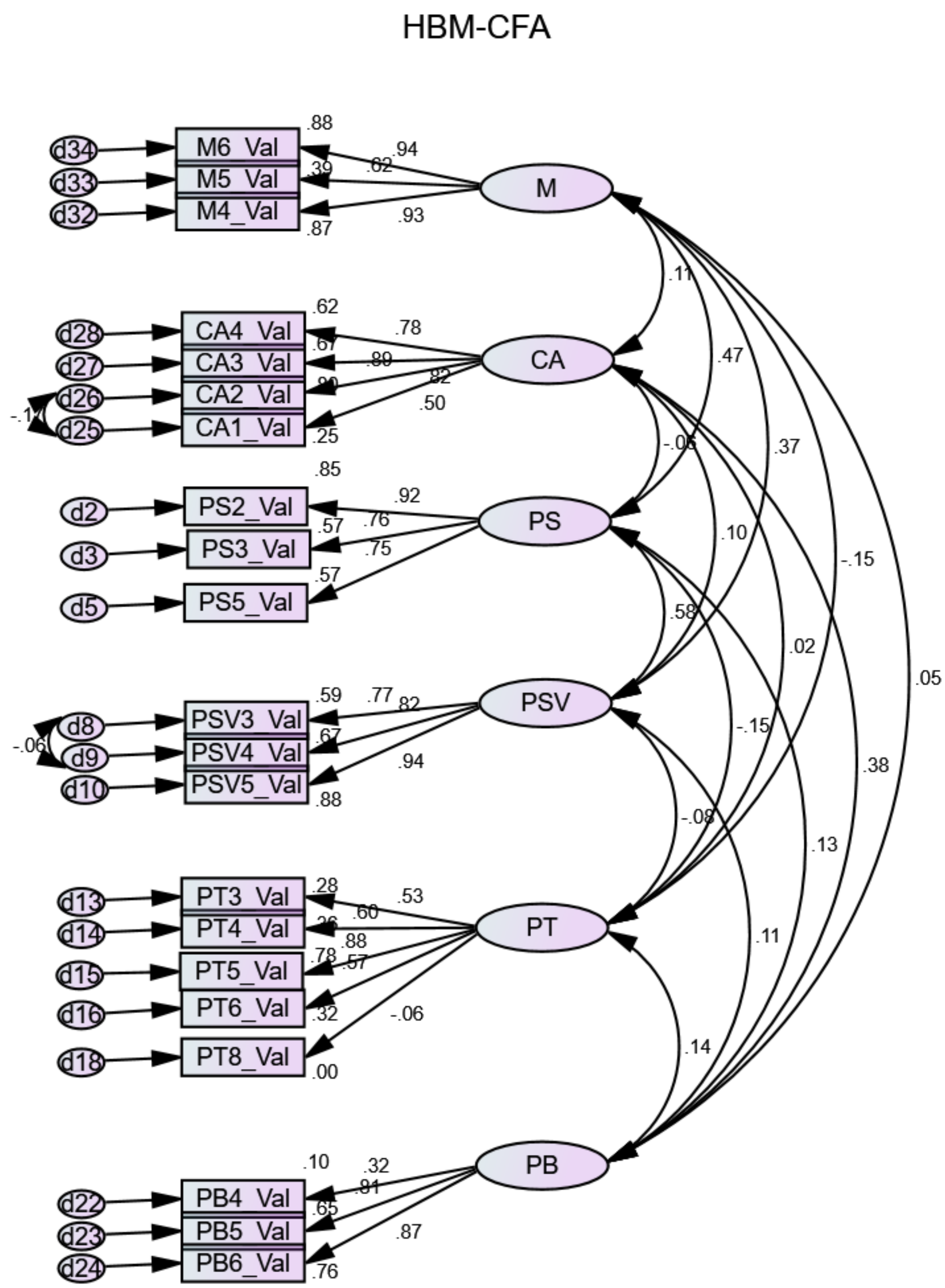


Figure 23: HBM Modified Measurement Model

Structural Equation Modeling

We used CFA to evaluate the relationship between our observed variables and their underlying latent (observed) constructs. CFA allowed us to determine whether the structure provides a good fit and to understand if there is a relationship between the observed variables. If the factor loadings for each latent variable were very high in the standardized loadings, their standard errors to be low and their critical ratio to be real, we could tentatively retain our indicators for each latent construct as we move into SEM. We used our CFA to determine which items to consolidate for the SEM analysis to conduct the 4-factor analysis for TAM and 6 factor analysis for HBM.

Formative models represent the construct and are used to determine cause. For modeling fitting we put in multiple reflective indicators to show the theorized model. Error values are added to each endogenous variable. The indicators are consolidated into 1 item by taking an average of the items. On the output parameters we select the standardized residuals covariances.

The consolidated items were Motivation (M4, M5, M6), Cues to Action (CA1, CA2, CA3, CA4), Perceived Susceptibility (PS2, PS3, PS5), Perceived Severity (PSV3, PSV4, PSV5), Perceived Threat (PT3, PT4, PT5, PT6), Perceived Benefits (PB4, PB5, PB6), Perceived Usefulness (PU1, PU2, PU3, PU4, PU5, PU6, PU7), Perceived Ease of Use (PEOU1, PEOU2, PEOU3, PEOU5, PEOU6), Intention to Use (IU1, IU2, IU3, IU4, IU5), and Attitude (ATT1, ATT2, ATT3).

SEM Model for TAM

Table 15: Goodness of Fit Statistics for Generic and Modified TAM SEM

Model Fit	**Statistical Range**	**Generic Model** (Figure 24**)**	**Modified Model (**Figure 132**)**
Sample Size	-	69	69
Sample Moments	-	15	10
Distinct Parameters	-	14	9
Degrees of Freedom (df)	-	1	1
Chi Squared χ^2	Approximates the df	9.996	9.996
Probability	≥ 0.05	*.002*	*.002*
Likelihood ratio CMIN/DF	1< CMIN/DF <3 Closer to 1 but not to exceed 3	*9.996*	*9.996*
Normed Fit Index NFI	NFI ≥ 0.95	**.954**	*.933*
Comparative Fit Index CFI	CFI ≥ 0.95	.957	*.937*
RMSEA-Root Mean Square Residual	RMSEA < 0.05 Should not exceed 0.1	*.364*	*.364*
Goodness of fit Index GFI	0.80 < GFI < 1	**.948**	**.936**
AGFI	0.80 < AGFI < 1	*.222*	*.360*

Values that fail the standard are in italics. Values that pass are in BOLD.

The model is recursive with a sample size of 69. There are two models for TAM; the generic (Figure 24) and modified (Figure 132). There are 6 variables in the generic model; 4 observed exogenous variables and 1 observed endogenous variable and 1 unobserved exogenous variable. There are 5 covariance links between IU-ATT, PU-ATT, PU-IU, IU-PEOU and PU-PEOU. The modified model contains 5 variables; 3 observed exogenous variables, 1 observed endogenous variable and 1 unobserved exogenous variable. There are 2 covariance links between PU-PEOU and PU-ATT. The model fit statistics show that both these models have a RMSEA of .364 and a CMIN/df at 9.996 which indicates the model is not a close fit. Review of the R^2=.594 and R^2=.592 also indicative that the model is weak fit (Table 15).

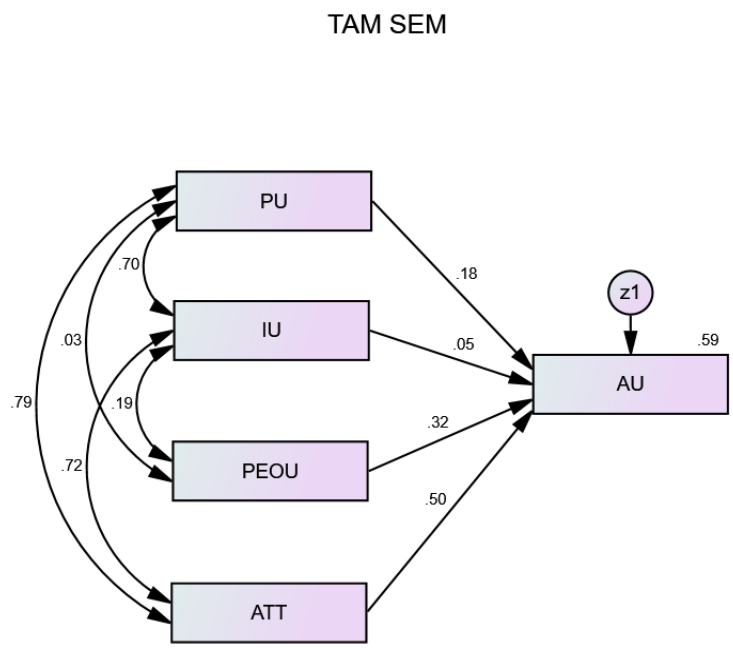


Figure 24: Generic SEM Model of TAM

A review of the unstandardized regression weights critical ratio (≥±1.96) and p-value show that the PEOU and ATT are the only significant factor in both models (Table 186).

SEM Model for HBM

Table 16: Goodness of Fit Statistics for Generic, Modified and Revised HBM SEM

Model Fit	Statistical Range	Generic Model (Figure 25	Modified Model (Figure 134)	Revised Model (Figure 135)
Sample Size	-	69	69	69
Sample Moments	-	28	21	10
Distinct Parameters	-	17	13	9
Degrees of Freedom (df)	-	11	8	1
Chi Squared χ^2	Approximates the df	8.676	7.838	.803
Probability	≥ 0.05	**.652**	**.449**	**.370**
Likelihood ratio CMIN/DF	1< CMIN/DF <3 Closer to 1 but not to exceed 3	*.798*	*.980*	*.803*
Normed Fit Index NFI	NFI ≥ 0.95	*.904*	*.868*	**.982**
Comparative Fit Index CFI	CFI ≥ 0.95	1.000	1.000	1.000
RMSEA-Root Mean Square Residual	RMSEA < 0.05 Should not exceed 0.1	.000	.000	.000
Goodness of fit Index GFI	0.80 < GFI < 1	**.969**	**.968**	**.994**
AGFI	0.80 < AGFI < 1	**.921**	**.916**	**.942**

Values that fail the standard are in italics. Values that pass are in BOLD.

The model is recursive with a sample size of 69. There are 3 versions of models for HBM; generic (Figure 25), modified (Figure 134) and revised (Figure 135). The generic model contains 8 variables; 6 observed exogenous variables, 1 observed endogenous variable and 1 unobserved exogenous variable. There are 4 covariance links between PSV-PS, PB-CA, PS-M, and PSV-M. The modified model reduced PS as the covariance link between PSV-PS was .825

showing high collinearity. The modified model contains 7 variables; 5 observed exogenous variables, 1 observed endogenous variable and 1 observed exogenous variable. There are 2 covariance links between PB-CA and M-PSV. The revised model reduced M and PT from the modified model so that is contains 5 variables; 3 observed exogenous variable, 1 observed endogenous variable and 1 unobserved exogenous variable. There are 2 covariance links between PB-CA and CA-PSV. The R^2 values for each of the models is approximately .33, which indicates the models are very weak fits (Table 190).

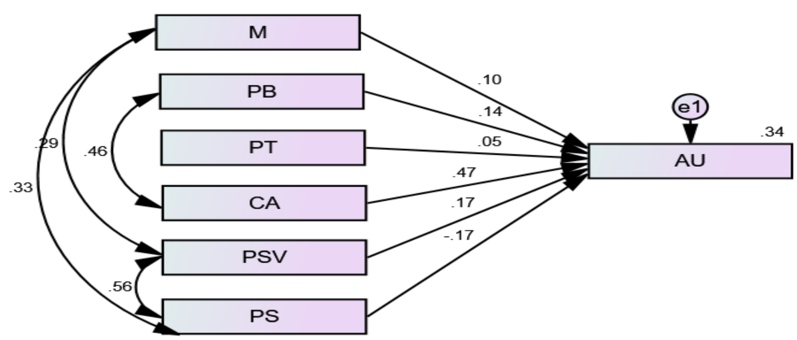


Figure 25: Generic SEM Model for HBM

A review of the unstandardized regression weights critical ratio (≥±1.96) and p-value show that the CA is the only significant factor in all 3 models (Table 189).

SEM Model for Hypothesized Model

The hypothesized model is an integrated model of TAM and HBM. Our initial hypothesized model contained 5 exogenous variables (PB, PS, PT, PU and PEOU), 2 endogenous variables (IU and AU), with IU serving as a mediating construct. However, our analysis processes required that we change the hypothesized model to contain 8 variables; 6 exogenous variables (ATT, PEOU, PU, PB, CA and PSV), 1 observed endogenous variable (AU) and 1 unobserved exogenous variable (z1). The modified model of the hypothesized model contains 5 covariance links ATT-PU, ATT-PEOU, ATT-CA, PU-CA, PB-CA. The RMSEA on the modified model is .147 which indicate not a close fit, but all other model statistics indicate a moderate fit which is supported by the R^2=.626 (Table 17).

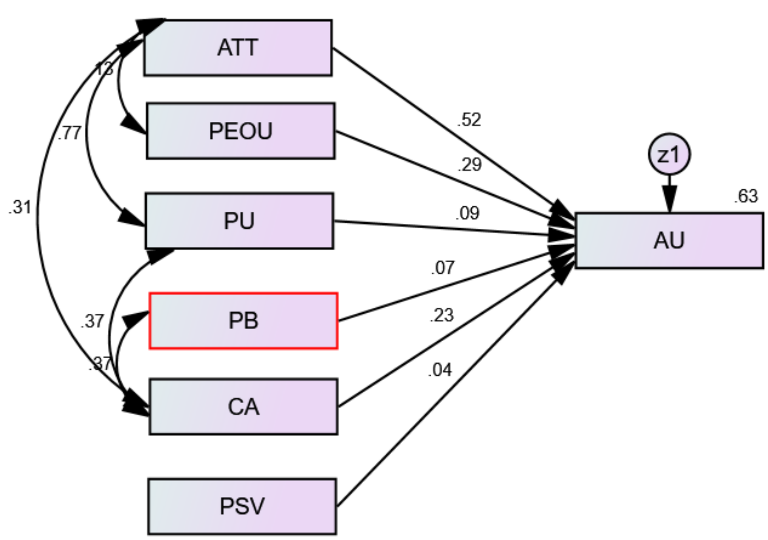


Figure 26: Modified SEM Model for Hypothesized TAM/HBM

The best fit models from the TAM, HBM and TAM/HBM models were evaluated based on their Goodness of Fit Statistics and the R^2 values which are contained in Table 17 below. Although causal sequence cannot be determined, we do see that the hypothesized model which combines TAM and HBM constructs does have the best RMSEA value and the highest R^2 value. These results may demonstrate that our theory of combining constructs from both TAM and HBM are worth further in-depth study.

Table 17: Goodness of Fit Statistics for Modified TAM/HBM, Modified TAM and Revised HBM SEM Models

Model Fit	**Statistical Range**	**Modified Model TAM/HBM** (Figure 26)	**Modified Model TAM** (Figure 132)	**Revised Model HBM** (Figure 135)
Sample Size	-	69	69	69
Sample Moments	-	28	10	10
Distinct Parameters	-	18	9	9
Degrees of Freedom (df)	-	10	1	1
Chi Squared χ^2	Approximates the df	24.687	9.996	.803
Probability	≥ 0.05	*.006*	*.002*	**.370**
Likelihood ratio CMIN/DF	1< CMIN/DF <3 Closer to 1 but not to exceed 3	**2.469**	*9.996*	*.803*
Normed Fit Index NFI	NFI > 0.95	*.879*	*.933*	**.982**
Comparative Fit Index CFI	CFI > 0.95	*.920*	*.937*	1.000
RMSEA-Root Mean Square Residual	RMSEA < 0.05 Should not exceed 0.1	*.147*	*.364*	.000
Goodness of fit Index GFI	0.80 < GFI < 1	**.903**	**.936**	**.994**
AGFI	0.80 < AGFI < 1	**.746**	**.360**	**.942**
R^2		**0.626**	0.594	0.33

Values that fail the standard are in italics. Values that pass are in BOLD.

Cohort Study Data Analysis

The 69-participant cohort in the cross-sectional study design of the larger study provided a complete dataset for additional analysis and were used to address hypothesis H_4 through H_8. We anticipated that since there is no formula for computing the required sample size for volunteer-based sampling, the traditional N=30 should suffice (Ritter & Sue, 2007). We also noted that, Bujang and Baharum (2016) indicate N=61 yields R0 = 0.0, R1 (alternative hypothesis) = 0.4 for correlation tests with a power of 90% and alpha of 0.05 (Cohen, 1992) indicates N=64 detects a mean difference medium effect size (.5 standard deviation) with a power of 80% and alpha of 0.05. The 69-person cohort coupled with a full standard deviation improvement exceed either recommendation. The 69-person cohort is also favorable considering other published ITS research using only 11 to 58 volunteers for analysis (Davidovic, Warren, & Trichina, 2003; Folsom-Kovarik, Schatz, & Nicholson, 2010; Mcquiggan, Mott, & Lester, 2008).

The techniques that were used to analysis the cohort data included frequency, graphical display, and Wilcoxon signed-rank tests. We also looked at the effectiveness of intelligent tutoring systems and calculated a standard deviation to understand learning gains. We calculated this with Cohen's d and with a Hake's mean gain. Data for the 69-Participant Cohort are contained in Appendix Q.

Learner Profile and Attributes

The 69-participant cohort that completed the course and the surveys in their entirety mean age is 43.7 years (range 24-69 years), they were 75% female (N=52) with experience in healthcare at a mean of 15.7 years (range 1-45 years). Age and years of experience in healthcare are the two continuous variables in the experiment. The Kolmogorov-Smirnov (Age: KS=.134

p=.004 Experience: KS: .150 p=.001) and Shapiro-Wilk tests (Age: SW=.938 p=.002 Experience: SW: .916 p=.000) for Normality both showed that the data was not normally distributed. Our study population profile mirrored the results of other public health workforce studies (Jones et al., 2015).

Sixty-eight (68%) of respondents (N=47) indicated they have experience dealing with febrile rash illness, while 32% (N=22) indicated they had no experience dealing with febrile rash illness (Table 204).

The survey contained 3 questions that asked about expertise with dealing with a patient with a febrile rash illness, expertise using and ITS and expertise in package and shipping specimens for febrile rash illness. The expertise question “How would you assess your expertise in dealing with a patient with febrile rash illness?”, respondents were evenly distributed in the novice (27.5% N=19), competent (27.5% N=19) and proficient (27.5% N=19). This was followed by a 13% (N=9) beginner and 4.3% (N=3) expert identification.

The expertise question, “How would you assess your expertise in using and intelligent tutoring system ITS?”, 65.2% (N=45) of respondents identified as novice and 21.7% (N=15) identified as beginner, 8.7% (N=6) identified as competent, 4.3% (N=3) as proficient, 0% as expert.

The expertise question, “How would you assess your expertise in packaging and shipping clinical specimens for febrile rash illness?”, 36.2% (N=25) identified as novice, 24.6% (N=17) as beginner, 27.5% (N=19) as competent, 8.7% (N=6) as proficient and 2.9% (N=2) as expert (Table 205).

The learner attribute survey also assessed the self-selected confidence that participants believed of themselves in areas of prior knowledge, grit and motivation (Table 207).

Comparative Analysis for Cohort (N=69)

In the comparative analysis, we ask participants if time would have been better spent on researching the content on the internet, talking with a knowledgeable mentor or taking a class with a discussion group rather than taking the course on the ITS platform. The ITS platform was significantly preferred over the 3 choices by 84.1%, 63.8% and 73.9% respectively (Table 206).

Knowledge and Application Based Assessment for Cohort (N=69)

The average test points for pretest was 6.8 points or 68%, the average for the post test was 8.7 points or 87% ($p<0.01$). The descriptive statistics show that there is an increase in scores from pre to post tests. The 25th percentiles saw an increase of 2 points, the 50th by 2 points and the 75th percentile by 2 points. The test statistics show that the ITS indeed demonstrates a statistically significant change in learning effectiveness ($Z=-6.05$, $p<0.01$) (Table 208). There was a 288% increase for respondent to receive all 10 points and a 150% increase for respondents to receive 9 points. 20% of respondents improved their post test scores by 2 points, 19% by 3 points, 17% by 1 point, 10% by 4 points, 4% by 5 points, 1% by 6 points, and 1% by 7 points. Seventeen 17% percent (N=12) of respondents did not show any increase or decrease in points when comparing their pretest to their post test scores. Seven percent 7% (N=5) of respondents showed a decrease of 1 point and 1% (N=1) a decrease of 2 points (Table 209).

In the knowledge application scenario, 75% (52/69) of respondents were able to demonstrate their ability to apply the knowledge gained (Table 209).

Our study reports an overall 1.00 standard deviation pre to post improvement for our 69-person cohort signifying significant learning effectiveness using an ITS.

Hake's mean gain = (mean post-test % – mean pre-test %) / (100% - mean pre-test %). Our Hake's mean gain is 0.596=0.6 which is substantial for an educational gain.

Perception levels for TAM Concepts for Cohort (N=69)

Perception levels for the TAM concepts are graphically displayed in Figure 138. The mode of the responses on the concepts of PU, PEOU and ATT was "Agree". Inferential comparisons of TAM concepts to ambivalence of use are displayed in Table 223 with the one-sample Wilcoxon Signed Rank test. With the power at α=0.05 and β=0.4, the null hypothesis regarding ambivalence was rejected for all indicators in the model concepts of attitude, perceived ease of use and perceived usefulness. The null hypothesis was also rejected for 3 of 5 indicators in the model concept of intention for use. The 2 indicators that retained the null hypothesis were, "Over the next 3 months, I expect that I would use an ITS" and "Over the next 3 month, I intend to use an ITS for training".

Perception Levels for HBM Concepts for Cohort (N=69)

Perception levels for the HBM concepts are graphically displayed in Figure 139. The mode of responses for the concepts of PS, CA and M was "Likely" and for PT was "Extremely Unlikely". For 4 of the 5 indicators for PSV the mode is "Slightly Likely". The mode for 4 of the 5 indicators for PB was "Extremely Likely". Inferential comparisons of HBM concepts to ambivalence of use are displayed in Table 224 with the one-sample Wilcoxon Signed Rank test. With the power at α=0.05 and β=0.4, the null hypothesis regarding ambivalence was rejected for all indicators in the model concepts of perceived susceptibility, perceived threat, cue to action and motivations. The null hypothesis was also rejected for 4 of 5 indicators in the model concept of perceived severity and 4 of 5 indicators of perceived benefits. The 2 indicators that retained the null hypothesis were, “Over the last 12 months, if my community was infected with a febrile-rash like illness outbreak it would be severe?” and “Understanding the need for an accurate laboratory test for a febrile rash illness will decrease the chances of exposure for myself.”

The HBM concepts were further stratified in terms of perceptions of self-verses the community which are displayed in Figure 140-Figure 144. For PS, the mode toward self was “Unlikely” and toward community was “Likely”. For PSV, the mode toward self was “Unlikely” and toward community was “Slightly Likely”. For PT, the mode toward self was “Extremely Unlikely” and toward community was “Unlikely” and for PB, “Extremely Likely” for self and community.

Non-Participation Rate

Participation in the study was voluntary and resulted in the following number of participants at each stage: 940 invitations were sent to national, state and local public health professionals, 179 made course queries, 129 signed informed consents, 104 completed learner attributes surveys, 97 completed pre-test assessments, 73 completed the course and application scenario question, 72 completed the post-test assessment, and 69 completed the technology acceptance model survey and the health belief model survey. There were 42 participants who did not make a course query but did completed a non-participation survey discussed below. The response rate indicates a limited reach among the public health workforce.

To better understand the non-participation rate, forty-two respondents who did not participate in the study did provide feedback as to why they did not participate. 40% (17/42) identify "no time" and 29% (12/42) identify "information technology barriers (i.e. system compatibility issues)". These two most cited reasons were also validated by email and telephonic discussions. Statistically, Bujang and Baharum (2016) indicate N=46 yields an R0 = 0.0, R1 = 0.4 for correlation tests with a power of 80% and alpha of 0.05. Interpolation of Bujang and Baharum scale for 42 participants infers a theoretical R1 of .43. Cohen (1992) indicates N=38 detects a large effect size (.8 standard deviation) mean differences with a power of 80% and alpha of 0.05. 42 respondents coupled with the proportions in two non-participation reasons provide assurance these were the most important reasons for non-participation.

In terms of time, non-participating public health professionals advised that they had too many commitments at work to commit the 30 minutes expected for this research. That infers to reach greater proportions of public healthcare workers, the ITS must be required to be used. Additionally, 179 opened the introduction to the course. Of those, for the 69-person cohort, the expected 30-minute time for training also proved too optimistic for most. Not counting one outlier who took 291 minutes to complete the course, the median time of completion of the remaining 68 participants was 46 minutes with a range from 11 to 115 minutes. It is assumed that those spending the greatest amount of time in the system needed the greatest amount of remediation. For the remaining 110, the 30-minute time expectation for the course and the possibility of the course exceeding 30 minutes may explain as much as 2/3rds who did not complete the entire course.

Information technology barriers may also explain as much as 1/3 of the 110 who reneged on completing the course. Specifically, some individuals needed additional instruction on how to connect to the platform and to perform functions within the platform once accessed despite the fore mentioned video explaining connection and use of the platform. More importantly, email communications during the study and the free text responses in the surveys showed that many respondents had course terminations not by their own choice. Many stated that the course "shut down on its own", would "not allow completion of the process" or would "not move forward or continue". Later analysis revealed that many health departments do not allow access to cloud applications of this type through their organization firewall and participants did not want to attempt the course on their personal device. Additionally, many health departments rely on Windows Explorer browsers at their workstations. The prototype used in this research was compatible with Chrome, Edge, or Firefox browsers, not Windows Explorer.

Hypotheses

H_1

We posed the question, "Are the TAM model constructs of Perceived usefulness (PU), Perceived ease of use (PEOU), Attitude (ATT) and intention to use (IU) significant indicators of actual use (AU) for the intelligent tutoring system for public health education and training?" The null hypothesis is that TAM model constructs will have no effect on actual use (AU).

In performing the SEM of TAM, we could not determine causal inferences. The model fit statistics showed the model to have a RMSEA of .364 and a CMIN/df at 9.996 which indicates the model is not a close fit. Review of the R^2=.594 also indicative that the model is weak fit (Table 15).

While we could not determine effect of each of indicators, upon review of the regression weights, critical ratio, and p-value, we do see some influence from PEOU and ATT on AU.

We failed to reject or retain the null hypothesis for H_1.

H_2

We posed the question, "Are the HBM model constructs of Perceived Susceptibility (PS), Perceived Severity (PSV), Perceived Threat (PT), Perceived Benefits (PB), Cues to Action (CA), and Motivations (M) significant indicators of actual use (AU) of an intelligent agent (tutor) for public health education and training functions?" The null hypothesis is that HBM model constructs will have no effect on the system outcome construct, actual use (AU).

In performing the SEM of HBM, we could not determine causal inferences. The model fit statistics shows the R^2 value as .33, which indicates the model is very weak fit (Table 175).

While we could not determine effect of each of indicators, upon review of the regression weights, critical ratio, and p-value, we do see some influence from CA on AU.

We failed to reject or retain the null hypothesis for H_2.

H_3

We posed the question, "Will the conceptual model TAM/HBM Model demonstrate a better prediction of the actual use (AU) of the ITS in public health research as compared to that of the individual models?" The null hypothesis is that the TAM/HBM model will not have a better predicative effect on actual use (AU) when compared to TAM and HBM.

In performing the SEM of the conceptual TAM/HBM model, we could not determine causal inferences in our original concept. Based on the CFA analysis and the SEM for TAM and HBM, we changed our concept to include ATT, PEOU, PU, PB, CA and PSV and exclude PS. The RMSEA on the modified model is .147 which indicate not a close fit, but all other model statistics indicate a moderate fit which is supported by the R^2=.626 (Table 17).

While we could not fully complete a comparative analysis of the 3 models (TAM, HBM, and TAM/HBM), we were able to show that of the conceptual model that combined constructs from the individual models had the best RMSEA value and the highest R^2 value. This many indicate that our theory of combining constructs from both TAM and HBM are worthy of further in-depth study.

We failed to reject or retain the null hypothesis for H_3.

H_4

In a comparative analysis, we ask participants if time would have been better spent on researching the content on the internet, talking with a knowledgeable mentor or taking a class with a discussion group rather than taking the course on the ITS platform. The ITS platform was significantly preferred over the 3 choices (Figure 17, Table 206).

We reject the null hypothesis for H_4 that public health professionals are ambivalent to training modality and show a preference for the ITS.

H_5

We posed the question, "Does an AOP ITS that uses ATI improve a public health professionals knowledge level and application of knowledge in an outbreak scenario?" The two-part null hypothesis is that the AOP ITS with ATI will not demonstrate participants improved post-assessment performance level over pre-assessment performance level or competency in applying knowledge in an outbreak scenario assessment.

For H_5 of the limited published literature in scholarly journals, ITS typically induce pre to post student learning improvements in the range of 0.25 to 1.0 standard deviation (Kulik & Fletcher, 2016). Our study reports an overall 1.00 standard deviation pre to post improvement signifying significant learning effectiveness of the ITS with ATI and remediation.

Improved post assessment performance level over pre-assessment performance level was also demonstrated in the study and 69-cohort.

We saw a 74% ((53/72); (51/69)) increase in overall scores with most respondents improving their scores by 2 points. In the knowledge application scenario, 74% (54/73) in the study and 75% (52/69) in the 69-cohort of respondents were able to demonstrate their ability to apply the knowledge gained.

The ITS demonstrated the most improvement for respondents who identified below proficient level of competency (i.e. Novice, Beginner, Competent).

The improvement level for respondents who identified as "Expert" may not have been as high due to the content being invalid from State to State. Respondents in the free text boxes and in email communication during the study advised, that although the content is taken from the nationally recognized authority on the content, that some States have chosen to adapt different methods for validation and evaluation for rash like illness.

These results allowed us to reject the two-part null hypothesis for H_5 that participants will not demonstrate improved post-assessment performance level over pre-assessment performance level or competency in applying knowledge in an outbreak scenario assessment.

H_6

We posed the question, "Does an AOP ITS that uses ATI promote senses of useful, easy to use, positive attitude, and intention to use in public health professional users?" The null hypotheses are that public health professionals will be ambivalent about the usefulness (PU), easy to use (PEOU), attitude (ATT), or intent to use (IU) an AOP ITS with ATI.

For H_6 results from the Wilcoxon signed-rank test indicate that public health professionals are not ambivalent but rather in agreement in using an ITS as it correlates to PU, PEOU and ATT as the mode of their responses on each concept was "Agree". However, there is a level of ambivalence in IU particularly in the temporal indicators for future use (i.e. over the next 3 months).

Thus, we reject the null hypothesis that public health professionals will be ambivalent about the usefulness (PU), easy to use (PEOU) and attitude (ATT) but retain the null hypothesis for intent to use (IU) an ITS.

H_7

We posed the question, "Does content in an AOP ITS that uses ATI communicate perceived susceptibility, severity, threat, benefit, cue to action or motivation in public health professional users for the selected outbreak pathogen or prescribed health regime?" The null hypothesis is that public health professionals users of the AOP ITS with ATI will be ambivalent about the perceive susceptibility (PS), severity (PSV), threat (PT), benefits (PB), cues to action (CA) or motivation (M) toward the selected pathogen or prescribed health regime.

For H_7 results from the Wilcoxon signed-rank test indicate that public health professionals are not ambivalent in using an ITS as it correlates to the HBM concepts of PS, PT, CA, and M. The mode of their responses on the concepts of PS, CA and M was "Likely" but for PT was "Extremely Unlikely". Respondents are not ambivalent for 4 of the 5 indicators for PSV with the mode of "Slightly Likely". The fifth indicator is temporal on the severity of an outbreak on the community and does indicate ambivalence. Respondents are not ambivalent for 4 of 5 indicators for PB with the mode of "Extremely Likely". There is ambivalence on 1 indicator as it pertains to perceived benefits about learning about the content of the ITS to decrease exposure to self.

We further stratified our analysis for PS, PSV, PT and PB in terms of perceptions of self- verses the community. We found for PS the mode toward self as “Unlikely” but toward community as “Likely”. For PSV, the mode toward self was “Unlikely” and toward community was “Slightly Likely”. For PT, the mode toward self was “Extremely Unlikely” and toward community was “Unlikely” and for PB “Extremely Likely” for self and for the community.

Our results also revealed that public health professionals are highly influenced to use new technology if they learn about it from others if it is in a self-paced environment and if their colleagues communicate about it to them.

Thus, we reject the null hypothesis that public health professionals users of the ITS will be ambivalent about the perceive susceptibility (PS), severity (PSV), threat (PT), benefits (PB), cues to action (CA) or motivation (M) toward the selected pathogen or prescribed health regime.

H_8

We posed the question, “Does an AOP ITS using ATI attract invited public health professionals to receive public health professional’s knowledge and application meet a pathogen outbreak scenario?” The null hypothesis is that public health professional will not voluntarily engage in non-mandatory training for the given pathogen outbreak scenario.

The non-participation rate for the study forces acceptance of the null hypothesis that for the most part public health professional will not voluntarily engage in non-mandatory training for the given pathogen outbreak scenario.

CHAPTER 5: CONCLUSION

The U.S. public health system is continually challenged by unexpected epidemiological events that pose significant risks to the health of the community and require a commensurate surge in the public health system capacity to stem the spread of the disease. The complexity and even changing nature of funding and surge events drives agencies to innovate in order to maintain and support a competent workforce as well as update, or evolve the knowledge, skills and abilities (KSA) necessary to prevent, mitigate, or even eliminate the health crisis arising from a disease.

This research investigates the capability of an agent-based, online personalized (AOP) intelligent tutoring system (ITS) that adaptively uses aptitude treatment interaction (ATI) to deliver public health training and assure competency. Also, presented is a conceptual model that combines Davis' Technology Acceptance Model (TAM) and the Public Health Service's Health Behavior Model (HBM) concepts to understand actual use of new technology in the public health sector. TAM is used to evaluate the effectiveness and the behavioral intent to use the system. HBM is used to explain and predict the preventative health behavior of actual use of the ITS.

This study was conducted in a cross-sectional experimental study design with the prime purpose of understanding suitability and actual use of intelligent tutoring system technology for the training and education of government public health workers. The study has: (1) successfully led to improvement in the research pedagogy for public health professionals; (2) provided an innovative solution to address the gap in educational strategies and align with public health practice; and (3) provided a viable cost-effective method for training with the decrease in expert human mentors.

Our findings indicate the use of the ITS increases participant performance while providing a high level of acceptance, ease of use, and competency assurance. Without the determination of casual sequence, the TAM/HBM conceptual model demonstrated the best fit for predicting actual use of an ITS with the constructs of attitude, cues to action, and perceived ease of use showing the most influence. However, discussion of our findings indicates limited potential for an ITS to make a major contribution to adding workforce surge capacity unless members are directed to utilize it and technology barriers in the current public health IT infrastructure overcome.

This study tested the suitability and the technology acceptance of an adaptive e-learning system in public health practice based on the TAM and HBM. The learning gains were assessed by summative knowledge-based assessment and knowledge application within the ITS. Confirmatory Factor Analysis (CFA) were used to perform construct reliability and validity checks. If the item (indicator) did not represent the construct (factor) well it was reduced from additional analysis. If the item represented the factor well, it was consolidated within the construct to be used in the SEM analysis. The acceptance of the e-learning technology was assessed by conducting structural equation modeling analysis (SEM) on the factors associated with TAM and HBM.

The following hypotheses were tested:

> H_1 - Technology Acceptance Model (TAM): "Are the TAM model constructs of Perceived usefulness (PU), Perceived ease of use (PEOU), Attitude (ATT) and intention to use (IU) significant indicators of actual use (AU) for the intelligent tutoring system for public health education and training?" The null hypothesis is that TAM model constructs will have no effect on actual use (AU).

H_2 - Health Belief Model (HBM): "Are the HBM model constructs of Perceived Susceptibility (PS), Perceived Severity (PSV), Perceived Threat (PT), Perceived Benefits (PB), Cues to Action (CA), and Motivations (M) significant indicators of actual use (AU) of an intelligent agent (tutor) for public health education and training functions?" The null hypothesis is that HBM model constructs will have no effect on the system outcome construct, actual use (AU).

H_3 - Integrated TAM/HBM Model: "Will the conceptual model TAM/HBM Model demonstrate a better prediction of the actual use (AU) of the ITS in public health research as compared to that of the individual models?" The null hypothesis is that the TAM/HBM model will not have a better predicative effect on actual use (AU) when compared to TAM and HBM.

A 69-participant cohort in the cross-sectional study design of the larger study provided a complete dataset for additional analysis and were used to address hypotheses H_4 through H_8. Wilcoxon signed-ranked tests were used to measure ambivalence in using the adaptive online personalized ITS as it correlates to TAM and HBM concepts.

H_4 - "Do public health professionals' prefer an ITS platform, internet search, mentor or discussion group training modality?". The null hypothesis is public health professional are ambivalent about training modality.

H_5 - "Does an AOP ITS that uses ATI improve a public health professionals knowledge level and application of knowledge in an outbreak scenario?" The two-part null hypothesis is that the AOP ITS with ATI will not demonstrate participants improved post-assessment performance level over pre-assessment performance level or competency in applying knowledge in an outbreak scenario assessment.

H_6 - "Does an AOP ITS that uses ATI promote senses of useful, easy to use, positive attitude, and intention to use in public health professional users?" The null hypotheses are that public health professionals will be ambivalent about the usefulness (PU), easy to use (PEOU), attitude (ATT), or intent to use (IU) an AOP ITS with ATI.

H_7 - "Does content in an AOP ITS that uses ATI communicate perceived susceptibility, severity, threat, benefit, cue to action or motivation in public health professional users for the selected outbreak pathogen or prescribed health regime?" The null hypothesis is that public health professional users of the AOP ITS with ATI will be ambivalent about the perceive susceptibility (PS), severity (PSV), threat (PT), benefits (PB), cues to action (CA) or motivation (M) toward the selected pathogen or prescribed health regime.

H_8 - "Does an AOP ITS using ATI attract invited public health professionals to receive public health professional's knowledge and application meet a pathogen outbreak scenario?" The null hypothesis is that public health professional will not voluntarily engage in non-mandatory training for the given pathogen outbreak scenario.

Summaries of the outcomes for each hypothesis is given in the tables below.

Table 18: Hypothesis H1-H4 Summary

H	Abbreviated Research Question & Null	Statistical Inference	Response Level	Reference
H_1	"Are the TAM model constructs of Perceived usefulness (PU), Perceived ease of use (PEOU), Attitude (ATT) and intention to use (IU) significant indicators of actual use (AU) for the intelligent tutoring system for public health education and training?" The null hypothesis is that TAM model constructs will have no effect on actual use (AU).	Fail to Reject or Retain Null	Causal inferences could not be determined	**Table 15 & Figure 24**; Tables 183-188, Figures 131-132
H_2	"Are the HBM model constructs of Perceived Susceptibility (PS), Perceived Severity (PSV), Perceived Threat (PT), Perceived Benefits (PB), Cues to Action (CA), and Motivations (M) significant indicators of actual use (AU) of an intelligent agent (tutor) for public health education and training functions?" The null hypothesis is that HBM model constructs will have no effect on the system outcome construct, actual use (AU).	Fail to Reject or Retain Null	Causal inferences could not be determined	**Table 16 and Figure 25**; Tables 189-197, Figures 133-135
H_3	"Will the conceptual model TAM/HBM Model demonstrate a better prediction of the actual use (AU) of the ITS in public health research as compared to that of the individual models?" The null hypothesis is that the TAM/HBM model will not have a better predicative effect on actual use (AU) when compared to TAM and HBM.	Fail to Reject or Retain Null	Causal inferences could not be determined	**Table 17 and Figure 26**; Tables 198-203, Figures 136-137
H_4	"Do public health professionals' prefer an ITS platform, internet search, mentor or discussion group training modality?". The null hypothesis is public health professional are ambivalent about training modality.	Reject Null	In a comparative analysis, the ITS platform was significantly preferred over the 3 choices.	Figure 17, Figure 74, Table 41, Table 206

Table 19: Hypothesis H5-H8 Summary

H	Abbreviated Research Question & Null	Statistical Inference	Response Level	Reference
H_5	"Does an AOP ITS that uses ATI improve a public health professionals knowledge level and application of knowledge in an outbreak scenario?" The two-part null hypothesis is that the AOP ITS with ATI will not demonstrate participants improved post-assessment performance level over pre-assessment performance level or competency in applying knowledge in an outbreak scenario assessment.	Reject Null	The average test points for pretest was 6.8 points or 68%, the average for the post test was 8.7 points or 87% (p<0.01). The descriptive statistics show that there is an increase in scores from pre to post tests. The test statistics show that the ITS indeed demonstrates a statistically significant change in learning effectiveness (Z=-6.05, p<0.01). In the knowledge application scenario, 75% (52/69) of respondents were able to demonstrate their ability to apply the knowledge gained.	Figure 16, Table 2, Table 3, Table 33-37, Table 208, Table 209
H_6	"Does an AOP ITS that uses ATI promote senses of useful, easy to use, positive attitude, and intention to use in public health professional users?" The null hypotheses are that public health professionals will be ambivalent about the usefulness (PU), easy to use (PEOU), attitude (ATT), or intent to use (IU) an AOP ITS with ATI.	Reject Null	Results from the Wilcoxon signed-rank test indicate that public health professionals are not ambivalent but rather in agreement in using an AOP ITS as it correlates to PU, PEOU and ATT as the mode of their responses on each concept was "Agree". However, there is a level of ambivalence in IU particularly in the temporal indicators for future use (i.e. over the next 3 months).	Table 230, Figure 138
H_7	"Does content in an AOP ITS that uses ATI communicate perceived susceptibility, severity, threat, benefit, cue to action or motivation in public health professional users for the selected outbreak pathogen or prescribed health regime?" The null hypothesis is that public health professionals users of the AOP ITS with ATI will be ambivalent about the perceive susceptibility (PS), severity (PSV), threat (PT), benefits (PB), cues to action (CA) or motivation (M) toward the selected pathogen or prescribed health regime.	Reject Null	Results from the Wilcoxon signed-rank test indicate that public health professionals are not ambivalent in using an AOP ITS as it correlates to the HBM concepts of PS, PT, CA, and M. The mode of their responses on the concepts of PS, CA and M was "Likely" but for PT was "Extremely Unlikely". Respondents are not ambivalent for 4 of the 5 indicators for PSV with the mode of "Slightly Likely". The fifth indicator is temporal on the severity of an outbreak on the community and does indicate ambivalence. Respondents are not ambivalent for 4 of 5 indicators for PB with the mode of "Extremely Likely". There is ambivalence on 1 indicator as it pertains to perceived benefits about learning about the content of the ITS to decrease exposure to self.	Table 231, Figure 139
H_8	"Does an AOP ITS using ATI attract invited public health professionals to receive public health professional's knowledge and application meet a pathogen outbreak scenario?" The null hypothesis is that public health professional will not voluntarily engage in non-mandatory training for the given pathogen outbreak scenario.	Retain Null	The non-participation rate forces acceptance of the null hypothesis that for the most part public health professionals will not voluntarily engage in non-mandatory training for the given pathogen outbreak scenario.	Table 25, Table 32, Figure 66

In developing our hypotheses, we asked about the possibility of mediating effects from some of our constructs. Unfortunately, because we could not develop a causal sequence, mediating effects could not be determined. Secondly, we assumed in our study design that the factors were not independent of each other, but our results show us that that is not accurate. The factors are shown to be independent of each other which is supported by the structural equation modeling analysis wherein the constructs are not highly related to each other. The benefit of a cross sectional study allowed us to determine if two or more variables are related. We were able to identify relationships between PEOU, ATT and CA to AU. Other incidental findings are presented below.

Incidental Findings

Our CFA analysis was conducted for construct validity as part of our SEM analysis. Fortuitously, the CFA allowed us to evaluate the survey instrument and evaluate knowledge application to better understand our study population, public health professionals, and their desire for innovative training tools and their barriers for training.

The single factor CFA conducted on each latent variable with their observed indicators allowed for construct validity and instrument evaluation. We found that all 7 observed indicators could be retained for Perceived Usefulness. Four of the 6 observed indicators for Perceived Ease of Use could be retained (remove PEOU4 and PEOU7). The 5 observed indicators for Intention to Use and the 3 observed indicators for Attitude could be retained. Three of the 5 observed indicators for Perceived Susceptibility (remove PS1 and PS4) and Perceived Severity (remove PSV1 and PSV2) could be retained. Although four of the 8 observed indicators for Perceived Threat could be retained (remove PT1, PT2, PT7, PT8), the lower loadings on them suggest these questions should be revised. Of the six observed indicators for Perceived Benefits, 3 could be retained (remove PB1, PB2, PB3) but with a revision on PB4 considered. The 4 observed indicators for Cues to Action could be retained but a revision of CA1 might be warranted. Of the six observed indicators for Motivations, 3 could be retained (remove M1, M2, M3), revision to M5 could be considered to improve loading. The 4 observed indicators for Actual Use demonstrated high loadings which indicated retainment with the exception to AU4 which is a time specific question.

The study population consistently demonstrated their health beliefs with less confidence towards community when compared to self (i.e. perceived threat, motivations, perceived susceptibility, perceived severity, and perceived benefits). It is reasonable then to revise the HBM survey to only include questions geared to self or community and not a combination of the two.

The construction of a new survey instrument from the CFA is a possibility. However, the responses to the survey specifically the TAM survey from the study population was of further interest. It is reasoned that using a standardized tool with only the change of the technology name should yield similar results to the many hundreds of studies done with TAM within healthcare populations (e.g. intention to use as a significant indicator for actual use). Our results though were quite different from those studies demonstrating that the homogeneity in study populations or the extrapolation from medical, nursing and dental students may be an experimental design flaw for the pedagogy in public health education (Tao et al., 2018).

Our study population, public health professionals, were motivated to participate in the study. They found the platform useful and would likely return to it in the future as well as advised that it was more preferential when compared to an internet search, mentor discussion or class discussion. However, the biggest barriers identified, in using the ITS, were time and technology barriers. In email and telephonic discussions, participants advised they had too much work to be able to participate in a study and that 30 minutes was too much time to commit to the study. The researchers also spent considerable time explaining how to connect to the platform and to perform functions within the platform once assess was achieved. This may indicate that resources and training on computer-based systems, information technology content specific, might be needed in the future. These findings support the assertions from the previously referenced researchers in Chapter 1 of this dissertation. Although not directly solicited, the public health professionals in the study did advise that they had too many commitments at work and could not allow even 30 minutes to participate in training and that they did not have the staffing support to commit to training (Hilliard & Boulton, 2012) (Tao et al., 2018).

Our study sought to perform a comparison analysis of 2 theoretically informed frameworks and one hypothesized framework: TAM, HBM and TAM/HBM hypothesized model to better predict actual use. We saw that constructs for technology acceptance and constructs from health beliefs have direct influence on estimated use. Even though causal sequences could not be determined, we were able to evaluate the models based on R^2 and Goodness of Fit Statistics. We saw that there was potential that our theory of combining constructs from TAM and HBM is worth further investigation. We also saw that applying the Technology Acceptance Model to the study population, public health professionals, is also worth further investigation.

Limitations

Limitations to the study include the small sample size, need for better instrument, platform reliability and compatibility and the cross-sectional study design.

The sample size that was assumed when the study was completed was an N of 179 based on the number of course attempts which was 15% above the needed power analysis estimation of N=153. However, upon cleaning of the data N was reduced to 69, 55% under the needed power analysis estimation. Insufficient sample size effects the credibility of research conclusions when using SEM analysis methods. The rule of thumb guidance is between 5-10 observations per indicator in setting a lower bound for the adequacy of sample size (Westland, 2010). In our analysis we had 2-4 observations per indicator. Based on the sample size, even if our models demonstrated parsimony, it would have been difficult to justify causation resulting in a rejection of the models.

The instruments used in this study was based on previous studies. The CFA demonstrated that there could be revisions to the evaluation instrument design to develop a better instrument for future studies with public health professionals.

The reliability of the research prototype platform was also a limitation in the study. The course attempt data started at N=179 but by the fourth slide 58 participants had ended their session indicating some type of information technology barriers.

Another significant limitation is that although the course content is taken from the nationally recognized authority on notifiable diseases and conditions, application to the nation may be limited. As with all notifiable conditions it is up to the state to adapt their methods for validation and evaluation (CDC, 2019).

The cross-sectional study design has inherent disadvantages as it is designed to capture a specific moment in time which may not be representative of behaviors of our study population over time. It also does not help determine cause and effect very well. We did try to control for these disadvantages by asking temporal questions when it came to usage but unfortunately, our participant group were not able to make affirmative choices for future use of the technology.

Future Directions

To improve quality and efficiency in public health practice, innovative collaboration with a focus on artificial intelligence (AI) research and development in the public health domain are essential. By using theoretically informed frameworks (i.e. TAM and HBM) to guide exploratory research, we may discover casual inferences which can be used for predictive modeling. Our research with a focused AI on intelligent tutoring systems demonstrated significant improvement in our understanding of ITS use for surge capacity public health events and training by attempting to integrate the technology acceptance model and the health belief model factors. While causal inferences could not be fully established, the research does lay the foundation for explaining how innovative technology could be used in future studies for public health professionals. Cues to Action, attitude and perceived ease of use are among the behavioral and technology acceptance factors that had the most direct influence on use from public health professionals.

The small sample size and the use of a cross sectional study design significantly affected the use of SEM within this study. Future studies could include analysis using partial least squares SEM (PLS-SEM), which is the accepted analytical method when small sample size or treatment of missing values are among the data quality issues (Hair, Ringle, & Sarstedt, 2013). The fact that our population mirrors that of other public health studies also lends to the advantageousness of using PLS-SEM as the more heterogenous a population, the more observations are needed to reducing sampling error (Hair et al., 2013). Additionally, replication of this study could be conducted in a longitudinal study design with focused recruitment on small samples over a longer period. This design would be more advantageous for the cause and effect outcomes.

The study further identified several barriers to training public health professionals for a surge capacity event or for a non-surge event. The non-participation rate demonstrates that most public health professionals will not voluntarily engage in non-mandatory training for the given pathogen outbreak scenario. Participants identified that content can be State-specific, and this should be considered when developing course content for public health professionals. The use of an ITS for training public health professionals is a plausible platform worthy of further exploration that is supported by the outcomes of the knowledge-based assessments and the comparative technology survey from this study. This study also demonstrated the continually need to study the public health population and not extrapolate from the research standard of a homogenous study population.

The use of ITS technology to advance public health practice can make a significant impact on preparing the workforce to detect, prevent and respond to public health surge capacity events. It can support training with subject matter experts in remote areas. It can assess competency prior to deployment of human resource. It is scalable, flexible, cost effective and provides an engaging platform. However, before new technology can be introduced to the U.S. Public Health system, future research must be conducted to better understand how best to address end-users (i.e. public health professionals) workforce time limitations and unique state and organizational-imposed limitations. This is also true of workforce perceptions, attitude, motivation, and barriers to using new technology.

APPENDIX A: LEARNER ATTRIBUTES SURVEY

There are two scales used in the questions below.

The first scale uses the Brenner's Clinical Competency Scale from Novice to Expert. Use this scale to indicate your level of competency in the following questions

Novice = Minimal or only textbook knowledge of

Beginner = Some working knowledge of

Competent = Good background knowledge and area of practice

Proficient = Depth of understanding of discipline and area of practice

Expert = Comprehensive and authoritative knowledge of

The second scale is a measurement scale from extremely unconfident to extremely confident. **Indicate how confident you are in the following questions.**

Measurement Scale is a Likert scale from Extremely Unconfident to Extremely confident.

Extremely unconfident	**Unconfident**	**Slightly unconfident**	**Neither**	**Slightly confident**	**Confident**	**Extremely confident**

48 points across-Grit, Prior Knowledge, Skill and Motivation

Q1. What is your age? (Not scored) 154360

Q2. How many years have you worked as a health professional or in the healthcare sector? (Not Scored) 154361

Q3. What is your gender? Male, Female (Not Scored) 154362

Q4. Do you have any experience dealing with a febrile rash illness? (Prior Knowledge, Skill) 154363

Yes= you DO have experience with febrile rash illness (3)

No= you DO NOT have experience with febrile rash illness (0)

Q5. How would you assess your expertise in dealing with a patient with febrile rash illness? (Expert levels based on Brenner's model) (Prior Knowledge, skill) 154364

Novice = Minimal or only textbook knowledge of (1)

Beginner = Some working knowledge of (2)

Competent = Good background knowledge and area of practice (3)

Proficient = Depth of understanding of discipline and area of practice (4)

Expert = Comprehensive and authoritative knowledge of (5)

Q6. How would you assess your expertise in using an intelligent tutoring system (ITS)? (prior knowledge, skill) 154365

Novice = Minimal or only textbook knowledge of (1)

Beginner = Some working knowledge of (2)

Competent = Good background knowledge and area of practice (3)

Proficient = Depth of understanding of discipline and area of practice (4)

Expert = Comprehensive and authoritative knowledge of (5)

Q7. How would you assess your expertise in packaging and shipping clinical specimens for febrile rash illness? (prior knowledge, skill) 154366

Novice = Minimal or only textbook knowledge of (1)

Beginner = Some working knowledge of (2)

Competent = Good background knowledge and area of practice (3)

Proficient = Depth of understanding of discipline and area of practice (4)

Expert = Comprehensive and authoritative knowledge of (5)

Q8. On the Likert Scale from Extremely Unconfident to Extremely Confident, please indicate how confident you are in the following question: How confident are you in your knowledge about the rule out diagnostic process for febrile rash-like illnesses? (prior knowledge, grit) 154367

Q9. On the Likert Scale from Extremely Unconfident to Extremely Confident, please indicate how confident you are in the following question: How confident are you that if a patient walked into your healthcare facility with a rash and fever that you would be able to order the correct laboratory procedures based on clinically and epidemiological evidence? (prior knowledge, grit) 154368

Q10. **On the Likert Scale from Extremely Unconfident to Extremely Confident, please indicate how confident you are in the following question:** How confident are you in your willingness to learn about the rule out diagnostic process for febrile rash-like illnesses on an intelligent tutoring system (ITS) platform? (Grit, Motivation) 154369

Q11. On the Likert Scale from Extremely Unconfident to Extremely Confident, please indicate how confident you are in the following question: How confident are you that you will complete the entire course in the Intelligent Tutoring System (ITS) format provided? (Grit, Motivation) 154370

Q12. On the Likert Scale from Extremely Unconfident to Extremely Confident, please indicate how confident you are in the following question: How confident are you that if you found this learning platform useful (ITS) that you would return to it for a refresher course? (Motivation) 154371

Q13. Free Text: Optional: Provide any comments or clarification for the answers you provided above. 154588

APPENDIX B: TECHNOLOGY ACCEPTANCE MODEL QUESTIONNAIRE (TAM)

(F. Davis, 1989; D. Gefen, D. W. Straub, & M. Boudreau, 2000)

Measurement Scale is from Extremely Disagree to Extremely Agree. Indicate your level of agreement on the following questions as it relates to the intelligent agent (tutor)-GIFT platform, you just used.

Extremely disagree	Disagree	Slightly Disagree	Neither disagree or agree	Slightly Agree	Agree	Extremely Agree

Perceived Usefulness

1. Using an intelligent agent (tutor) would enable me to accomplish tasks more quickly. 154177
2. Using an intelligent agent (tutor) would improve my job performance. 154178
3. Using an intelligent agent (tutor) would increase my productivity. 154179
4. Using an intelligent agent (tutor) would enhances my effectiveness on the job. 154180
5. Using an intelligent agent (tutor) would make it easier to do my job. 154181
6. Overall, I would find the intelligent agent (tutor) system useful in my job. 154182
7. Over the last 12 months, I would find using an intelligent agent (tutor) to be useful in my job. 154589

Perceived Ease of Use

1. Learning to operate the intelligent agent (tutor) system was easy for me. 154183
2. It was easy to get the intelligent agent (tutor) system to do what I want it to do. 154184
3. My interaction with the intelligent agent (tutor) system was clear and understandable. 154185
4. The intelligent agent (tutor) system was flexible to interact with. 154186
5. It was easy for me to become skillful at using the intelligent agent (tutor) system 154187
6. Overall, the intelligent agent (tutor) system was easy to use. 154188
7. Over the last 12 months, I would have found using the intelligent agent (tutor) system easy to use. 154590

Intention for Use

1. Assuming I have access to an intelligent tutor platform, I intend to use it for training. 154189
2. Given that I now have access to an ITS platform, I predict that I will use it for training. 154190
3. If I get to use an intelligent tutor, I expect that I will use it. 154191
4. Over the next 3 months, I would expect that I would use an intelligent tutoring system. 154591
5. Over the next 3 months, I intend to use an intelligent tutoring system for training. 154592

Attitude

1. Using an ITS platform for remedial training on febrile rash illness is a good idea 154192
2. I like the idea of using an intelligent tutor system for getting health information on febrile rash illness. 154193
3. Using an ITS platform for remedial training on febrile rash illness is a pleasant experience. 154194

What changes would have to be made for this technology (intelligent tutor) to be useful for the type of work that you do? 154593

APPENDIX C: COMPARISON EVALUATION

Instead of the time spent taking this ITS course, my time would have been better spent on the Internet researching a surge capacity public health event, such as febrile rash illness outbreak. Yes or no. 154195

Instead of the time spent taking this ITS course, my time would have been better spent talking with a knowledgeable mentor about a surge capacity public health event, such as febrile rash illness outbreak. Yes or no. 154196

Instead of the time spent taking this ITS course, my time would have been better spent taking a class with a discussion group so that I could interact with and learn together with my peers about a surge capacity public health event, such as febrile rash illness outbreak. Yes or no. 154197

Free Text: Optional: Provide any comments or clarification for the answers you provided above. 154594

APPENDIX D: HEALTH BELIEF MODEL QUESTIONNAIRE (HBM)

(Ahadzadeh et al., 2015; Becker et al., 1978; Champion & Champion, 1984; Rosenstock, 1974a)

Measurement Scale is from Extremely unlikely to Extremely likely. Indicate your level of agreement on the following questions about perceived susceptibility and perceived severity

Extremely unlikely	Unlikely	Slightly unlikely	Neither	Slightly likely	Likely	Extremely likely

- Febrile rash illness refers to diseases such as Varicella-chickenpox, Rubeola-measles, Rubella-German measles, and Enterovirus-hand foot mouth disease.
- Community refers to the location that you preformed your public health services.
- The questions that state "you" refer to you the public health professional it is not a generalization.

Perceived Susceptibility

1. Taking all possible factors into consideration, how likely do you think your chances of getting a febrile rash illness are? (154110)
2. How likely do you think your community will have a febrile rash illness outbreak in the future? (154113)
3. What is the likelihood that your community would be exposed to an outbreak of febrile rash illness as compared to other communities? (154116)
4. Over the last 12 months, I consider myself susceptible to a febrile rash-like illness. (154595)
5. Over the last 12 months, I consider my community susceptible to a febrile rash-like illness outbreak. (154596)

Perceived Severity

If you were infected how severe would it likely be?

1. Over the last 12 months, if you were infected with a febrile rash illness, how likely are you to have a serious infection? (154597)
2. Over the last 12 months, if you were infected with a febrile rash illness, how likely do you think that you would experience long term problems from that infection? (154120)
3. If your community were to experience a febrile rash illness, how likely would the severity of the illness be on your community? (154121)
4. If your community experienced a febrile rash illness outbreak, how likely do you think that the community would experience long term problems from that outbreak? (154123)
5. Over the last 12 months, if my community were infected with a febrile rash-like illness outbreak it would be severe? (154598)

Measurement Scale is from Extremely Disagree to Extremely Agree. Indicate your level of agreement on the following questions

Extremely disagree	Disagree	Slightly Disagree	Neither disagree or agree	Somewhat Agree	Agree	Extremely Agree

Perceived Threats

1. Over the last 12 months, I would be afraid for myself to have the laboratory testing done for febrile rash illness. (154423)
2. Over the last 12 months, I would be afraid to perform the laboratory testing for persons in my community for febrile rash illness. (154424)
3. I do not know the accurate laboratory tests required for febrile rash illness. 154599
4. The laboratory tests required for febrile rash illnesses are not reliable. 154426
5. Preventing febrile rash illness is next to impossible for myself? 154600
6. Preventing febrile rash illness is next to impossible for the community? 154428
7. Over the last12 months, I consider that there was a threat to myself to be infected with a febrile rash-like illness? 154601
8. Over the last 12 months, I consider that there was a threat to my community to be infected with a febrile rash-like illness outbreak. 154602

Perceived Benefits

1. I think it is important to know how to stay healthy. 154433
2. I think it is important that my community knows how to stay healthy 154434
3. Understanding the need for an accurate laboratory test for a febrile rash illness will decrease the chances of exposure for my community? 154438
4. Understanding the need for an accurate laboratory test for a febrile rash illness will decrease the chances of exposure for myself? 154604
5. Over the last 12 months, I consider that training myself on febrile rash-like illness will be a benefit to me. 154439
6. Over the last 12 months, I consider that training myself on febrile rash-like illness would be a benefit to my community. 154603

Cues to Action

1. Gaining more knowledge on a topic, such as laboratory tests for febrile rash illnesses, would improve my confidence to perform the tests? 154440
2. Learning about technology from others influences my use of it. 154441
3. Learning in a self-paced environment would influence my use of technology. 154442
4. Receiving communication from colleagues about technology such as an intelligent tutor would influence my use. 154443

Motivations

1. I have a general concern about my health. 154444
2. I have a general concern for the health of the community 154445
3. I frequently do things to improve my health 154446
4. I frequently do things to improve the health of the community 154447
5. I search for new information related to my health 154450
6. I search for new information related to keeping the community healthy 154451

Actual Use Behavior

1. Would you recommend the implementation of an intelligent tutoring system (ITS) for training of public health professionals in your organization? 154452
2. Would you be to recommend the continuous use of ITS technology for training of public health professionals? 154453
3. Would you recommend the using of ITS technology for performing training tasks? 154454
4. Over the next 3 months, I would likely use ITS technology. 154606

Free Text: Optional: Provide any comments or clarification for the answers you provided above. 154605

APPENDIX E: PRE/POST TEST ASSESSMENT

Q1

Question Difficulty	Easy
Associated Concepts	Lab Testing Varicella (Chickenpox)

What is the preferred specimen for laboratory confirmation of varicella disease? 154392 (154251)

- Serum 0
- Stool 0
- Skin Lesion 1
- Whole Blood 0
- Urine 0

Q2 (Q7-Question Bank)

Question Difficulty	Hard
Associated Concepts	Specimen and Lab Collection Varicella (Chickenpox)

In the surveillance case definition for Varicella which is **NOT contained in the** laboratory criteria for diagnosis: 154393 (154252)

- Isolation of varicella virus from a clinical specimen 0
- Direct Fluorescent Antibody (DFA) 0
- Polymerase chain reaction (PCR) 0
- Significant rise in serum varicella IgG by any standard assay 0
- Positive IgM for serology 1

Q3 (Q9)

Question Difficulty	Hard
Associated Concepts	Specimen and Lab Collection Varicella (Chickenpox), Lab Testing Varicella (Chickenpox)

In the blood specimen for serology for varicella, which of the following statements in NOT accurate: 154395 (154254)

- IgM EIA is a single serum which a previous immunization may negate IgM response 0
- IgG EIA is preferred for paired sera and will detect 4-fold rise or significant antibody level change indicative of recent infection. 0
- IgG EIA can be conducted in a single serum to detect immune status. 0
- IgM EIA is preferred for paired sera and will detect a 4-fold rise or significant antibody level change indicative of recent infection. 1

Q4 (Q12)

Question Difficulty	Medium
Associated Concepts	Lab Testing for Measles

What is the **primary** clinical specimen that should be collected for measles diagnosis? 154397 (154256)

- Serum for IgM and IgG testing 1
- Urine for IgM and IgG testing 0
- Stool IgM and IgG testing 0
- Whole Blood IgM and IgG testing 0

Q5 (Q15)

Question Difficulty	Hard
Associated Concepts	Specimen and Lab Collection Measles

In the laboratory criterion of the case definition for diagnosis of measles, which statement does NOT apply? 154398 (154257)

- Positive serologic test for Measles IgM antibody 0
- Significant rise in measles antibody level by a standard serologic assay 0
- Isolation of measles virus from a clinical specimen 0
- Positive Direct Fluorescent Antibody (DFA) 1

Q6 (Q18)

Question Difficulty	Medium
Associated Concepts	Lab Testing for Measles

The timeframe within which whole blood specimens are transported to the lab should be within 48 hours of collection and stored at 4°C. 154399 (154258)

- True 1
- False 0

Q7 (Q20)

Question Difficulty	Medium
Associated Concepts	Specimen and Lab Collection Measles

Detecting IgM in a serum specimen after infection with measles virus starts around the time of rash onset and may be detected for 1–2 months. 154400 (154259)

- True 1
- False 0

Q8 (Q21)

Question Difficulty	Medium
Associated Concepts	Specimen and Lab Collection Measles

Detecting IgG in a serum specimen after infection with measles virus starts at about 5–10 days after rash onset, but typically persists for a lifetime. 154401 (154260)

- True 1
- False 0

Q9 (Q22)

Question Difficulty	Hard
Associated Concepts	Lab Testing for Measles, Specimen and Lab Collection Measles

What type of specimen will you need for an IgM Enzyme Immunoassay (EIA) test for measles diagnosis? 154402 (154261)

- Urine 0
- Whole Blood 0
- Serum 1
- Nasal Swab 0

Q10 (Q23)

Question Difficulty	Hard
Associated Concepts	Lab Testing for Measles, Specimen and Lab Collection Measles

What are the implications of 4-fold rise or significant IgG level increase in an IgG EIA? 154403 (154262)

- Indicative of immunity 0
- Indicative of recent infection 1
- Indicative of no infection 0
- Indicative of past infection 0

APPENDIX F: QUESTION BANK WITH ANSWER KEY

Q1

Question Difficulty	Easy
Associated Concepts	Lab Testing Varicella (Chickenpox)

What is the preferred specimen for laboratory confirmation of varicella disease?

- Serum 0
- Stool 0
- Skin Lesion 1
- Whole Blood 0
- Urine 0

Q2

Question Difficulty	Medium
Associated Concepts	Lab Testing Varicella (Chickenpox)

What part of a skin lesion should a swab be taken for laboratory confirmation of varicella?

- Base of a wet lesion 1
- Base of a crusted lesion 0
- Top of a crusted lesion 0
- Top of a wet lesion 0

Q3

Question Difficulty	Easy
Associated Concepts	Lab Testing Varicella (Chickenpox)

When seeking laboratory confirmation of varicella, one plain glass slide should be allowed to air dry once it contains two filled in dime sized circles from the base of a wet lesion?

- True 1
- False 0

Q4

Question Difficulty	Hard
Associated Concepts	Lab Testing Varicella (Chickenpox)

How many plain glass slides should be collected for laboratory confirmation of varicella disease?

- One as long as it has two filled in dime sized circles from the swab 0
- Two slides with two filled in dime sized circles from the base of a wet lesion 1
- Two slides from swabs from two wet lesions each with one dime sized circle. 0
- One slide with a quarter sized circle for the swab at the base of a wet lesion 0

Q5

Question Difficulty Easy

Associated Concepts Lab Testing Varicella (Chickenpox)

Serum specimens should be collected in a vacutainer (red stopper) or serum separator tube when testing for varicella immunity (IgG)?

- True 1
- False 0

Q6

Question Difficulty Medium

Associated Concepts Lab Testing Varicella (Chickenpox)

IgM testing may be performed on unimmunized people or persons with questionable immunity?

- True 1
- False 0

Q7

Question Difficulty Hard

Associated Concepts Specimen and Lab Collection Varicella (Chickenpox)

In the surveillance case definition for Varicella which is **NOT** laboratory criteria for diagnosis:

- Isolation of varicella virus from a clinical specimen 0
- Direct Fluorescent Antibody (DFA) 0
- Polymerase chain reaction (PCR) 0
- Significant rise in serum varicella IgG by any standard assay 0
- Positive IgM for serology 1

Q9

Question Difficulty Hard

Associated Concepts Specimen and Lab Collection Varicella (Chickenpox), Lab Testing Varicella (Chickenpox)

In the blood specimen for serology, which of the following statements in NOT accurate:

- IgM EIA is a single serum which a previous immunization may negate IgM response 0
- IgG EIA is preferred for paired sera and will detect 4-fold rise or significant antibody level change indicative of recent infection. 0
- IgG EIA can be conducted in a single serum to detect immune status. 0
- IgM EIA is preferred for paired sera and will detect a 4-fold rise or significant antibody level change indicative of recent infection. 1

Q11

Question Difficulty	Easy
Associated Concepts	Specimen and Lab Collection Measles, Specimen and Lab Collection Varicella (Chickenpox)

Select illnesses that are considered communicable febrile rash illness, select all that apply.

- Measles 1
- Rubella 1
- Salmonella 0
- Varicella 1
- Hand, Foot, Mouth 1
- Giardia 0

Q12

Question Difficulty	Medium
Associated Concepts	Lab Testing for Measles

What is the **primary** clinical specimen that should be collected for measles diagnosis?

- Serum for IgM and IgG testing 1
- Urine for IgM and IgG testing 0
- Stool IgM and IgG testing 0
- Whole Blood IgM and IgG testing 0

Q14

Question Difficulty	Medium
Associated Concepts	Lab Testing for Measles

For clinical specimens for measles, under what conditions should the specimens is shipped?

- Refrigerate, do not freeze. Ship immediately. 1
- Freeze. Ship immediately. 0
- Refrigerate. Ship by next business day. 0
- Freeze. Ship by next business day. 0

Q15

Question Difficulty	Hard
Associated Concepts	Specimen and Lab Collection Measles

In the laboratory criterion in the case definition for diagnosis of measles, which statement does NOT apply?

- Positive serologic test for Measles IgM antibody 0
- Significant rise in measles antibody level by a standard serologic assay 0
- Isolation of measles virus from a clinical specimen 0
- Positive Direct Fluorescent Antibody (DFA) 1

Q16

Question Difficulty	Medium
Associated Concepts	Lab Testing for Measles

Lymphocytes are a good source for virus isolation?

- True 1
- False 0

Q17

Question Difficulty	Easy
Associated Concepts	Lab Testing for Measles

What color vacutainer tube will you use for whole blood specimens? (multiple choice) 10 seconds

- red stopper or serum separator tube 1
- Green stopper tube 0
- Purple stopper tube 0
- Black stopper tube 0

Q18

Question Difficulty	Medium
Associated Concepts	Lab Testing for Measles

The timeframe within which whole blood specimens are transported to the lab should be within 48 hours of collection and stored at 4°C.

- True 1
- False 0

Q19

Question Difficulty	Medium
Associated Concepts	Lab Testing for Measles

What is the appropriate temperature within which a whole blood specimen should be stored for transport?

- The whole blood should be stored at 10°C 0
- The whole blood should be stored at 15°C 0
- The whole blood should be stored at 30°C 0
- None of the above 1

Q20

Question Difficulty	Medium
Associated Concepts	Specimen and Lab Collection Measles

Detecting IgM in a serum specimen after infection with measles virus starts around the time of rash onset and may be detected for 1–2 months.

- True 1
- False 0

Q21

Question Difficulty	Medium
Associated Concepts	Specimen and Lab Collection Measles

Detecting IgG in a serum specimen after infection with measles virus starts at about 5–10 days after rash onset, but typically persists for a lifetime.

- True 1
- False 0

Q22

Question Difficulty	Hard
Associated Concepts	Lab Testing for Measles, Specimen and Lab Collection Measles

What type of specimen will you need for an IgM Enzyme Immunoassay (EIA) test for measles diagnosis?

- Urine 0
- Whole Blood 0
- Serum 1
- Nasal Swab 0

Q23

Question Difficulty	Hard
Associated Concepts	Lab Testing for Measles, Specimen and Lab Collection Measles

What are the implications of 4-fold rise or significant IgG level increase in an IgG EIA?

- Indicative of immunity 0
- Indicative of recent infection 1
- Indicative of no infection 0
- Indicative of past infection0

Q25

Question Difficulty	Medium
Associated Concepts	Lab Testing for Measles

If you have a serum sample, you will need to request a nasal sample as this is the primary specimen for measles diagnosis

- True 0
- False 1

Q26

Question Difficulty	Medium
Associated Concepts	Lab Testing for Measles

Freezing helps to secure viral transport media for shipping

- True 0
- False 1

Q27

Question Difficulty	Easy
Associated Concepts	Lab Testing for Measles

Freezing any clinical specimen for measles testing prior to shipping should be avoided to ensure good viral yield.

- True 1
- False 0

Q28

Question Difficulty	Easy
Associated Concepts	Lab Testing for Measles

Urine for measles testing should be frozen to avoid leakage during shipment

- True 0
- False 1

Q29

Question Difficulty	Easy
Associated Concepts	Lab Testing for Measles

Patient data is collected only after sample collection

- True 0
- False 1

Q30

Question Difficulty	Easy
Associated Concepts	Lab Testing for Measles

Minimum data points that should be collected from a patient suspected of measles infection are:

- Name, Date of Birth, Rash Onset Date, Vaccination History, Travel History, Antibody (IgM, IgG) results 1
- Name, Date of Birth, Rash Onset Date, Vaccination History, Travel History 0
- Name, Date of Birth, Rash Onset Date, Vaccination History 0
- Name, Date of Birth, Rash Onset Date, Travel History, 0

Q31

Question Difficulty	Easy
Associated Concepts	Signs and Symptoms of Measles

The signs and symptoms of measles include fever, malaise, cough, coryza, conjunctivitis, Koplik spots and maculopapular rash.

- True 1
- False 0

Q32

Question Difficulty	Easy
Associated Concepts	Signs and Symptoms of Varicella

The signs and symptoms of varicella include rash of blister lesions concentrated on the face, scalp, and trunk and then to the rest of the body (macular to papular to vesicular), prodrome prior to rash includes fever, headache, and tiredness.

- True 1
- False 0

Q33

Question Difficulty	Easy
Associated Concepts	Transmission of Measles

Measles is highly contagious viral illness that can be transmitted by direct contact with infectious droplets, airborne transmission, or indirect contact (fomite).

- True 1
- False 0

Q34

Question Difficulty	Easy
Associated Concepts	Transmission of Varicella

Varicella is transmitted by coughing and sneezing, direct contact and by aerosolization of virus from skin lesions.

- True 1
- False 0

Q35

Question Difficulty	Easy
Associated Concepts	Complications of Measles

Common measles complications include otitis media, bronchopneumonia, laryngotracheobronchitis and diarrhea.

- True 1
- False 0

Q36

Question Difficulty	Easy
Associated Concepts	Complications of Varicella

Complications for varicella in otherwise healthy people is not common. Persons at high risk for complications are infants, pregnant women and the immunocompromised.

- True 1
- False 0

Q37

Question Difficulty	Easy
Associated Concepts	Vaccination for Measles

The Measles, Mumps Rubella (MMR) vaccine has 2 doses. The first dose is recommended at age 12-15 months and the second dose at 4-6 years or 28 days following the first dose.

- True 1
- False 0

Q38

Question Difficulty	Easy
Associated Concepts	Vaccination for Varicella

The Varicella vaccine (VZV) has two 2 doses. The first dose is recommended at age 12-15 months and the second dose at 4-6 years.

- True 1
- False 0

Q39

Question Difficulty	Easy
Associated Concepts	Reporting Requirements for Measles

Laboratories and physicians are required to report immediately upon initial suspicion or laboratory test order.

- True 1
- False 0

Q40

Question Difficulty	Easy
Associated Concepts	Reporting Requirements for Varicella

Reporting of a varicella disease outbreak in the general community or any defined setting such as hospital, school, or other institution.

- True 1
- False 0

Q41

Question Difficulty	Easy
Associated Concepts	Evidence of Immunity for Measles

Evidence of immunity for measles include documentation of adequate vaccination, laboratory evidence of immunity, laboratory confirmation of measles or birth in the U.S. before 1957.

- True 1
- False 0

Q42

Question Difficulty	Easy
Associated Concepts	Shingles

Shingles is the reactivation of the varicella virus.

- True 1
- False 0

APPENDIX G: GIFT NAVIGATION FOR LABORATORY TESTING FOR FEBRILE RASH ILLNESS

Figure 27: GIFT Gateway Model Set Up After Selecting Course

Figure 28: Setup Status Connected; Configured, Select Continue to Launch Course

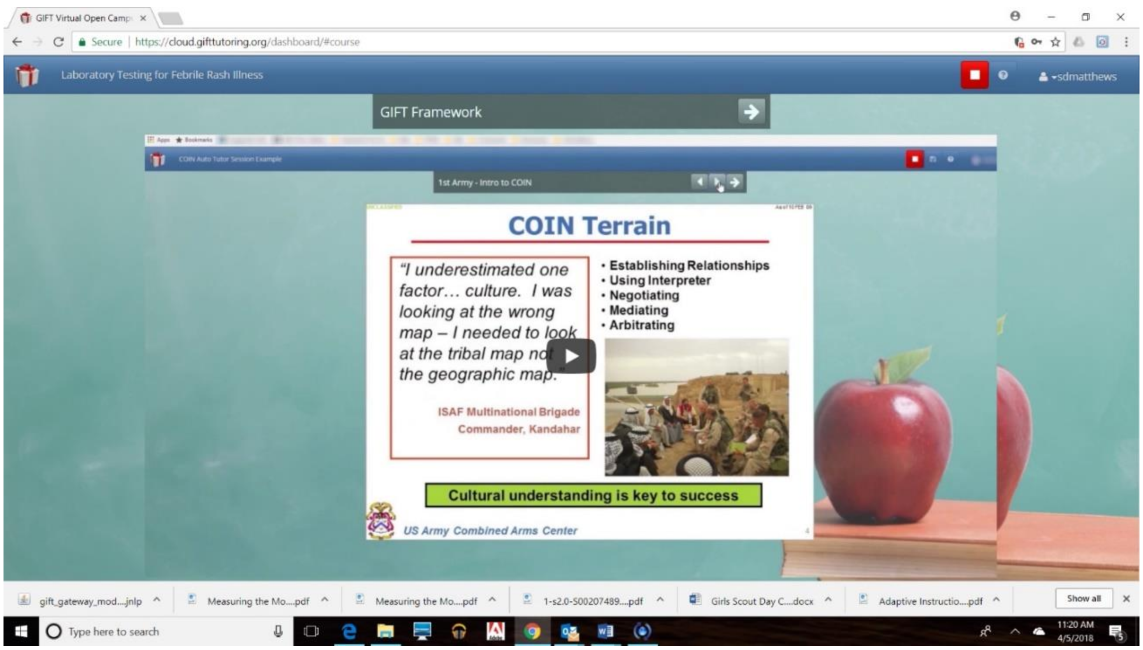


Figure 29: GIFT Framework Video

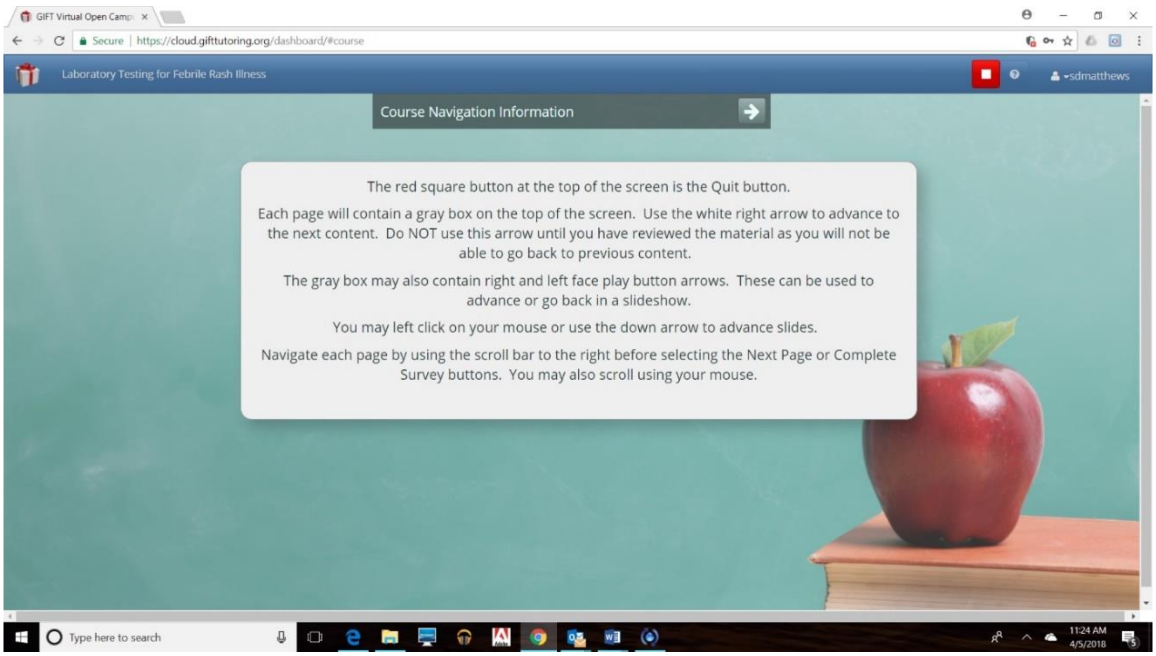


Figure 30: Course Navigation Information Page

If the learner already has data collected in the course, this prompt will show.

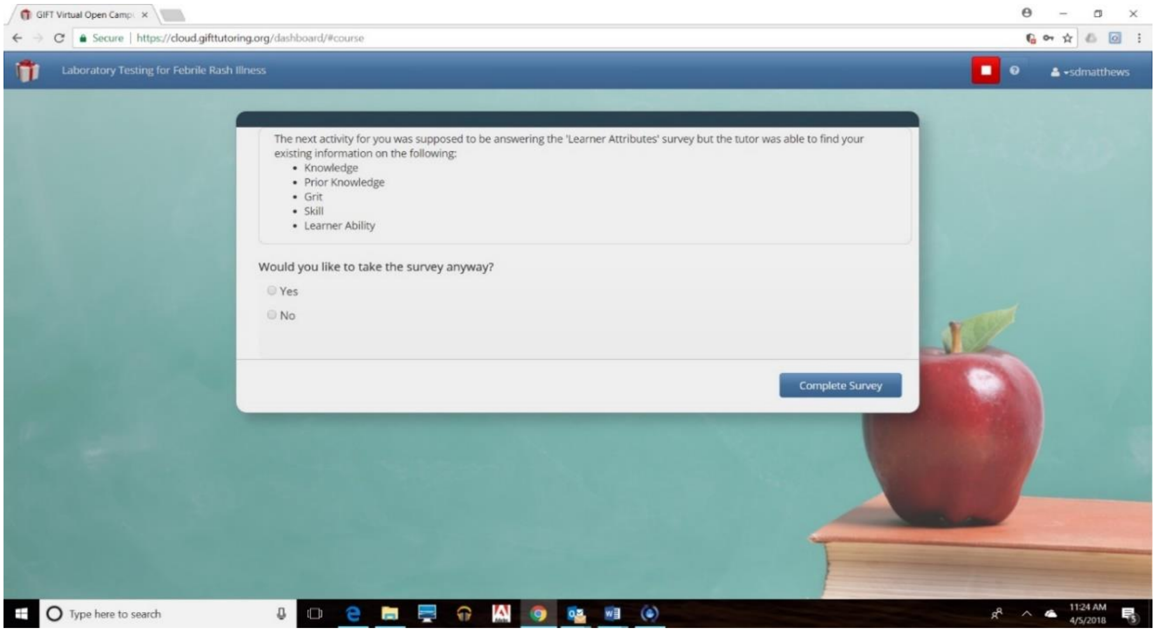


Figure 31: Prompt when Learner has data already collected in the course

Pre-Assessment Test

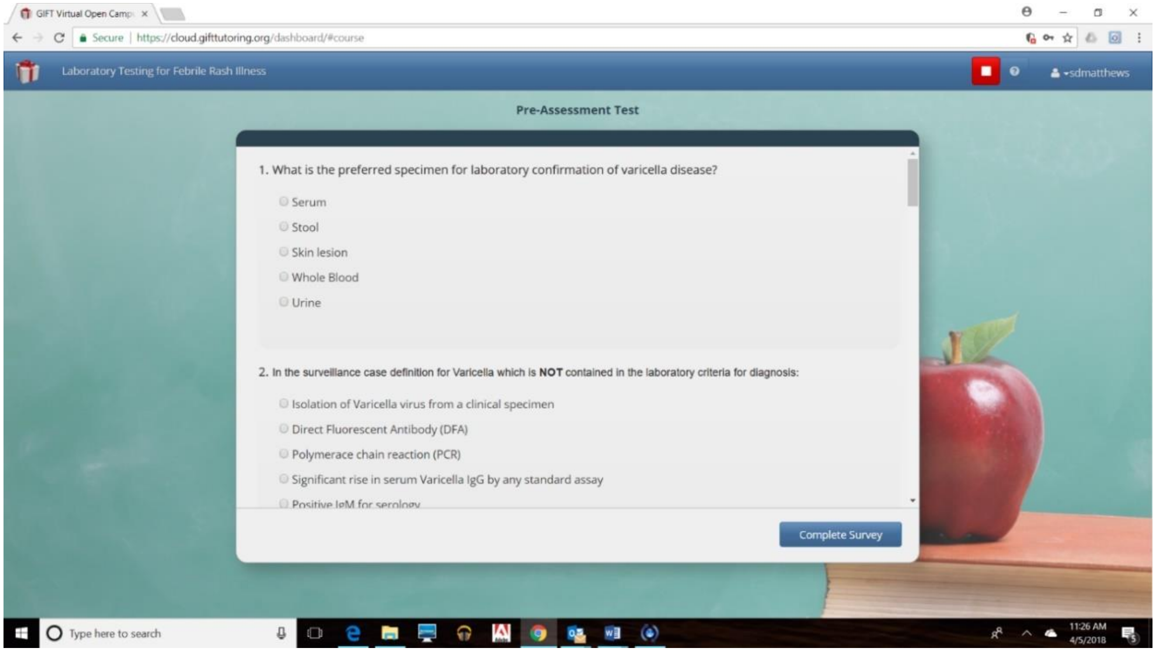


Figure 32: Pre-Assessment Test Prompt

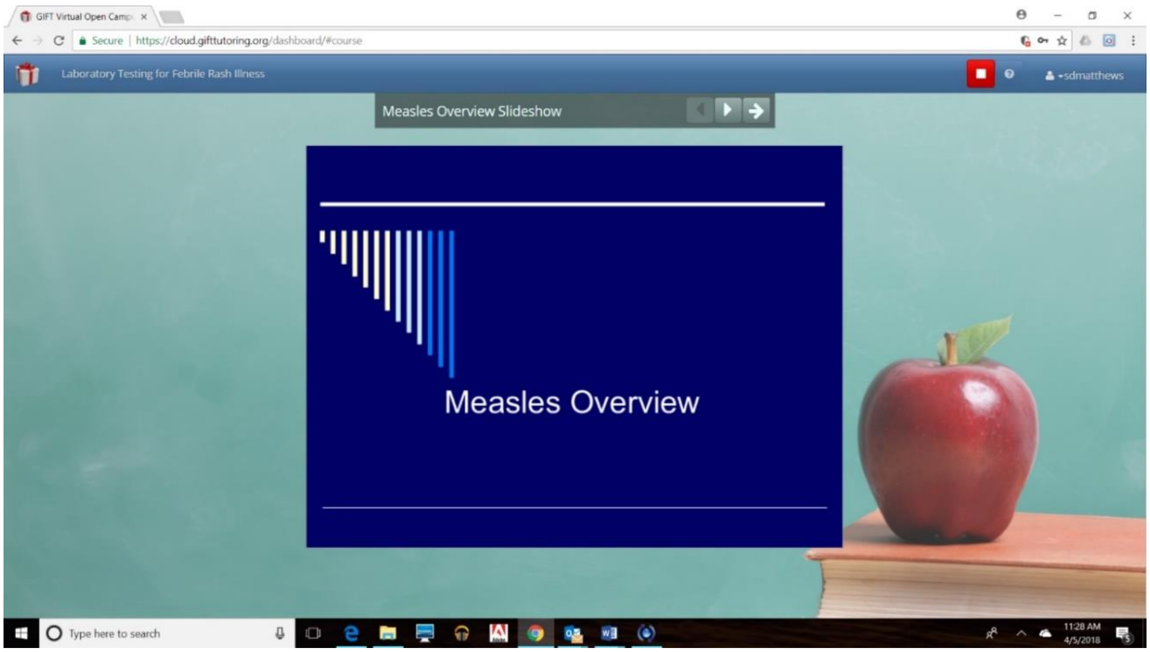


Figure 33: Measles Overview Slideshow

Knowledge Assessment Survey for adaptive learning. If learner does not demonstrate command of the concept additional content will be presented to the learner.

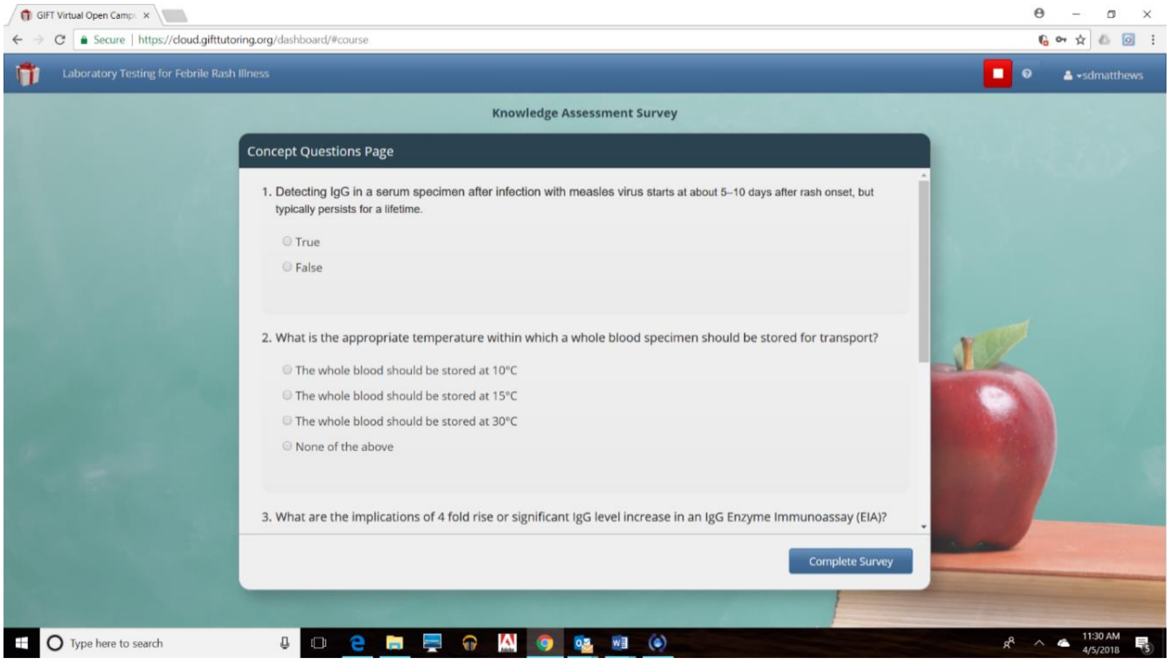


Figure 34: Knowledge Assessment Survey

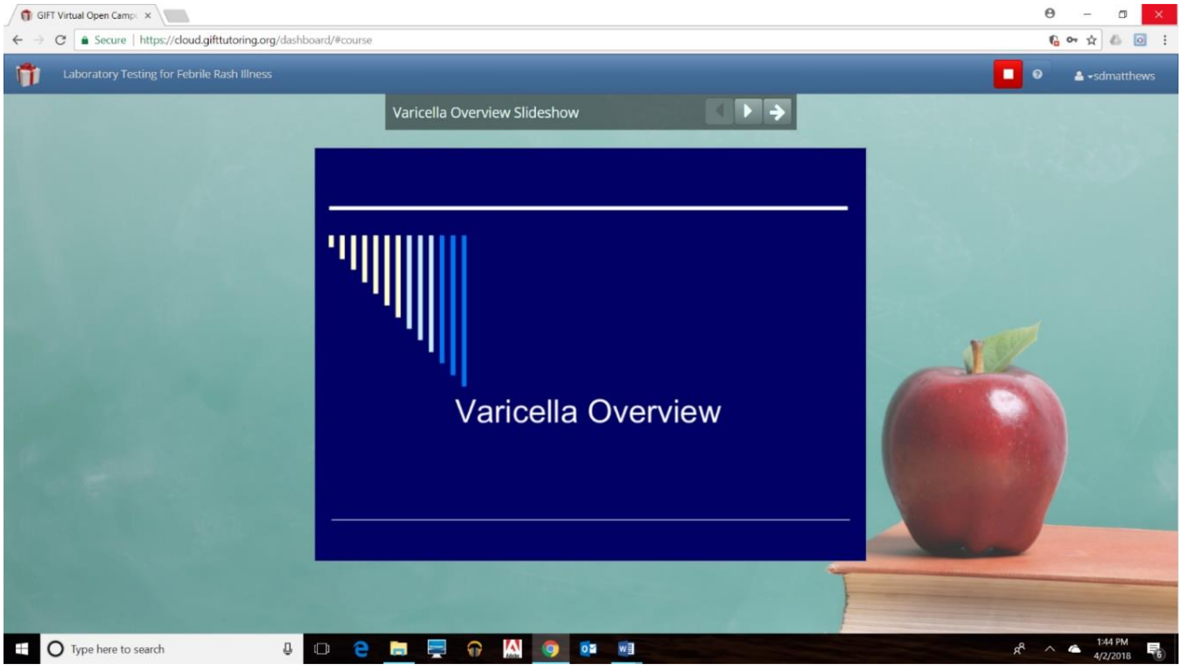


Figure 35: Varicella Overview Slideshow Prompt

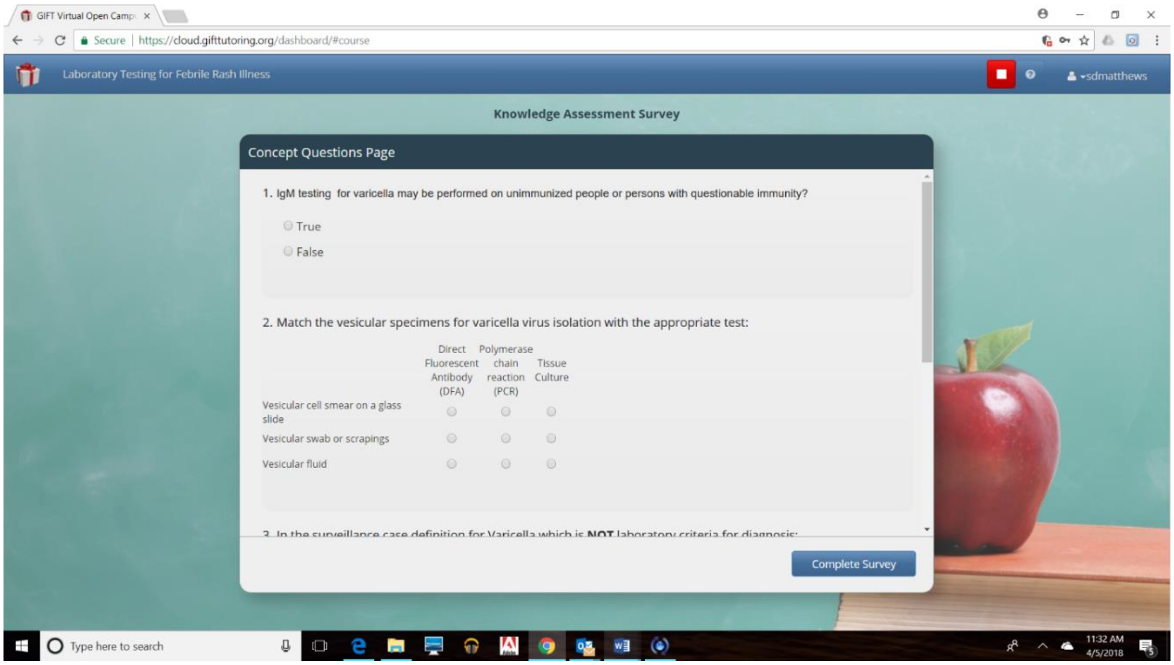


Figure 36: Knowledge Assessment Survey for Adaptive Learning

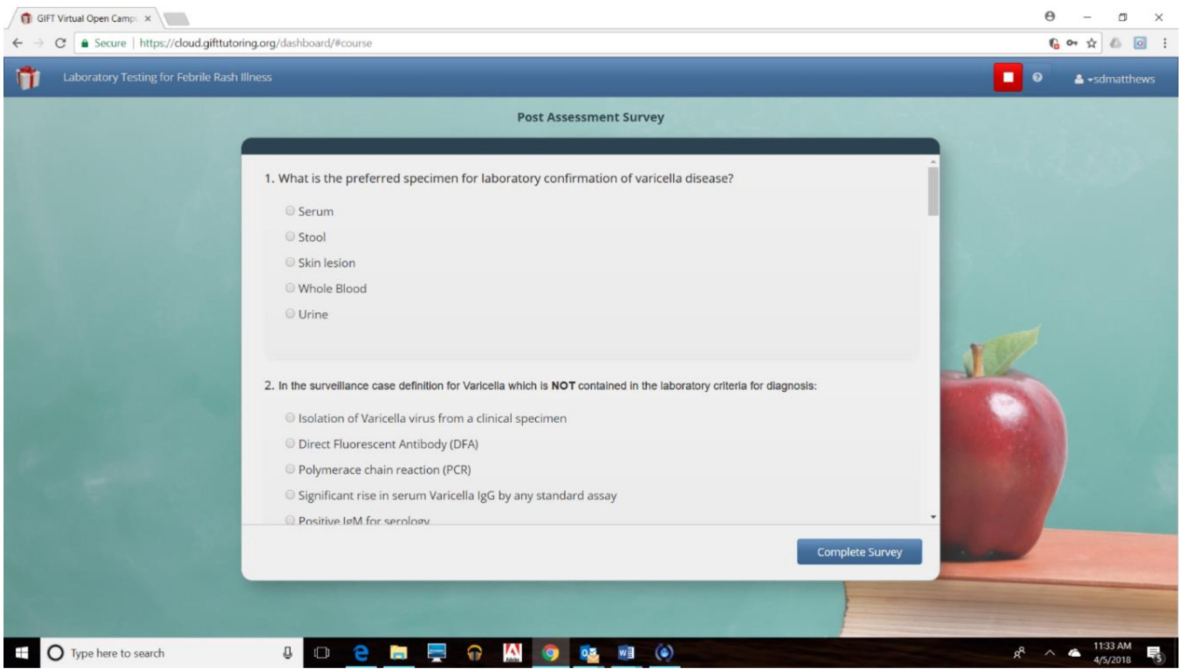


Figure 37: Post Assessment Survey Prompt

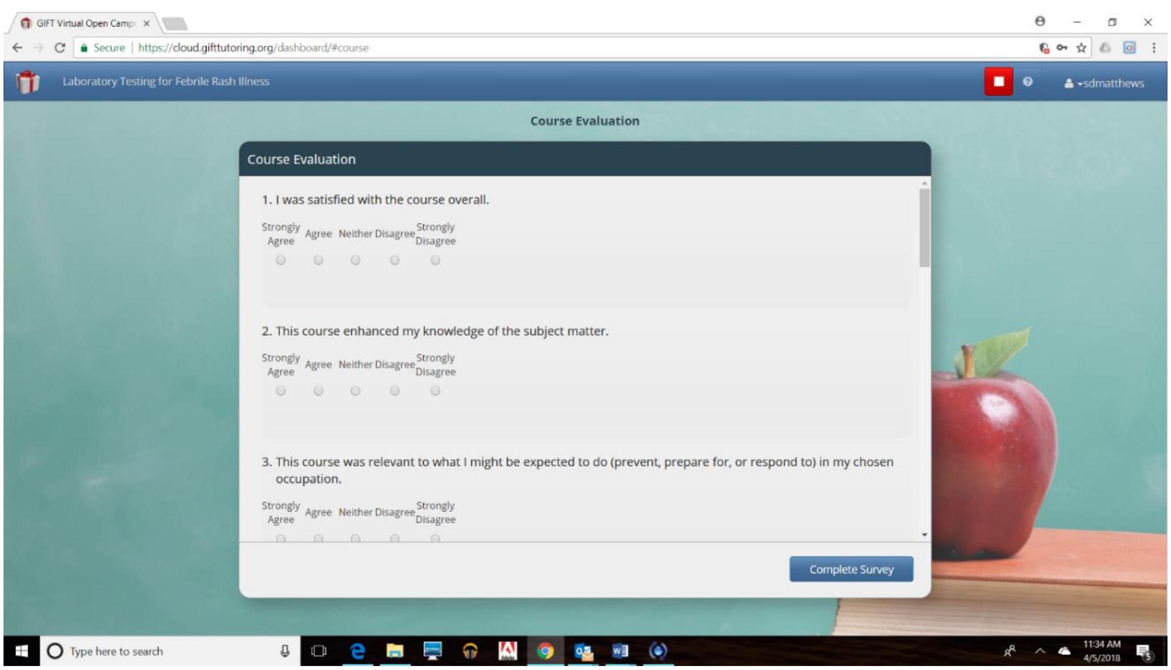


Figure 38: Course Evaluation Prompt

APPENDIX H: GIFT CREATOR NAVIGATION FOR LABORATORY TESTING FOR FEBRILE RASH ILLNESS

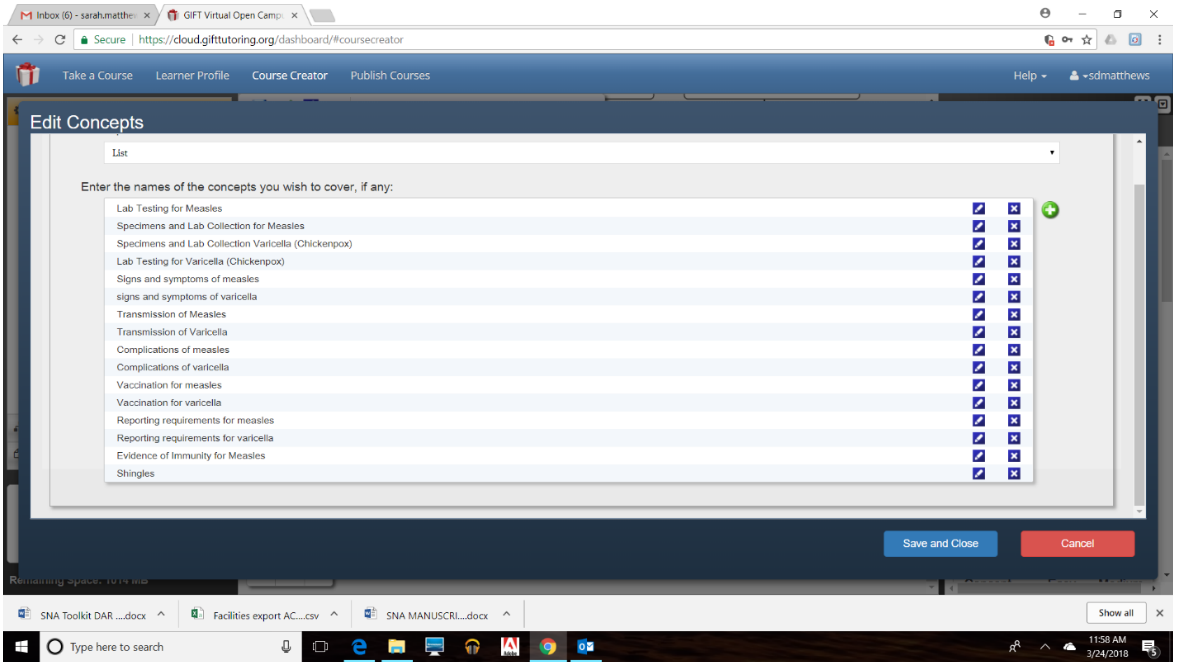


Figure 39: Course Concepts Edit Page

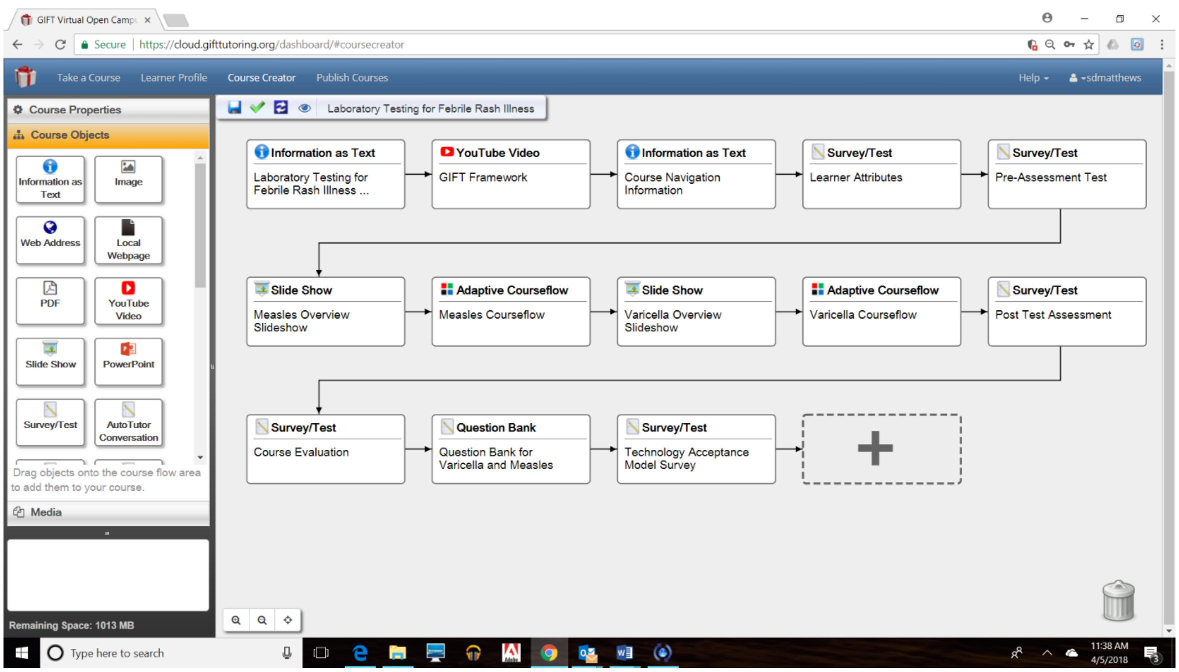


Figure 40: GIFT Course Schematic for Laboratory Testing for Febrile Rash Illness

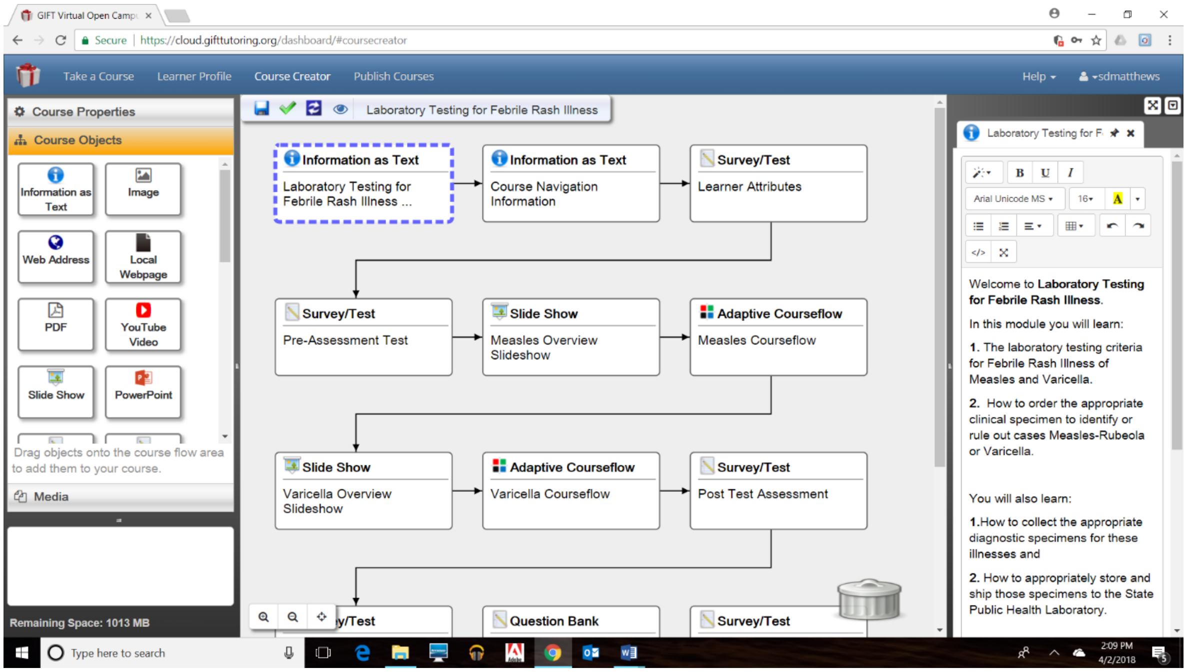


Figure 41: Example of Information as Text Course Object

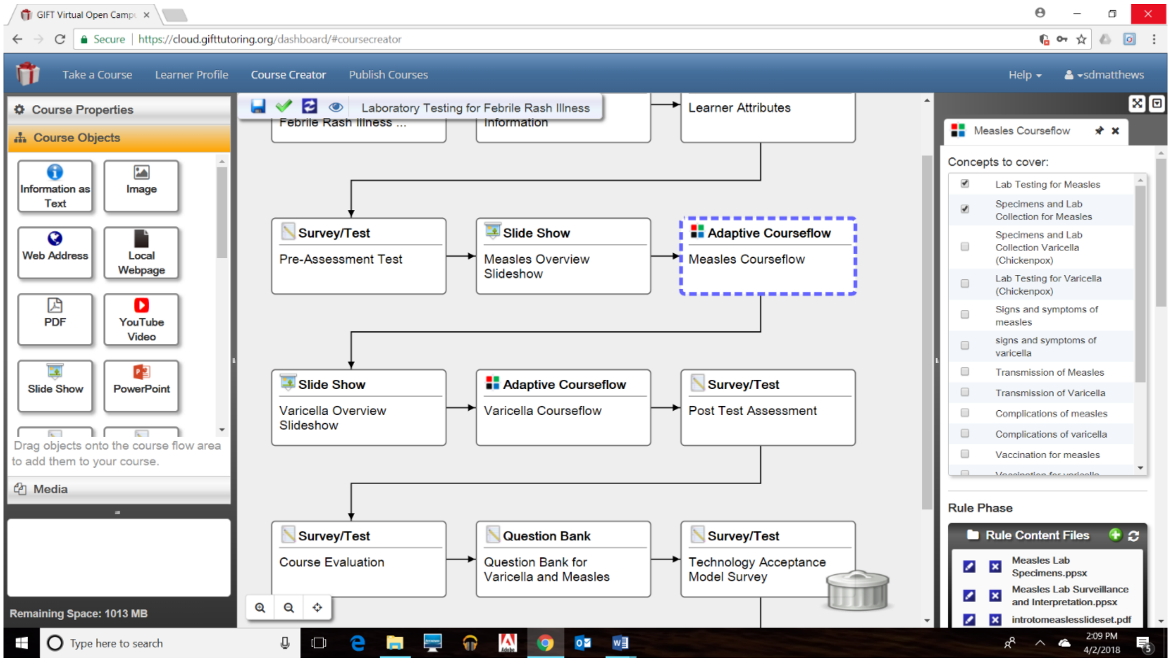


Figure 42: Example of Adaptive Courseflow Measle Courseflow

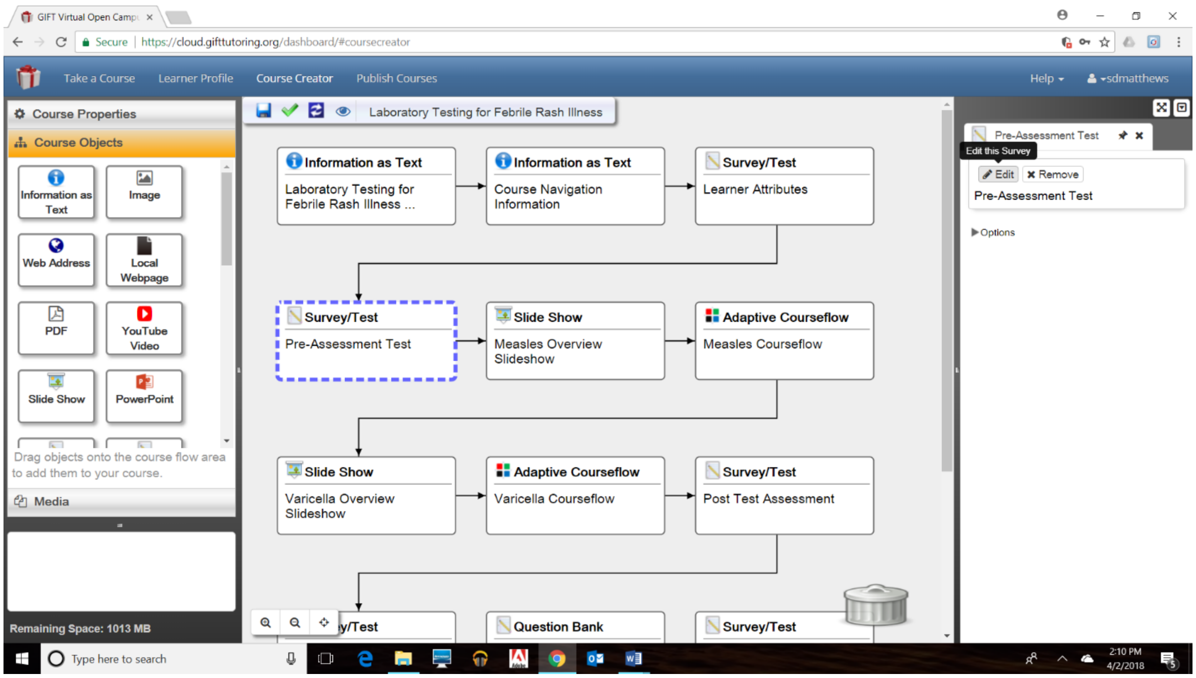


Figure 43: Example of Survey/Test Course Object-Pre-Assessment Test

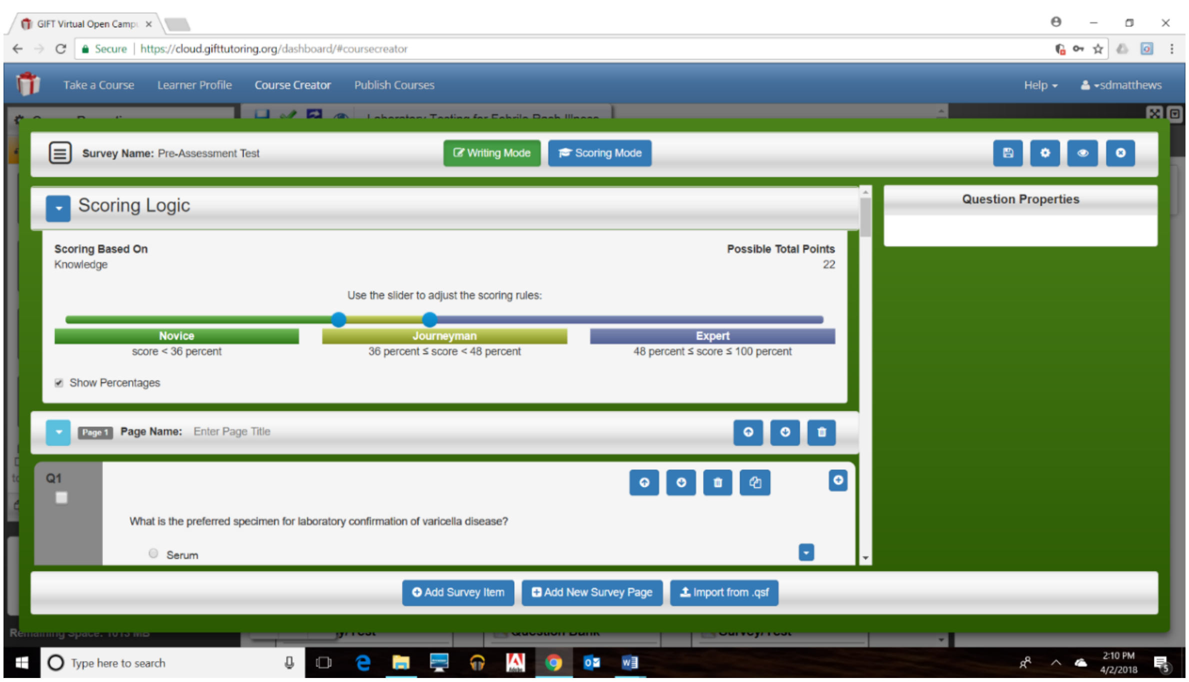


Figure 44: Example Writing and Scoring Mode for Survey

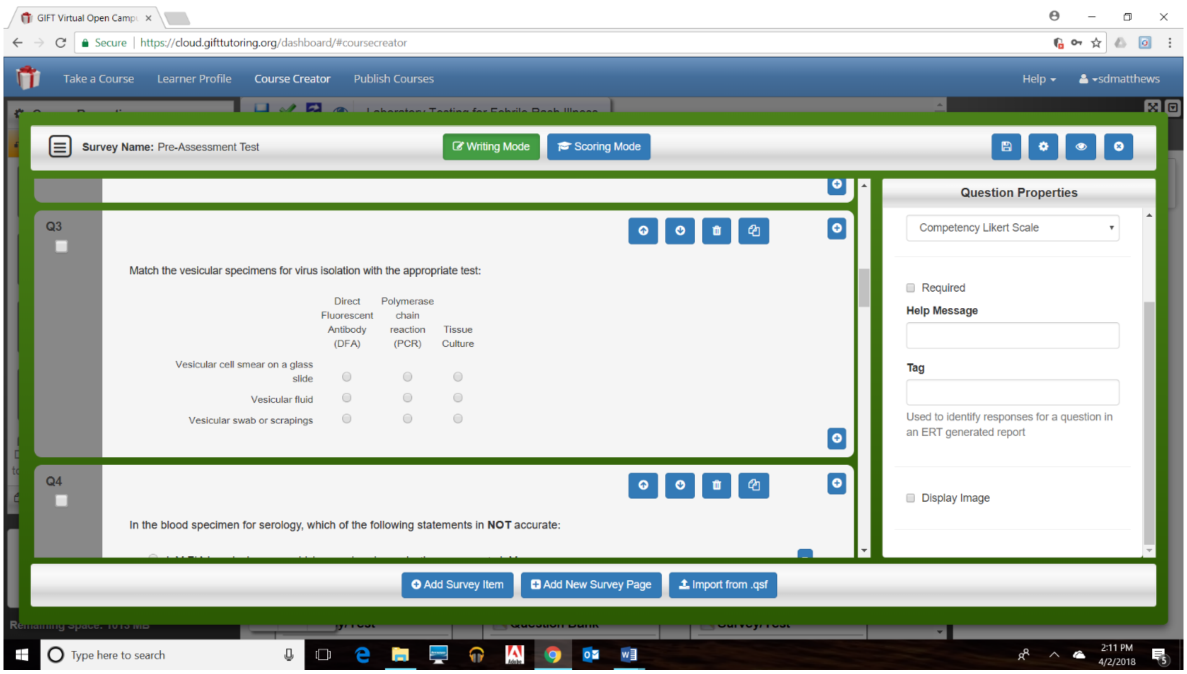


Figure 45: Example of Matrix/Matching Question

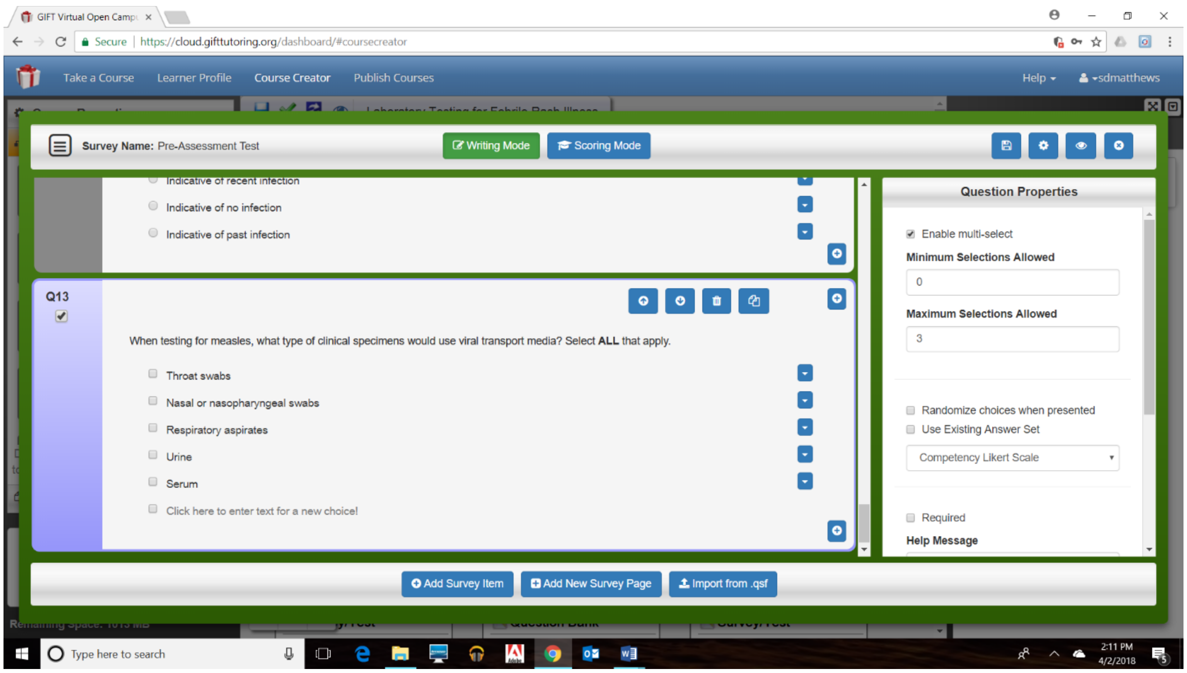


Figure 46: Example of Multiple Selection Question

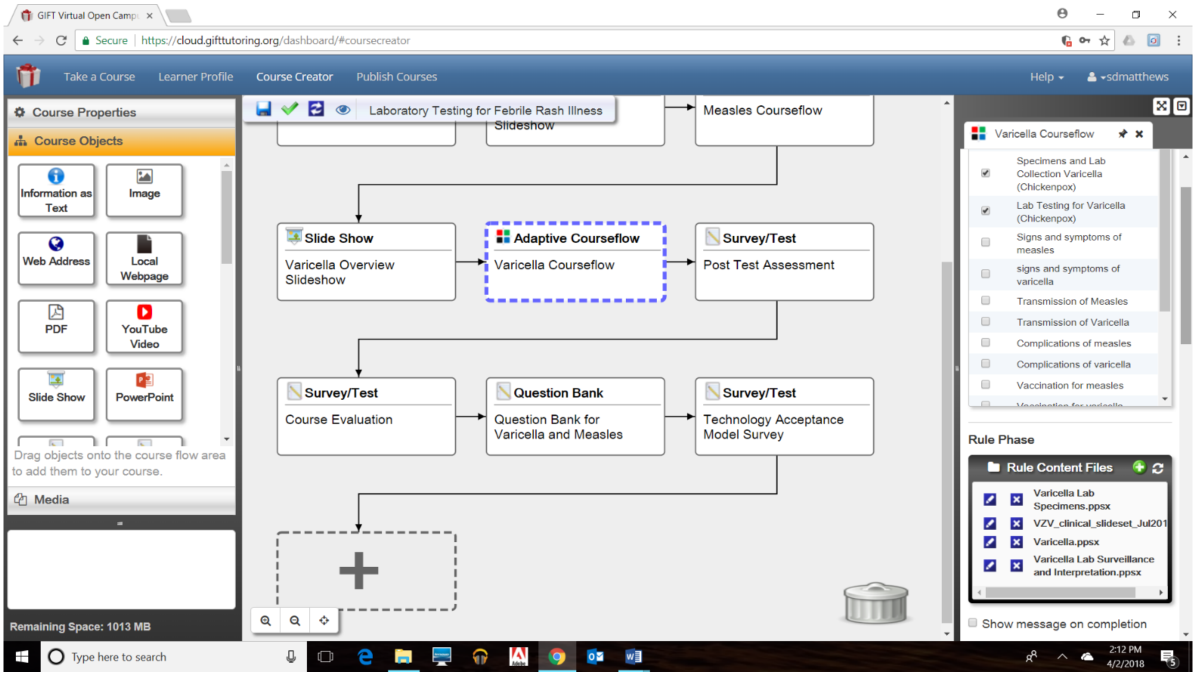


Figure 47: Example Adaptive Courseflow Course Object with Concepts and Rule Phase Demonstrated

APPENDIX I: UCF INSTITUTIONAL REVIEW BOARD

University of Central Florida

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Sarah Matthews**

Date: **October 08, 2018**

Dear Researcher:

On 10/08/2018 the IRB approved the following human participant research until 10/07/2019 inclusive:

Type of Review:	UCF Initial Review Submission Form Expedited Review
Project Title:	The suitability and acceptance of Intelligent Tutoring Systems for surge capacity events for governmental public health
Investigator:	Sarah Matthews
IRB Number:	SBE-18-14393
Funding Agency:	
Grant Title:	
Research ID:	N/A

The scientific merit of the research was considered during the IRB review. The Continuing Review Application must be submitted 30 days prior to the expiration date for studies that were previously expedited, and 60 days prior to the expiration date for research that was previously reviewed at a convened meeting. Do not make changes to the study (i.e., protocol, methodology, consent form, personnel, site, etc.) before obtaining IRB approval. A Modification Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at https://iris.research.ucf.edu .

If continuing review approval is not granted before the expiration date of 10/07/2019, approval of this research expires on that date. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

Use of the approved, stamped consent document(s) is required. The new form supersedes all previous versions, which are now invalid for further use. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Participants or their representatives must receive a copy of the consent form(s).

All data, including signed consent forms if applicable, must be retained and secured per protocol for a minimum of five years (six if HIPAA applies) past the completion of this research. Any links to the identification of participants should be maintained and secured per protocol. Additional requirements may be imposed by your funding agency, your department, or other entities. Access to data is limited to authorized individuals listed as key study personnel.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

This letter is signed by:

Institutional Review Board
FWA00000351
IRB00001138Office of Research
12201 Research Parkway
Orlando, FL 32826-3246

UNIVERSITY OF CENTRAL FLORIDA

APPROVAL

September 18, 2019

Dear Sarah Matthews:

On 9/18/2019, the IRB reviewed the following submission:

Type of Review:	Modification and Continuing Review
Title:	The suitability and acceptance of Intelligent Tutoring Systems for surge capacity events for governmental public health
Investigator:	Sarah Matthews
IRB ID:	MODCR00000223
Funding:	None
Grant ID:	None
IND, IDE, or HDE:	None
Documents Reviewed:	• HRP-251 - FORM - Faculty Advisor Review (002).pdf, Category: Faculty Research Approval; • CV_SarahMatthews_2018.doc, Category: Other; • IRB_HRP-502_TEMPLATE_ADULT_CONSENT_FORM_Version 6.pdf, Category: Consent Form; • IRB_HRP-503 - ITS Factors and levels_Version 3.docx, Category: IRB Protocol; • Recruitment Script_3.docx, Category: Recruitment Materials; • Updated Appendices_SMatthews_Dissertation_IRB Renewal.docx, Category: Survey / Questionnaire;

The IRB approved the protocol from 9/18/2019 to 9/17/2020.

In conducting this protocol, you are required to follow the requirements listed in the Investigator Manual (HRP-103), which can be found by navigating to the IRB Library within the IRB system.

If you have any questions, please contact the UCF IRB at 407-823-2901 or irb@ucf.edu. Please include your project title and IRB number in all correspondence with this office.

Sincerely,

Gillian Bernal

Gillian Bernal
Designated Reviewer

UNIVERSITY OF CENTRAL FLORIDA

Institutional Review Board
FWA00000351
IRB00001138
Office of Research
12201 Research Parkway
Orlando, FL 32826-3246

CLOSURE

July 22, 2020

Dear Sarah Matthews:

On 7/22/2020, the IRB reviewed the following protocol:

Type of Review:	Continuing Review
Title:	Factors and levels that promote the intent and actual use of Intelligent Tutoring Systems for surge capacity events for governmental public health
Investigator:	Sarah Matthews
IRB ID:	CR00000714
Funding:	None
Grant ID:	None
IND, IDE, or HDE:	None

The IRB acknowledges your request for closure of the protocol effective as of 7/22/2020. As part of this action:

- The protocol is permanently closed to enrollment.
- All subjects have completed all protocol-related interventions.
- Collection of private identifiable information is completed.
- Analysis of private identifiable information is completed.

If you have any questions, please contact the UCF IRB at 407-823-2901 or irb@ucf.edu. Please include your project title and IRB number in all correspondence with this office.

Sincerely,

Racine Jacques, Ph.D.
Designated Reviewer

APPENDIX J: FLORIDA DEPARTMENT OF HEALTH INSTITUTIONAL REVIEW BOARD

Mission:
To protect, promote & improve the health of all people in Florida through integrated state, county & community efforts.

Florida HEALTH

Ron DeSantis
Governor

Vision: To be the Healthiest State in the Nation

February 11, 2019

To: Sarah Matthews, MPH

Protocol Title: The suitability and acceptance of Intelligent Tutoring Systems for surge capacity events for governmental public health
Submission Type: Initial Review
Review Type: Expedited Procedures

Approval Date: February 8, 2019

The Department of Health Institutional Review Board has reviewed and approved your application, including the following documents:

- Recruitment flyer and script
- Consent form 03/05/18
- Appendices with Survey Instruments
- Study Protocol 10/01/18

Please keep in mind:

- Report all problems listed below as soon as possible, but no later than five working days.
- If you need to make changes to your study, complete the modification application.
- If you have to make a change to eliminate hazard to human subjects and there is not time to submit a modification, notify the IRB as soon as possible but no later than five working days.

If you have questions, want to offer suggestions, or talk with someone about this or other projects, please contact Rotanya Bryan at the Department of Health IRB at (850) 558-9628 or toll-free in Florida (866) 433-2775.

Thank you for your cooperation with the IRB.

Sincerely,

Bonnie Gaughan-Bailey

Association for the Accreditation of Human Research Protection Programs, Inc.
Full Accreditation

Bonnie Gaughan-Bailey, MPA, ASQ-CQIA
Biomedical Research Section
Public Health Research

Federal Wide Assurance#: 00004682

Florida Department of Health
Division of Community Health Promotion
4052 Bald Cypress Way, Bin A-13 • Tallahassee, FL 32399
PHONE: 850/245-4100 • FAX: 850/414-6091
FloridaHealth.gov

PHAB Accredited Health Department
Public Health Accreditation Board

APPENDIX K: RECRUITMENT EMAIL

Dear Participant:

My name is Sarah Matthews. I am a graduate student at the University of Central Florida in the Modeling and Simulation Program. I am conducting research on intelligent tutoring systems and their acceptance as a means for remedial education for governmental public health professionals. I am inviting you to participate in this research because you have been identified as currently or have had served as a governmental public health professional who may have familiarity with events involving rash-like illness.

Participation in this research includes following a link for the GIFT platform. By clicking on the link, you acknowledge that your participation in the study is voluntary, you are ≥18 years of age and that you may choose to terminate your participation in the study at any time for any reason.

The link takes you directly to the course which consists of PowerPoint presentations, videos, documents, surveys, and knowledge assessments on the content that will be presented to you. This course is anticipated to take between 15 minutes up to 1 hour depending on your understanding of the content presented.

There is no personal identifying information collected in this research.

The link below will take you to the Febrile Rash-Like Illness Course in the GIFT Platform. The knowledge portion for the study will focus on the laboratory criteria for testing.

https://cloud.gifttutoring.org/tutor/?eid=8412965a-a8a2-4a70-9890-c997cabf3edb

I have also attached a PDF document, GIFT Gateway Module Set Up, to this communication to help when accessing the GIFT platform.

The research timeframe is scheduled from November 19, 2018 to December 19, 2018. If you are receiving this communication outside of these dates, please disregard this communication.

If you are refusing to participate in this study, why did you not wish to participate?

- ☐ No time
- ☐ Not interested,
- ☐ Invasion of Privacy,
- ☐ Participation not supported by my employer,
- ☐ Previous experience with studies was unpleasant,
- ☐ Information technology barrier (i.e. system compatibility),
- ☐ Waste of time
- ☐ General Refusal
- ☐

Please click on the link to answer this question
http://ucf.qualtrics.com/jfe/form/SV_ePYHU8XbZR1iAv3.

If you have any questions or comments, please feel free to contact me.

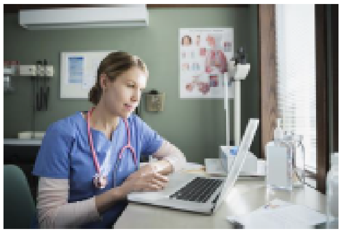
Sarah Matthews, MPH

University of Central Florida

Modeling and Simulation Program

Sarah.Matthews@knights.ucf.edu

APPENDIX L: RECRUITMENT FLYER



ARL GIFT

UNIVERSITY OF CENTRAL FLORIDA

NOVEMBER 28, 2019

INTELLIGENT TUTORING SYSTEM STUDY PILOT

Participation in Ph.D. Dissertation Pilot Study

If you are a public health professional that has some experience with febrile rash illnesses and have an interest in innovative technology, you may consider participating in a pilot study seeking to understand new methods for training public health professionals. The study will occur concurrently with your already scheduled training.

What to Expect...

Participation in this research includes following a link for the GIFT platform on your browser. The link takes you directly to the course which consists of PowerPoint presentations, videos, documents, surveys and knowledge assessments on the content that will be presented to you.

Following the course, you will be asked to participate in a focus group to discuss your experience in the tutoring environment.

There is no personal identifying information collected in this research. Participation in this study is voluntary.

How much time will it take...

The course is anticipated to take between 15 minutes and up to 1 hour depending on your understanding of the content presented.

The focus group discussion is anticipated to take no more than 1 hour.

Participants will need to please bring internet accessible computer and headphones/earplugs to the session.

Are you a public health professional?

Would you like to learn about an innovative approach to training?

Are you at least 18 years of age?

Do you have a computer with internet access?

Participate in a student pilot study!

November 28, 2019

9:30a.m.-11:30a.m.

DOH-Mosquito

1234 UCF Drive

Mosquito, FL

Questions about the study please contact the Principle Investigator:

Sarah Matthews, MPH

Sarah.Matthews@knights.ucf.edu

APPENDIX M: CONSENT FORM

University of Central Florida

Title of research study: The suitability and acceptance of Intelligent Tutoring Systems for surge capacity events for governmental public health

Informed Consent

Principal Investigator(s): Sarah D. Matthews, MPH

Faculty Supervisor: Michael D. Proctor, Ph.D., LTC (Retired), CMSP

Investigational Site(s): Procedural Pilot Study- Florida Department of Health Conference Room and Online through the GIFT Platform

Main Study: Online-GIFT Platform

Why am I being invited to take part in a research study?

We invite you to take part in a research study because you are or have worked as a governmental public health employee and have experience or familiarity with surge capacity events involving febrile rash-like illness (e.g. chickenpox, measles).

You must be 18 years of age or older to participate in this study.

What should I know about a research study?

- Someone will explain this research study to you.
- Whether or not you take part is up to you.
- You can choose not to take part.
- You can agree to take part and later change your mind.
- Your decision will not be held against you.
- You can ask all the questions you want before you decide.

Who can I talk to?

If you have questions, concerns, or complaints, or think the research has hurt you, talk to the research team at sarah.matthews@knights.ucf.edu

This research has been reviewed and approved by an Institutional Review Board ("IRB"). You may talk to them at 407-823-2901or irb@ucf.edu if:

- Your questions, concerns, or complaints are not being answered by the research team.
- You cannot reach the research team.
- You want to talk to someone besides the research team.
- You have questions about your rights as a research subject.
- You want to get information or provide input about this research.

If you want to talk with someone independent of the research team for questions, concerns, or complaints about the research; questions about your rights; to obtain information; or to offer input, you can contact the Florida Department of Health Institutional Review Board.

An Institutional Review Board is a group of people who review research to ensure participants are protected and the research is conducted in an ethical way. You can contact the IRB at: 850-245-4585.

Why is this research being done?

This study would seek to understand if an intelligent agent (i.e. Intelligent Tutoring System) would be suitable and accepted for education and training functions of public health professional for a surge capacity public health event. The study would utilize an extension of the Davis' Technology Acceptance Model (TAM) by integrating constructs from the Public Health Service's Health Belief Model (HBM) to better understand actual use of new technology in public health research.

There are gaps in training professionals in governmental public health. These gaps are especially noticeable when the system is challenged by unexpected surge capacity events such as epidemics, outbreaks, natural disasters or bioterrorism events or any event that has significant risk to the health of the community. Intelligent agents such as the use of an adaptive tutor offer a novel approach to facilitate personalized education for governmental public health professionals to maintain expertise and knowledge, skills and abilities to prevent or mitigate the consequences of these unexpected surge events.

How long will the research last?

We expect that you will be in this research study for 15 minutes to 2 hours.

How many people will be studied?

We expect about 150 people will be in this research study nationally. The procedural pilot study is anticipated to have 10% of the anticipated needed study population (~15 people).

What happens if I say yes, I want to be in this research?

Participation in this research includes following a link to GIFT platform by your computer's browser and taking a course in the GIFT platform. The course consists of PowerPoint presentations, videos, documents, surveys and knowledge assessments on the content that will be presented to you. This course is anticipated to take between 15 minutes up to 1 hour depending on your understanding of the content presented.

GIFT Experiment capability on cloud.gifttutoring.org, participants are not required to provide their name or any personally identifiable information. The data is stored in a temporary log file on the server for each participant. That data is mapped to the GIFT experiment and contains a unique participant identifier so that participants can partake in other courses available. The participant identifier is unique per entry into the platform. If a participant leaves the course before completing the course their responses are saved but analyzed as incomplete. The same participant can re-enter the system on the same computer but will be given a new participant identifier.

There is no personal identifying information collected in this research. Participation in this study is voluntary.

Participants in the procedural pilot study will be asked to participate in a 1-hour post-platform use focus group to gather information on the system design. The data will be used to reduce ambiguity in the content and to assure directions are sufficiently self-explanatory. Data collected during the procedural pilot study will be used to evaluate the design of the system and assessment and survey tools. Written notes will be taken during the focus group session. The results of the procedural pilot study will be presented to the student's dissertation committee but will not be used in any formal publications.

Data collected during the main study will be analyzed and used for peer-reviewed publications.

What happens if I do not want to be in this research?

Participation in research is completely voluntary. You can decide to participate or not to participate. This research contains an optional one question survey that asks why you chose not to participate.

What happens if I say yes, but I change my mind later?

You can leave the research at any time it will not be held against you.

Personal identifiers are not collected in the procedural pilot study or the study. If you change your mind while on the GIFT platform, your partial selections on the platform will be saved but will be counted as an incomplete course and the partial data may not be used for analysis. If you leave the platform and then decide to re-enter you will be prompted as a new learner.

What happens to the information collected for the research?

Efforts will be made to limit the use and disclosure of your personal information to people who have a need to review this information. We cannot promise complete secrecy. Organizations that may inspect and copy your information include the IRB and other representatives of this organization.

The GIFT platform is a research prototype maintained by the Army Research Laboratory (ARL). Registration on the platform contains a participant identifier that will track the courses the participants takes. A select few persons at ARL have direct access to the server on which data is temporarily stored until the principle research downloads it. However, this study does not require any registration to the site. No personal identifiers are collected or tracked.

If you leave the platform before completing the course, the system will collect your partial responses. Re-entering the platform through the provided link will assess you as a new learner.

Signature Block for Capable Adult

Your signature documents your permission to take part in this research.

Signature of subject Date

Printed name of subject

Signature of person obtaining consent Date

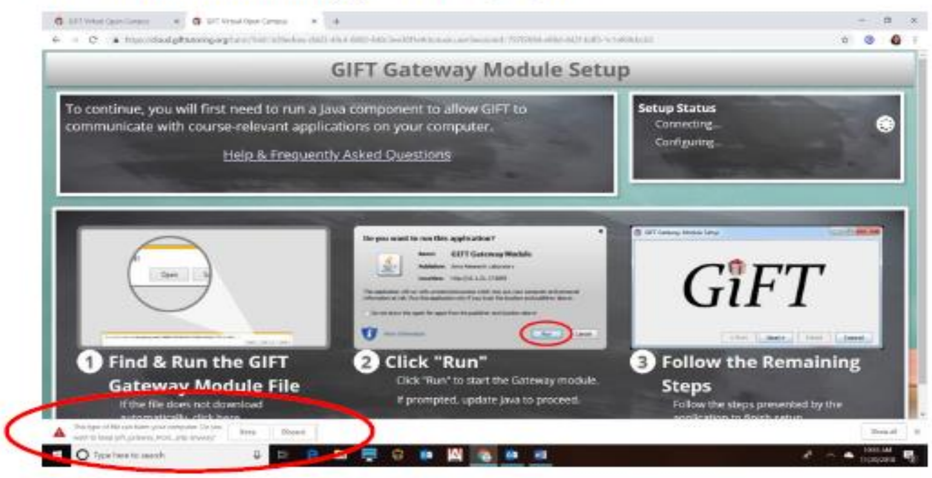
Printed name of person obtaining consent

APPENDIX N: GIFT GATEWAY MODULE SET UP DOCUMENT

Entering the GIFT Course

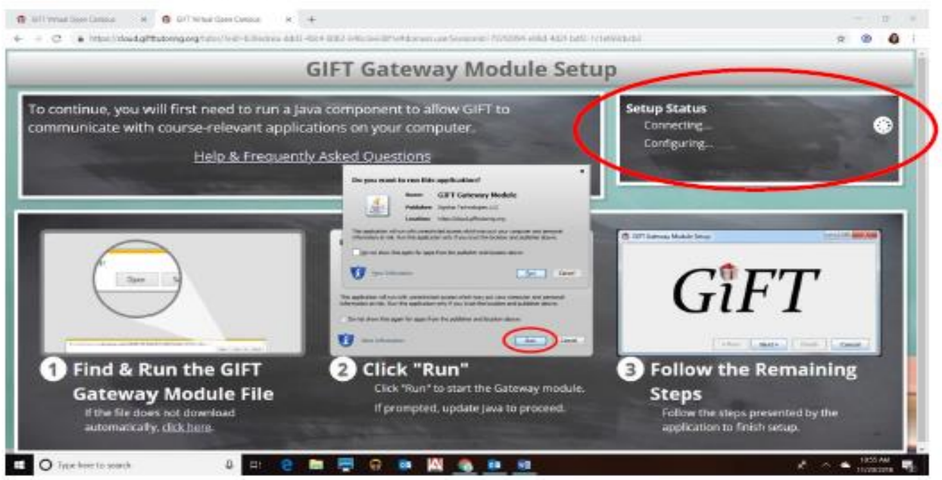
This is the first screen you will see upon selecting the course link. Select the Start button. You must have a Java component to run the course.

Once you have selected the start button. A message at the bottom of your screen will come up asking if you want to keep this file. The message may look like the one circled on the screen below or like the one on the instruction screen in grey. Select Keep or Open.

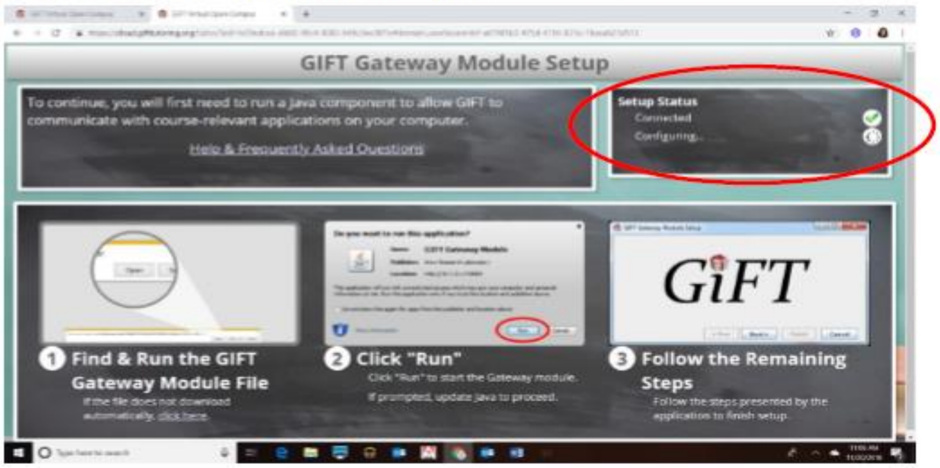


You will then see a message loading the Gift Gateway Module. Select the file. This will populate the Java Script dialogue box you see in the middle of the screen.

Select Run on the “Do you want to run this application” dialogue box. This will activate the Setup Status box in the upper right corner.



When you have two green arrows, your course will start.



APPENDIX O: PROCEDURAL PILOT DEBRIEFING GUIDE

Procedural Pilot Debriefing Guide

General Debriefing Plan: The debrief session should be conducted within a group format in an environment free of distraction. The session will be conducted with a knowledgeable facilitator, (the principle researcher) with a maximum duration of 50 minutes. Notes will be taken during the session. Present each question and ask participants to share their feedback.

1. I was able to access the course with limited issues.
2. I understood the initial instructions to access the course.
3. Once I was in the course platform, it was easy to understand how to navigate it?
4. The instructions provided were enough to understand my expectations as a participant.
5. Review the learner attributes survey questions. Assess if the wording of each question is understandable and not ambiguous? (Participants are not to share their actual response to the questions)
6. Review the course evaluation survey questions. Assess if the wording of each question is understandable and not ambiguous? (Participants are not to share their actual response to the questions)
7. Review the Technology Acceptance Model Questionnaire survey questions. Assess if the wording of each question is understandable and not ambiguous. (Participants are not to share their actual response to the questions)
8. Open discussion for improvement in any aspect of course delivery.

APPENDIX P: PILOT STUDY SYNOPSIS

Two sessions for the procedural pilot for the study, “The suitability and acceptance of Intelligent Tutoring Systems for surge capacity events for governmental public health” were conducted on November 28 and November 30, 2018. The first session was part of a scheduled Epidemiology Strike Team meeting in Region 5 at DOH-St. Lucie located at 5150 NW Milner Drive in the auditorium. The second session took place at Region 4, DOH-Polk as part of a staff meeting for the Epidemiology Unit located at 2090 East Clover Street, Bartow. The second session initially was to take place as part of Region 4 Epidemiology Strike Team Consortium Training but was cancelled because the agency was currently under travel restrictions that had been in place for several months with no indication of a lift. Additionally, the agency also restricted meetings of consortium groups. The investigator was able to recruit one of the health department sites for the second session.

Eight days prior to the session date, the recruitment email (Appendix) with an attached flyer (Appendix) were sent to two subject matter experts (SME) for review. Both SME confirmed that their work computers were equipped with Java as the GIFT platform requires a Java component to work. However, Java works better using Firefox or Google Chrome on their computers rather than Internet Explorer.

Both SME were not able to access the link to the GIFT platform and encountered the following error when access in different browsers (Firefox, Chrome, Internet Explorer).

Initially, we thought it might be a firewall issue but one of the SME tried the link on his iPhone with Safari and sent the link to a personal email and with Silk with the same error message result.

Well, This is a Problem...

While 'unable to retrieve server properties': An error occurred while attempting to contact the server. Please check your network connection and try again.

[DetailedException:
reason = Temporary socket handler received socket closed message.
details = Temporary socket handler received socket closed message.]

Figure 48: Error Message Received During Procedural Pilot Study for Network Connectivity

Subsequent trial and error on different computers and browsers, were able to identify that the Department of Health network would not allow the platform to run. A request was placed for the use of the platform on the Guest Network. Meanwhile alternative processes were investigated such as the use of computers from the UCF centers, personal computers from the investigator and UCF students. Fortunately, the ability to use the Guest Network was granted prior to the pilot dates.

As a result of the SME review, a document entitled "GIFT Gateway Module Set Up Document" (Appendix N) was created to help with setting up the platform for potential participants. Additionally, feedback from the SME's requested a delineation with the course to emphasize to participants which parts of the course are the training module, and which are the research evaluation portions. This was incorporated into the course with an "Informative Text" course object entitled "Research Framework Start" (Figure 49). Grammar, spelling, and punctuation edits were given. A request for accompanying handouts for the course to facilitate retention was suggested. The SME's advised that the course took about 30 minutes to complete.

Two days prior to session one date, the recruitment email (Appendix K) with an attached recruitment flyer (Appendix L) and Consent Form (Appendix M) were sent to the potential participants of session one.

Prior to each session, the investigator prepared copies of the debrief forms (Appendix O) and the consent forms (Appendix M). Per IRB recommendations, each participant must have a copy of the complete consent (electronic or hard copy). During the sessions, Page 4 of the Consent Form was given to each participant to sign and collected by the facilitator.

With the feedback from session one, edits were made to the platform and a new course was published. The link to this course was inserted into the recruitment email as an edit. Two days prior to session two date, the recruitment email (Appendix K) with an attached recruitment flyer (Appendix L) and Consent Form (Appendix M) were sent to the potential participants of session two.

The total number of participants inclusive of both sessions was 17 (N=17). Participants in session 1 totaled 10, in session 2 totaled 5 and 2 participants completed the course between the dates of the two sessions. Due to the significant edits to the first session's published course the data was not analyzed because pilot study participants could not be parsed out from non-participants (i.e. Technical support, facilitator, etc.) when debugging the system. During the second session, 5 completed attempts were analyzed with the second published course. Figure 49 shows the schematic course flow for second published course.

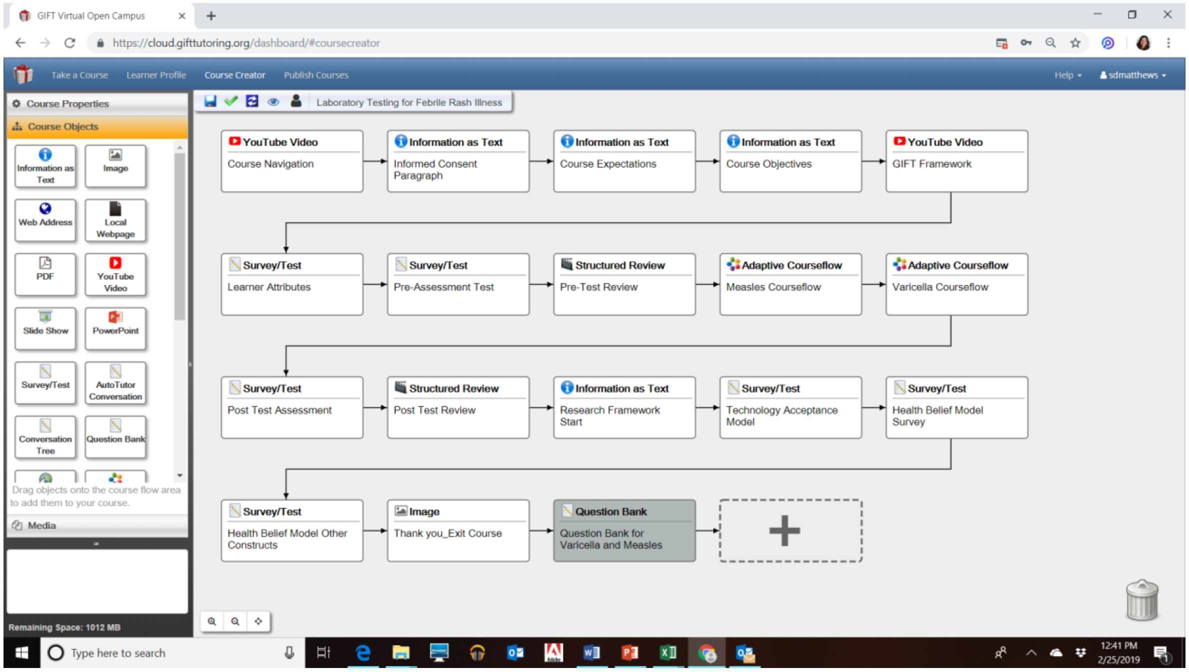


Figure 49: Courseflow for Pilot Study for Laboratory Testing for Febrile Rash Illness

Session 1-November 28, 2018

Network Connections and Hardware Functionality

Ten (N=10) study participants were present onsite during session 1 of the pilot study. This session was plagued with connectivity issues. All participants reported being kicked out of the platform and reloading at random. It was discovered that working on the DOH Guest network allowed access but had limited accessibility due to numbered allowed connections statewide. The solution to connect to hotspots on DOH issued iPhone was a work around solution that proved effective. One of the participants who had started the course, switched network connections after the course started and which caused the course to halt without the ability to continue. The course had to be restarted. Another participant was able to resume the course when switching network connections but a few minutes into the resumed course the course prematurely ended with a message from the platform stating the same. This participant refused to complete the surveys again and subsequently discovered that the system will allow circumvention of the questions by repeatedly clicking the “complete survey” button. One participant computer switched to airplane mode after starting the course and we were unable to switch it back. Another computer was used.

One participant frustrated when system kicked her out of the network and then prematurely ended the course decided to leave the pilot without finishing the course. Another participant became frustrated and left the study early because she was kicked out when the refresh button was selected on the top of the page and was directed to the beginning of the course to restart.

Two to five participants had difficulty navigating their own computers especially when connecting to the hotspot Wi-Fi connections as they had not done this action prior to the session. Some of the earbuds were not compatible with the computers.

Feedback, Requests and Clarifications

Feedback

The course content was not in the correct order for some of the participants. One participant stated that she received the post-test before the knowledge assessment on Varicella. Some of the remediation content was also not given in the correct sequence. For example, the Content (Med-Cam) and varicella video (ppt) shown during the course and should have only been shown as remediation content.

Grammar, punctuation edits were given. Content on measles slides does not match the voice on the video. The slide says, “no greater than 28 day” but the narrator says, “no less than 28 days”.

Requests

This section will address the requests that participants voiced during the debrief session as recommendations to make the course run smoothly or for better understanding and the corrections taken to incorporate them.

1. Participants requested that during the “Course Navigation” video to advise that videos can be paused during the course
    a. This was added to the published course for session 2
2. Participants advised that Likert Scale was confusing and requested 5 point rather and 7 point.
    a. Upon review the facilitator noticed that some of the choices were out of sequence which may have contributed to the confusion. Choices were edited to be in the correct sequence and a guide on the top of the survey was added for clarification.
3. Participants requested for a review of the correct answers after the post-test.
    a. A “Structure Review” item was edited in the course flow to accommodate this request.
4. Participants requested more clarification on the “Structured Review” tabs and how to navigate it.
    a. This was added to the published course for session 2 in the “Course Navigation” video.

Clarifications

1. Participants did not understand the difference between Likert scale values (e.g. quite verses slightly). See Figure 50.
2. Participants most frequent complaint was the course took too long. Facilitator explained the system and how it is based-on learner inputs. Participants understood the logic of the length and were awed at the technology

There are two scales used in the questions below.

Novice = Minimal or only textbook knowledge of

Beginner = Some working knowledge of

Competent = Good background knowledge and area of practice

Proficient = Depth of understanding of discipline and area of practice

Expert = Comprehensive and authoritative knowledge of

And

Measurement Scale is a 7 point-Likert scale from Extremely Unconfident to Extremely confident. Quite is greater than slightly and extremely has the greatest degree of measurement (**Slightly < Quite < Extremely).**

Extremely unconfident 1	**Quite unconfident 2**	**Slightly unconfident 3**	**Neither 0**	**Slightly confident 4**	**Quite confident 5**	**Extremely confident 6**

Measurement Scale is a 7 point-Likert scale from likely to unlikely for Perceived Susceptibility and Perceived Severity

Quite is greater than slightly and extremely has the greatest degree of measurement (**Slightly < Quite < Extremely).**

Extremely unlikely 1	**Quite unlikely 2**	**Slightly unlikely 3**	**Neither 4**	**Slightly likely 5**	**Quite likely 6**	**Extremely likely 7**

Febrile rash illness refers to diseases such as Varicella-chickenpox, Rubeola-measles, Rubella-German measles and Enterovirus-hand foot mouth disease.

Community refers to the location that you preformed your public health services.

Figure 50: Edits to the Measurement Scales for Clarification

Session 2-November 30, 2018

Six (N=6) study participants were present onsite during session 2 of the pilot study, one participant had previously been through the first published course prior to the onsite visit. Session 2 utilized a newly published course with the recommended changes received from session 1 incorporated into the newer course.

Network Connections and Hardware Functionality

The connectivity and network issues demonstrated in Session 1 did not resume in session 2. There was need to clarify how to sign into email from hotspots when email access was not previously hooked up to the network. All participants were on the DOH Guests network with exception of 1 on hotspot.

Feedback, Requests and Clarifications

Feedback

Grammar, spelling, and punctuation edits were given.

Requests

This section will address the requests that participants voiced during the debrief session as recommendations to make the course run smoothly or for better understanding and the corrections taken to incorporate them.

1. Request was made to edit the initial email communication to include the preferred browsers (Chrome and Firefox).
2. Change the lab specimen matrix question to have added spaces to the statements or add a radio button style to the question as this was confusing.
3. Add a back button for the content.

Procedural Pilot Debriefing Guide Responses

1. I was able to access the course with limited issues. If any issues, please list.
    a. The responses to this question are presented above in the Network Connectivity and Hardware Functionality section.
2. I understood the initial instructions to access the course. If did not understand, please list.
    a. Participants found the instructions understandable, clear and "simple to the point".
3. Once I was in the course platform, it was easy to understand how to navigate it?
    a. Participants found the platform easy to navigate, user-friendly and the "design was easy to figure out".
4. The instructions provided were enough to understand my expectations as a participant.
    a. Participants found the instructions provided "communicated easily and effectively". The "course expectations were very well laid out".

5. Review the learner attributes survey questions. Assess if the wording of each question is understandable and not ambiguous? (Participants are not to share their actual response to the questions).
6. Review the Technology Acceptance Model survey questions. Assess if the wording of each question is understandable and not ambiguous? (Participants are not to share their actual response to the questions)
7. Review the Health Belief Survey Questions. Assess if the wording of each question is understandable and not ambiguous. (Participants are not to share their actual response to the questions)
   a. Participants provided feedback on typos, grammar, spelling, and punctuation on the questions. Most felt the questions were lengthy and repetitive. The Likert Scale Choices were confusing.
8. Open discussion for improvement in any aspect of course delivery.

- I really liked the video that went through the clinical description of measles. The presenter used a great format in showing the info, and the intonations he used when discussing the material in combination with that format really drew me in; one thing I learned in particular was that Koplik spots look like "grains of salt". I also think it is a good way to introduce the problem that we're dealing with so that people understand why we're so concerned, and so you might want to consider having it play first.
- The format was fine as a refresher for people who are already familiar with the material, but if I was trying to do JIT training for nurses or EH staff who were assigned to us to help with an outbreak, they would probably need some kind of cheat sheet to help them sort out IgG, EIA, PCR, DFA and any other acronym that they're hearing for the first time in quite a while, if at all.
- I'd recommend breaking the material down into smaller chunks, such as covering each type of lab test separately and giving a brief quiz before moving on to the next one, as another way of reinforcing all that information and allowing some more time for people to process it. The differences between IgM and IgG, and when and why they show up when they do can be particularly challenging for some people to understand, including HCPs who seem to keep ordering freaking serology tests for certain reportable diseases all the time, even though the results aren't telling us anything useful at all.
- I'm used to seeing seven-point Likert scales arranged as "Strongly Disagree", "Disagree", "Somewhat Disagree", "Neutral/Neither", "Somewhat Agree", "Agree", "Strongly Agree"; i.e., the transition goes from "sort of", to "mostly", to "definitely". I was thrown by seeing "somewhat" placed next to "strongly", so honestly didn't know what the scale was supposed to represent, and how agreeing with a statement varied from somewhat agreeing with it relative to strongly agreeing.
- Ability to increase speed of speakers. I liked that you could review your assessment scores. If the system could give feedback on what was missed to review, it could be helpful.
- I found the platform very useful. It would be great for just in time training to make sure everyone was on the same page.

- Overall, I did not have any major issues. I think this would be a great resource for epidemiologist and other people working in the field.
- Slide format could be altered to have less content on wordy slides.

Facilitator Led Debriefing

- The platform was informative. Liked the idea of using the technology for just in time training.
- Platform can be very beneficial. Need to refresh is good for increasing confidence level. Training was informative on primary specimens to collect not just because of the professional's limitations in skills (e.g. collected skin lesion initially thought it was because she was unable to collect blood.)
- Good to learn about the lab aspects of it with the different tests even for experienced epi's
- Experts even learned new information.
- Liked learning more about the laboratory portion.
- Flow was good.
- ITS video on GIFT remove.

Session 2- Data Analysis

The data obtained from the Learner Attributes Survey, the Pre/Post Test Summative Assessment and the Comparison Evaluation Questions contained in the Technology Acceptance Model (TAM) Survey will be utilized to address the hypothesis respecting suitability and acceptance of an ITS

Q1. What is your age?

Q2. How many years work experience do you have in healthcare sector?

Q3. What is your gender? Male, Female

Q4. Do you have any experience dealing with a febrile rash illness? (Prior Knowledge, Skill)

Yes= you DO have experience with febrile rash illness (3)

No= you DO NOT have experience with febrile rash illness (0)

Table 20: Pilot Study-November 30, 2018 Participant Demographics

Participant	Q1 Age	Q2 Years' Experience	Q3 Gender	Q4 Prior Knowledge/Skill with Febrile Rash Illness
1	59	20	Male	Yes
2	27	1	Male	No
3	40	5	Female	Yes
4	30-something :-)	3	Female	Yes
5	33	2.5	Male	No

The average age of the participants is 37.8 years (range 27-59 years). The average years of experience is 6.3 years (range 1-20 years). The participant population was 60% Male. Sixty (60%) of the participant population self-identified has having prior experience dealing with a febrile rash illness.

Q5. How would you assess your expertise in dealing with a patient with febrile rash illness? (Expert levels based on Brenner's model) (Prior Knowledge, skill)

Novice = Minimal or only textbook knowledge of (1)

Beginner = Some working knowledge of (2)

Competent = Good background knowledge and area of practice (3)

Proficient = Depth of understanding of discipline and area of practice (4)

Expert = Comprehensive and authoritative knowledge of (5)

Q6. How would you assess your expertise in using an intelligent tutoring system? (prior knowledge, skill)

Novice = Minimal or only textbook knowledge of (1)

Beginner = Some working knowledge of (2)

Competent = Good background knowledge and area of practice (3)

Proficient = Depth of understanding of discipline and area of practice (4)

Expert = Comprehensive and authoritative knowledge of (5)

Q7. How would you assess your expertise in packaging and shipping clinical specimens? (prior knowledge, skill)

Novice = Minimal or only textbook knowledge of (1)

Beginner = Some working knowledge of (2)

Competent = Good background knowledge and area of practice (3)

Proficient = Depth of understanding of discipline and area of practice (4)

Expert = Comprehensive and authoritative knowledge of (5)

Table 21: Pilot Study-November 30, 2018 Participant Expertise

Participant	Q5 Expertise on Febrile Rash (Prior Knowledge, Skill)	Q6 Expertise ITS (Prior Knowledge, Skill)	Q7 Expertise Pack/Ship (Prior Knowledge Skill)
1	Proficient	Beginner	Expert
2	Novice	Novice	Novice
3	Competent	Competent	Expert
4	Competent	Proficient	Beginner
5	Novice	Competent	Beginner

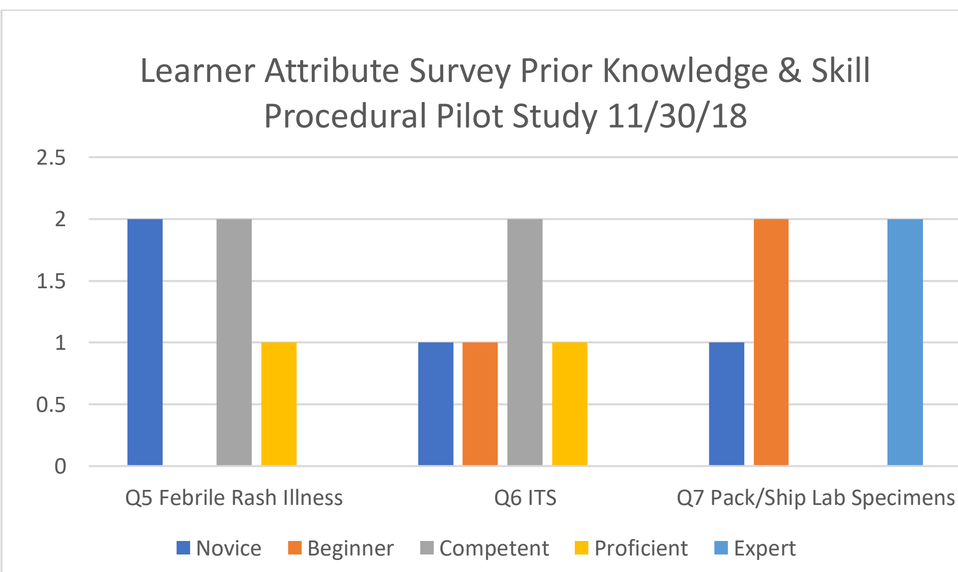


Figure 51: Pilot Study-November 30, 2018 Learner Attributes Prior Skill and Knowledge

When asked about expertise having prior knowledge and skill with of dealing with a patient with febrile rash illness was 40% of participants self-identified as novice, 40% as competent and 20% as Proficient. Expertise in using an intelligent tutoring system was self-identified as competent (40%) and 20% in the categories of novice, beginner, and proficient. Expertise in packing and shipping clinical specimens self-identified as novice (20%), beginner (40%) and expert (40%).

On the Likert Scale, please respond to the following questions:

Measurement Scale is a 7 point-Likert scale from Extremely Confident to Extremely unconfident

Extremely unconfident 1	Quite unconfident 2	Slightly unconfident 3	Neither 0	Slightly confident 4	Quite confident 5	Extremely confident 6

Q8. How confident are you in your knowledge about the rule out diagnostic process for febrile rash-like illnesses? (prior knowledge, grit)

Q9. How confident are you that if a patient walked into your healthcare facility with a rash and fever that you would be able to order the correct laboratory procedures based on clinically and epidemiological evidence? (prior knowledge, grit)

Q10. How confident are you in your willingness to learn about the rule out diagnostic process for febrile rash-like illnesses on an intelligent tutoring system platform? (Grit, Motivation)

Q11. How confident are you that you will complete the entire course in the Intelligent Tutoring System format provided? (Grit, Motivation)

Q12. How confident are you that if you found this learning platform useful that you would return to it for a refresher course? (Motivation)

Table 22: Pilot Study-November 30, 2018-Participant Confidence

Participant	Q8 Confident on Knowledge R/O Dx (prior knowledge, grit)	Q9 Confidence on Ordering correctly lab (prior knowledge, grit)	Q10 Confidence willingness to learn (Grit, Motivation)	Q11 Confidence complete course (Grit, Motivation)	Q12 Confident to return to platform (Motivation)
1	Quite confident	Quite confident	Extremely confident	Quite confident	Quite confident
2	Extremely unconfident	Extremely unconfident	Quite confident	Extremely confident	Quite confident
3	Slightly confident	Quite confident	Extremely confident	Extremely confident	Quite confident
4	Quite confident	Quite confident	Quite confident	Quite confident	Quite confident
5	Quite unconfident	Quite unconfident	Quite confident	Extremely confident	Extremely confident

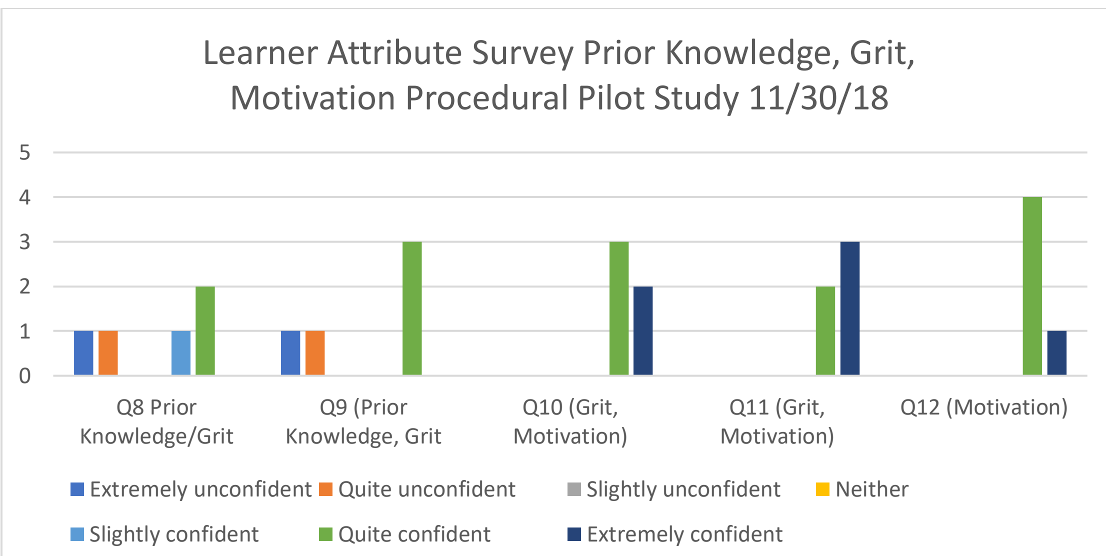


Figure 52: Pilot Study-November 30, 2018-Learner Attribute Survey for Prior Knowledge, Grit and Motivation

The learner attribute survey contained 5 questions that assessed self-identified confidence. The first two questions were written to assess participants' prior knowledge and grit. In the first questions, participants were asked about their confidence on knowledge of the rule out diagnostic process for febrile rash illness to which 40% responded with a degree of unconfident (extremely and quite), 20% was slightly confident and 40% were quite confident. The second question evaluated confidence in ordering and following the appropriate laboratory procedures for febrile rash illness to which participants responded with 20% extremely unconfident, 20% quite unconfident and 60% quite confident.

The latter 3 questions evaluated the participants' grit and motivation for using an ITS for learning, completing the course and willingness to return to the ITS platform. Responses to these 3 questions were all with the categories of quite confident and extremely confident.

Comparison Evaluation Questions

C1-Instead of the time spent taking this ITS course, my time would have been better spent on the Internet researching a surge capacity public health event, such as febrile rash illness. Yes or no.

C-2 Instead of the time spent taking this ITS course, my time would have been better spent talking with a knowledgeable mentor about a surge capacity public health event, such as febrile rash illness. Yes or no.

C-3 Instead of the time spent taking this ITS course, my time would have been better spent taking a class with a discussion group so that I could interact with and learn together with my peers about a surge capacity public health event, such as febrile rash illness. Yes or no.

Table 23: Pilot Study-November 30, 2018-Comparison Survey

Participant	C1 Internet	C2 Mentor	C3 Discussion Group
1	No	No	No
2	No	Yes	Yes
3	No	No	No
4	No	No	No
5	No	No	No

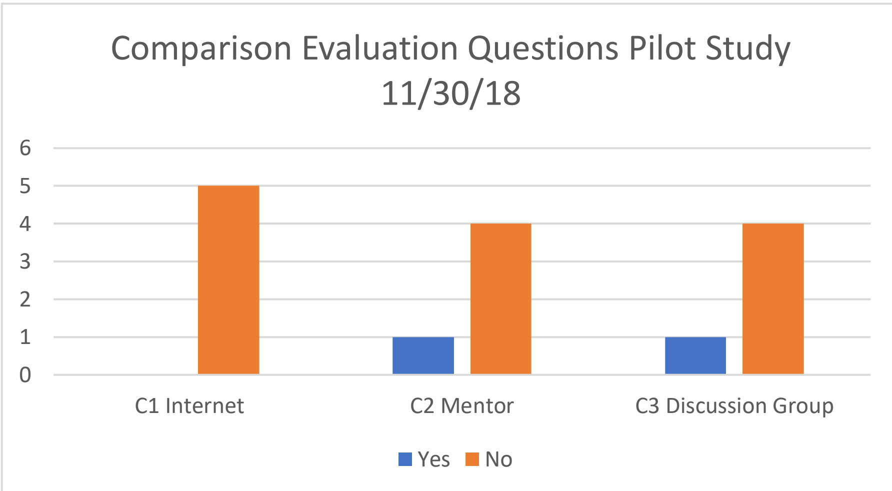


Figure 53: Pilot Study-November 30, 2018-Comparison Evaluation

The comparison evaluation questions sought to determine if the participants would have preferred to obtain the content from the ITS in the form of an internet search, a mentor, or a discussion group. Most responses were negative for utilizing the internet (100%), mentor (80%) or discussion group (80%) over the use of the ITS platform, demonstrating a favorable response to the utilization of the technology.

Table 24: Pilot Study-November 30, 2018-Pre/Post Test Score Comparisons (22 Total Points)

Participant	Pre-Test	Post-test	Percent Change
1	20	17	-0.15
2	15	21	+0.40
3	21	22	+0.05
4	14	20	+0.43
5	11	17	+0.55

The summative assessment process executed in this research illustrated that 80% of study participants demonstrated a positive change in knowledge acquisition when compared to their baseline test scores at the beginning of the course.

TAM Questionnaire Responses

Measurement Scale is a 7 point-Likert scale from Strongly Disagree to Strongly Agree

Strongly disagree 1	**Disagree 2**	**Somewhat Disagree 3**	**Neither disagree or agree 4**	**Somewhat Agree 5**	**Agree 6**	**Strongly Agree 7**

Perceived Usefulness

1. Using an intelligent agent (tutor) would enable me to accomplish tasks more quickly.
2. Using an intelligent agent (tutor) would improve my job performance.
3. Using an intelligent agent (tutor) would increase my productivity.
4. Using an intelligent agent (tutor) would enhances my effectiveness on the job.
5. Using an intelligent agent (tutor) would make it easier to do my job.
6. Overall, I would find the intelligent agent (tutor) system useful in my job.

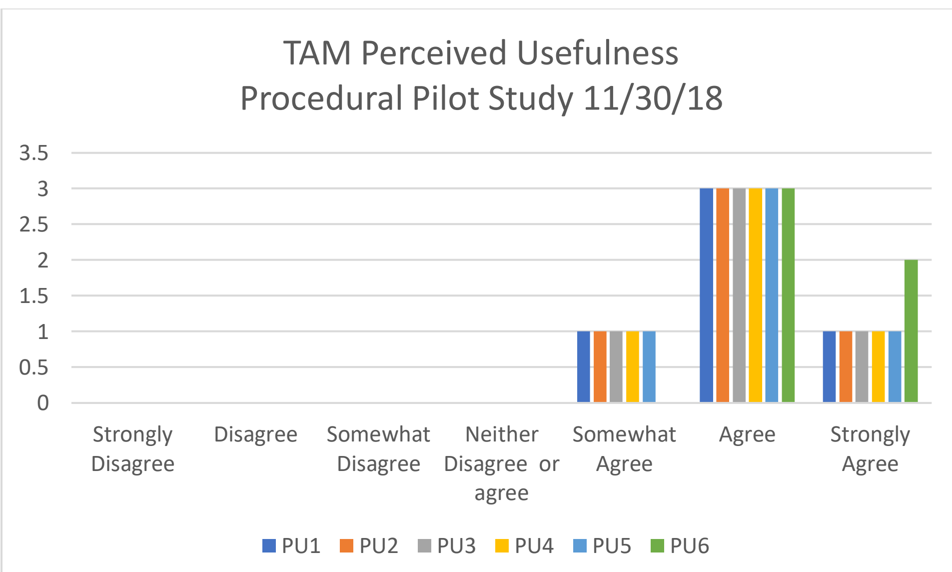


Figure 54: Pilot Study-11/30/2018-TAM Perceived Usefulness

Perceived Ease of Use

1. Learning to operate the intelligent agent (tutor) system was easy for me.
2. It was easy to get the intelligent agent (tutor) system to do what I want it to do.
3. My interaction with the intelligent agent (tutor) system was clear and understandable.
4. The intelligent agent (tutor) system was flexible to interact with.
5. It was easy for me to become skillful at using the intelligent agent (tutor) system
6. Overall, the intelligent agent (tutor) system was easy to use.

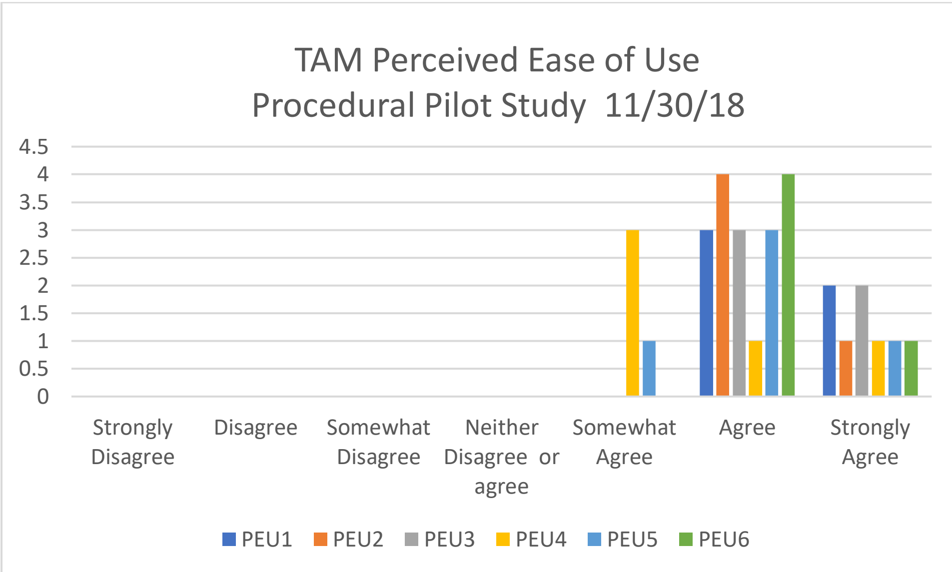


Figure 55: Pilot Study-11/30/2018-TAM Perceived Ease of Use

Intention for Use

1. Assuming I have access to an intelligent tutor platform, I intend to use it for training.
2. Given that I now have access to an ITS platform, I predict that I will use it for training.
3. If I get to use an intelligent tutor, I expect that I will use it.

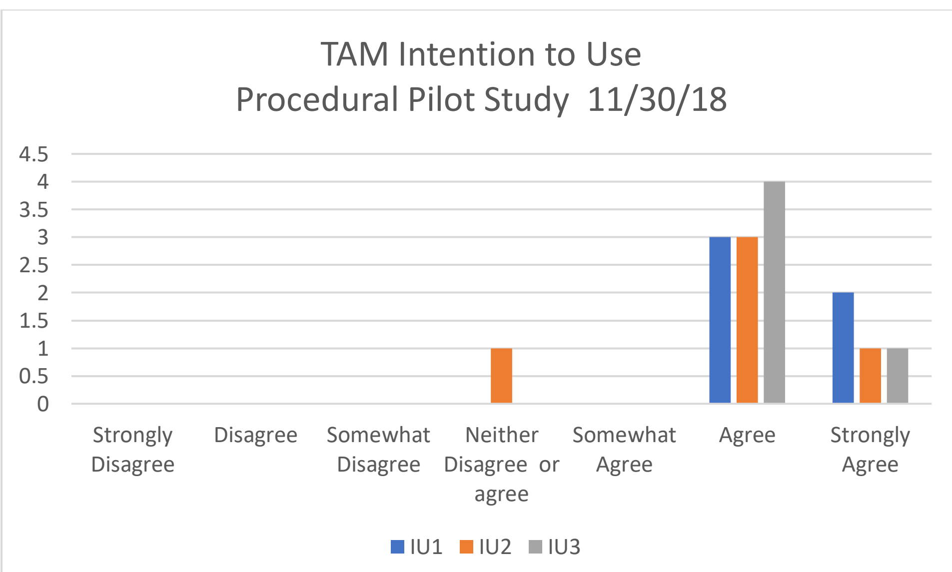


Figure 56: Pilot Study-11/30/2018-TAM Intention to Use

Attitude

1. Using an ITS platform for remedial training on febrile rash illness is a good idea
2. I like the idea of using an intelligent tutor system for getting health information on febrile rash illness.
3. Using an ITS platform for remedial training on febrile rash illness is a pleasant experience.

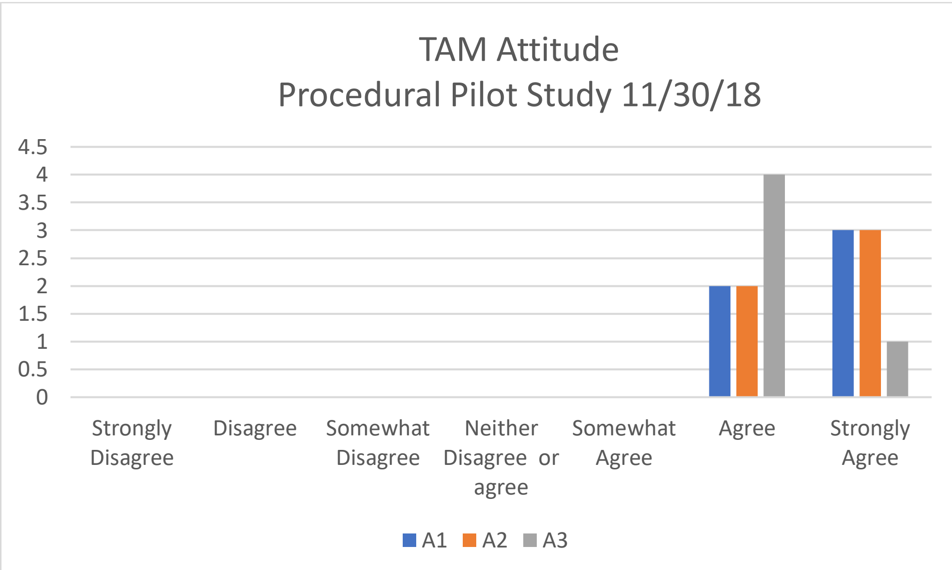


Figure 57: Pilot Study-11/30/2018-TAM Attitude

HBM Survey Responses

Measurement Scale is a 7 point-Likert scale from likely to unlikely for Perceived Susceptibility and Perceived Severity

Quite is greater than slightly and extremely has the greatest degree of measurement
(**Slightly < Quite < Extremely).**

Extremely unlikely 1	**Quite unlikely 2**	**Slightly unlikely 3**	**Neither 4**	**Slightly likely 5**	**Quite likely 6**	**Extremely likely 7**

Febrile rash illness refers to diseases such as Varicella-chickenpox, Rubeola-measles, Rubella-German measles, and Enterovirus-hand foot mouth disease.

Community refers to the location that you preformed your public health services.

Perceived Susceptibility

1. Taking all possible factors into consideration, how likely do you think your chances of getting a febrile rash illness are?
2. How likely are you to know a person that has experienced a febrile rash illness?
3. Based on an average person in the population, how likely are you to get a febrile rash illness?
4. How likely do you think your community will have a febrile rash illness outbreak in the future?
5. Considering the immunity status of your community, how likely it is that your community might get a febrile rash illness outbreak?
6. How likely is it that exposure to a febrile rash illness would come from your community?
7. What is the likelihood that your community would be exposed to an outbreak of febrile rash illness as compared to other communities?

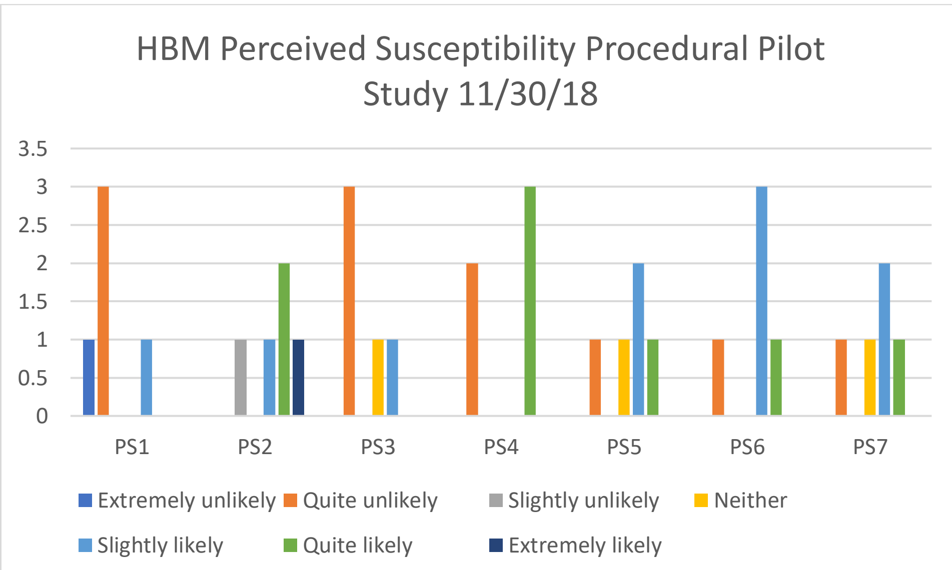


Figure 58: Pilot Study-11/30/2018 Perceived Susceptibility

Perceived Severity

1. If you were infected with a febrile rash illness, how likely are you to have a serious infection?
2. Compared to other serious illnesses you might have experienced, how likely are you to have a febrile rash illness with that level of severity?
3. If you were to be infected with a febrile rash illness, how likely is that to scare you?
4. If you were infected with a febrile rash illness, how likely do you think that you would experience long term problems from that infection?
5. If your community were to experience a febrile rash illness, how likely would the severity of the illness be on your community?
6. Compared to other serious illnesses your community might have experienced, how likely are is your community to have a febrile rash illness with that level of severity?
7. If your community experienced a febrile rash illness outbreak, how likely do you think that the community would experience long term problems from that outbreak?

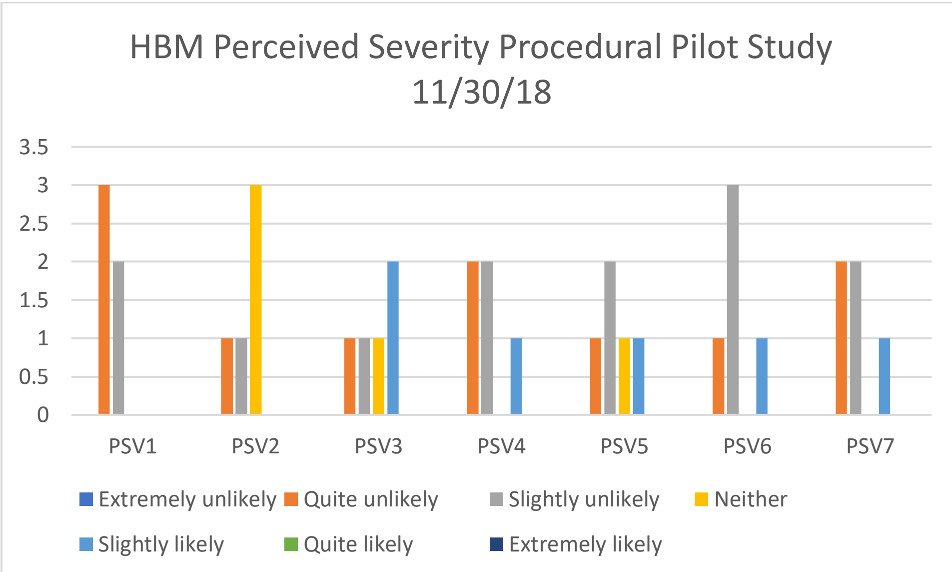


Figure 59: Pilot Study-11/30/2018 Perceived Severity

8. Have you had any other diseases or illnesses which you think were more serious than a febrile rash like illness? Yes or No
9. Has your community had any other diseases or illness which you think were more serious than a febrile rash illness? Yes or No

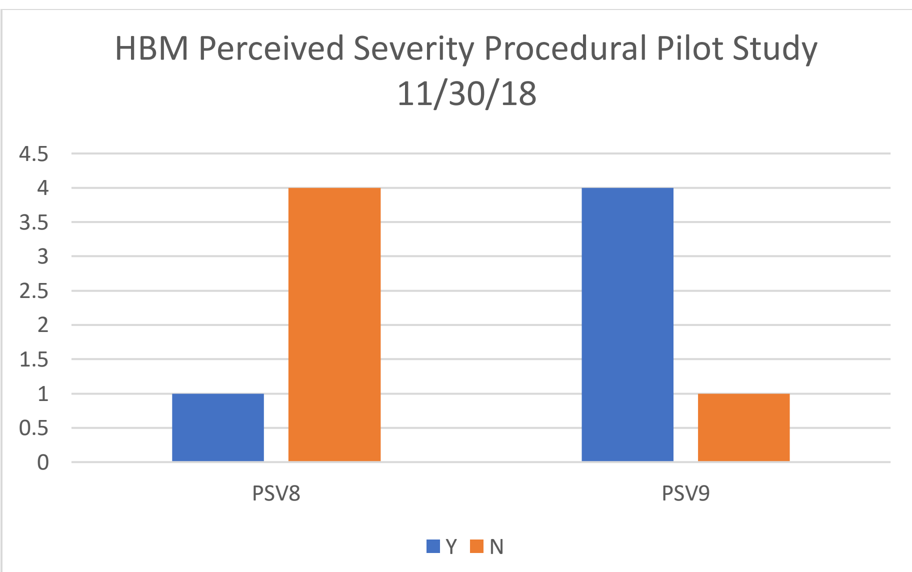


Figure 60: Pilot Study-11/30/2018 Perceived Severity Yes/No Questions

Measurement Scale is a 7 point-Likert scale from Strongly Disagree to Strongly Agree

Strongly disagree 1	Disagree 2	Somewhat Disagree 3	Neither disagree or agree 4	Somewhat Agree 5	Agree 6	Strongly Agree 7

Perceived Threats

1. I would be afraid for myself to have the laboratory testing done for febrile rash illness.
2. I am afraid to perform the laboratory testing for persons in my community for febrile rash illness.
3. I do not know the accurate laboratory tests required for febrile rash illness.
4. The laboratory tests required for febrile rash illnesses are not reliable.
5. Preventing febrile rash illness is next to impossible for myself?
6. Preventing febrile rash illness is next to impossible for the community?

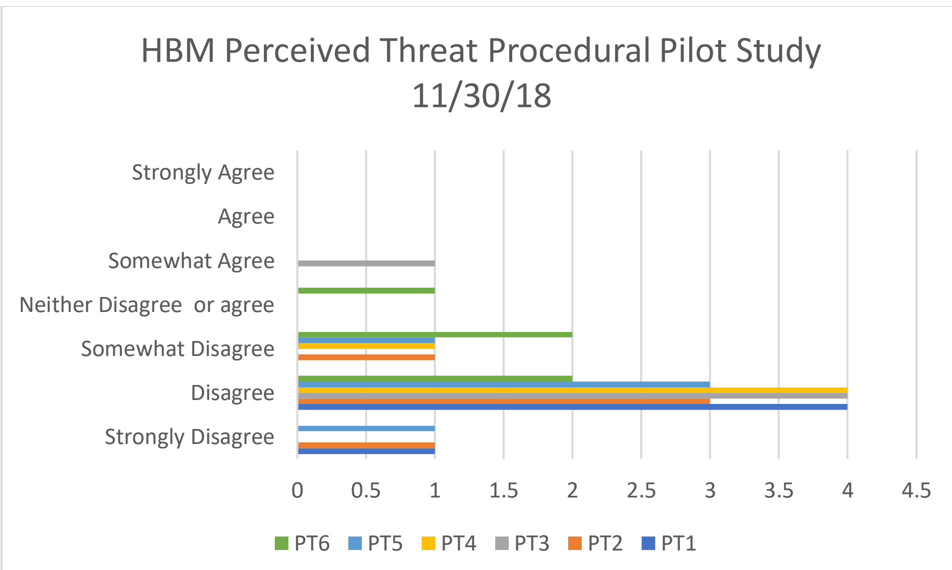


Figure 61: Pilot Study-11/30/2018 Perceived Threat

Perceived Benefits

1. I believe my community to be health conscious
2. As an individual, I am health conscious
3. My community often dwells on its health
4. I often dwell on my health
5. I think it is important to know how to stay healthy
6. I think it is important that my community knows how to stay healthy
7. I am likely to receive training on febrile rash illnesses.
8. My community is likely to receive training on febrile rash illnesses.

9. Having the accurate laboratory test for a febrile rash illness is helpful for the health of the community?
10. Understanding the need for an accurate laboratory test for a febrile rash illness will decrease the chances of exposure for my community?
11. Understanding the need for an accurate laboratory test for a febrile rash illness will decrease the chances of exposure for myself?

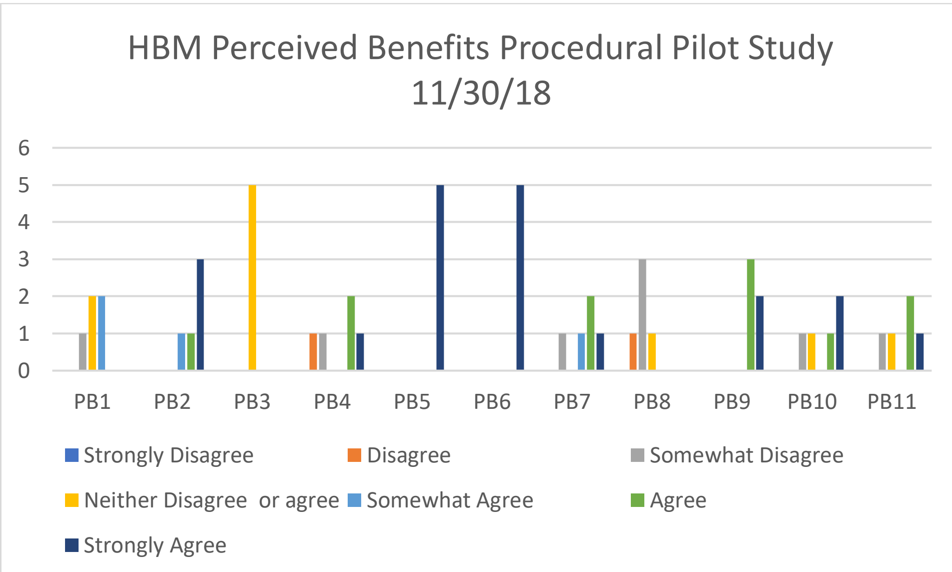


Figure 62: Pilot Study-11/30/2018 Perceived Benefits

Cues to Action

1. Gaining more knowledge on a topic, such as laboratory tests for febrile rash illnesses, would improve my confidence to perform the tests?
2. Learning about technology from others influences my use of it.
3. Learning in a self-paced environment would influence my use of technology.
4. Receiving communication from colleagues about technology such as an intelligent tutor would influence my use.

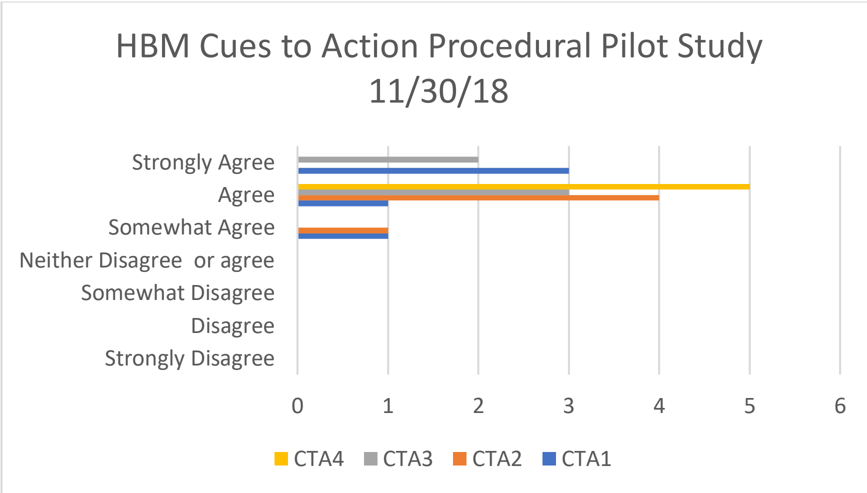


Figure 63: Pilot Study-11/30/2018 Cues to Action

Motivations

1. I have a general concern about my health.
2. I have a general concern for the health of the community
3. I frequently do things to improve my health
4. I frequently do things to improve the health of the community
5. I always follow medical orders because I believe they will benefit my state of health
6. I always follow medical orders because I believe they will benefit the state of health of my community
7. I search for new information related to my health
8. I search for new information related to keeping the community healthy

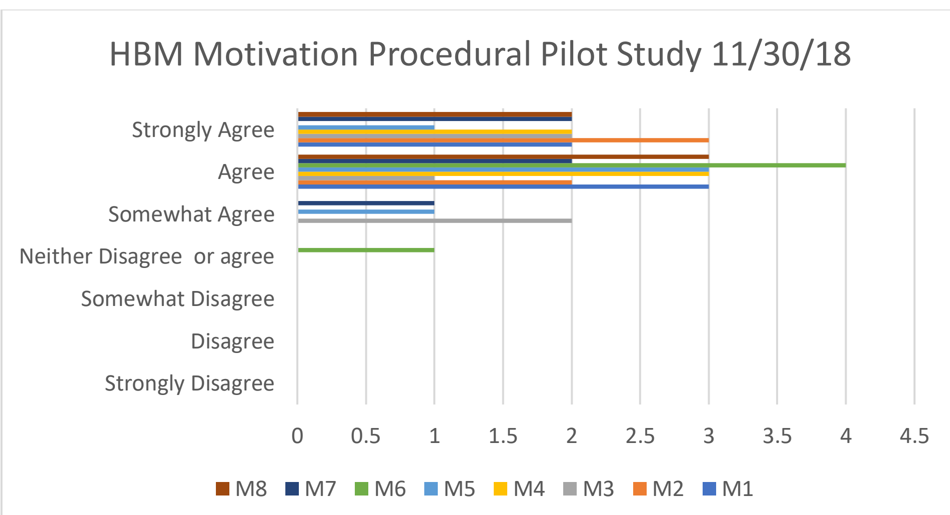


Figure 64: Pilot Study-11/30/2018 Motivation

Actual Use Behavior

1. How likely would you be to recommend the implementation of an ITS for training of public health professionals in your organization?
2. How likely would you be to recommend the continuous use of ITS technology for training of public health professionals?
3. How likely would you be to recommend the using of ITS technology for performing training tasks?

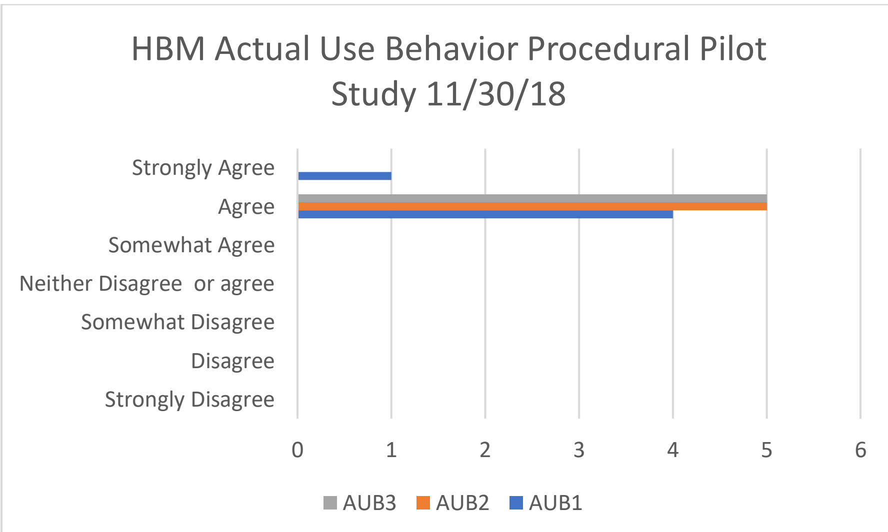


Figure 65: Pilot Study-11/30/2018 Actual Use Behavior

APPENDIX Q: DATA ANALYSIS FOR STUDY

Non-Participation Survey

Table 25: Non-Participation Survey-November 12, 2019

Field	Min	Max	Mean	Std Deviation	Variance	%	Count
If you are refusing to participate in this study, why did you not wish to participate?	1.00	8.00	3.76	2.78	7.71		42
No time						40.48%	17
No interest						11.90%	5
Invasion of Privacy						0.00%	0
Participation not supported by my employer						2.38%	1
Previous experience with studies was unpleasant						0.00%	0
Information technology barrier (i.e. system compatibility)						28.57%	12
Waste of time						2.38%	1
General Refusal						14.29%	6
Total						100%	42

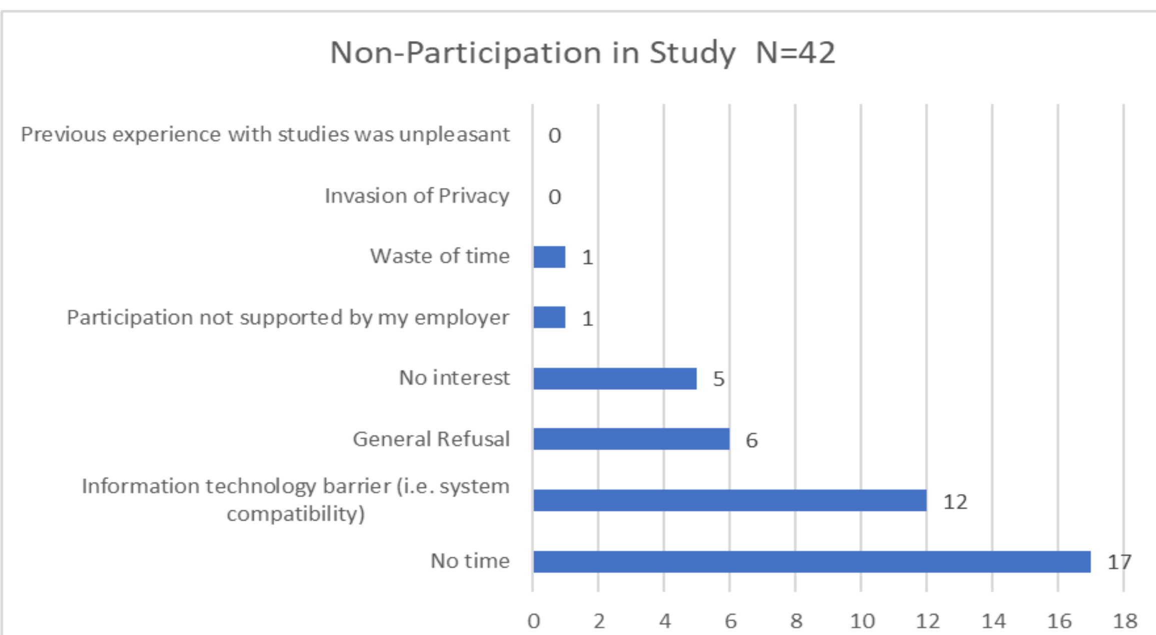


Figure 66: Non-Participant Survey (N=42) November 12, 2019

Learner Profile and Attributes

Table 26: Learner Profile: Age- November 12, 2019

Age Range	Age (Years)	Average Age	% by respondent	Median Age
18-24	2	0.019231	1.92307692	
25-34	28	0.269231	26.9230769	
35-44	27	0.259615	25.9615385	
45-54	16	0.153846	15.3846154	
55-64	23	0.221154	22.1153846	
65+	8	0.076923	7.69230769	
No Response	75			
Respondents	104			
Total	179	**44.83654**	**100**	**41.5**

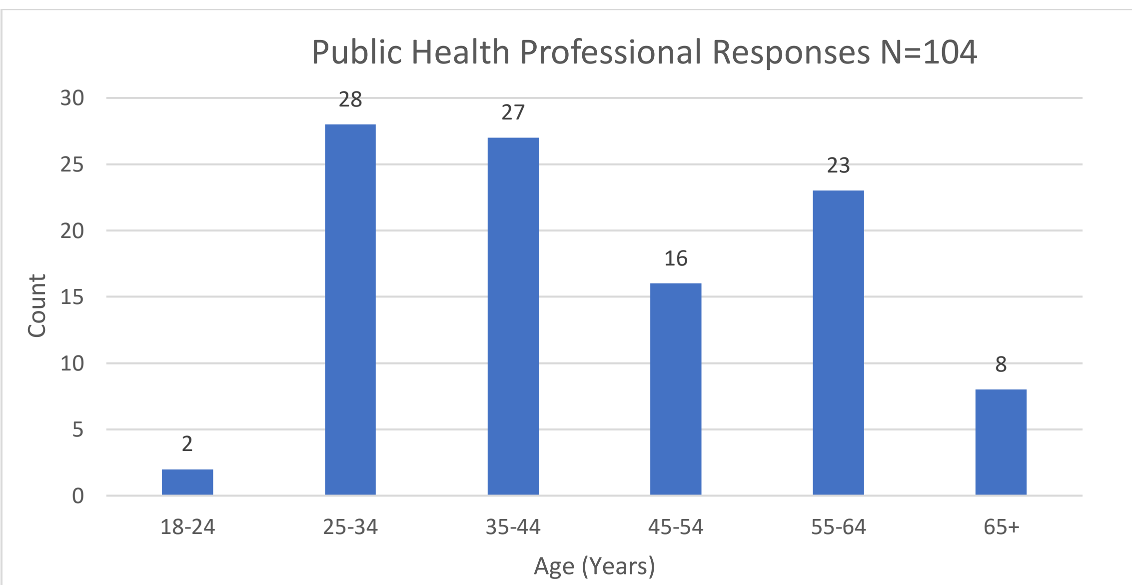


Figure 67: Learner Profile: Age (N=104)- November 12, 2019

Table 27: Learner Profile: Sex (N=104)-November 12, 2019

	Sex	%
Male	23	0.221154
Female	81	0.778846
No Response	75	

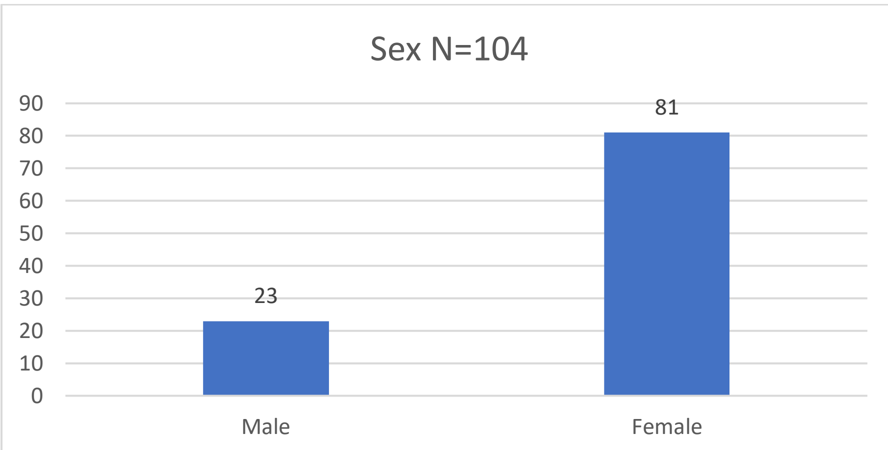


Figure 68: Learner Profile: Sex (N=104)-November 12, 2019

Table 28: Learner Profile: Years of Experience (N=104)-November 12, 2019

Range	Years of Experience	%
>1	1	0.009615
1-5	18	0.173077
6-10	23	0.221154
11-15	16	0.153846
16-20	11	0.105769
21-25	8	0.076923
26-30	8	0.076923
31-35	12	0.115385
36+	7	0.067308
No Response	75	

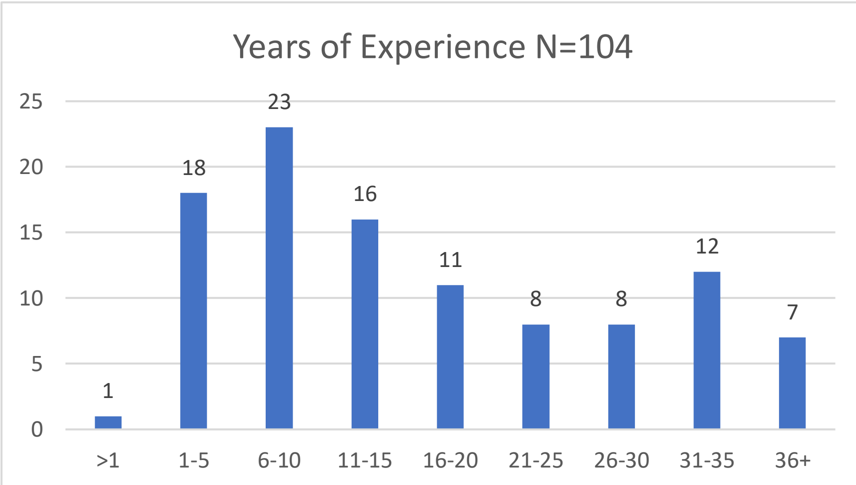


Figure 69: Learner Profile: Years of Experience (N=104)-November 12, 2019

Table 29: Learner Profile: Experience with Febrile Rash Illness (N=104), November 12, 2019

Experience with Febrile Rash Illness		%
Yes	78	0.75
No	26	0.25
No Response	75	

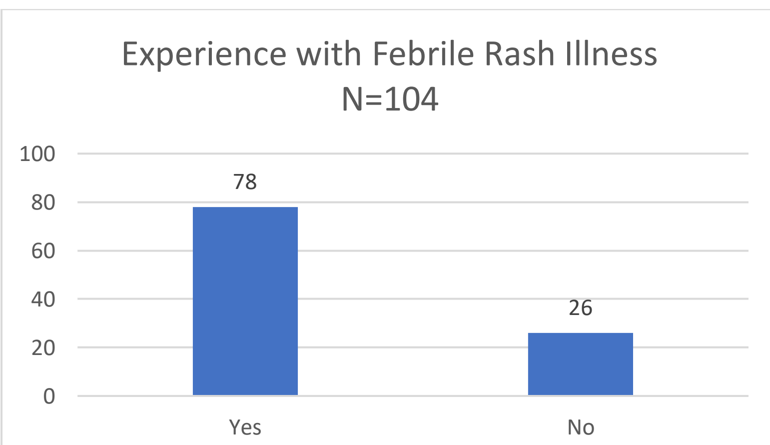


Figure 70: Learner Profile: Experience with Febrile Rash Illness (N=104), November 12, 2019

Table 30: Learner Profile: Expertise (N=104), November 12, 2019

	Dealing with Pt with Febrile Rash Illness	%	Using an ITS	%	Package and Shipping Specimens for Febrile Rash Illness	%
Novice	26	0.25	61	0.58654	35	0.33654
Beginner	15	0.14423	28	0.26923	28	0.26923
Competent	29	0.27885	10	0.09615	27	0.25962
Proficient	29	0.27885	4	0.03846	11	0.10577
Expert	5	0.04808	1	0.00962	3	0.02885
No Response	75		75		75	

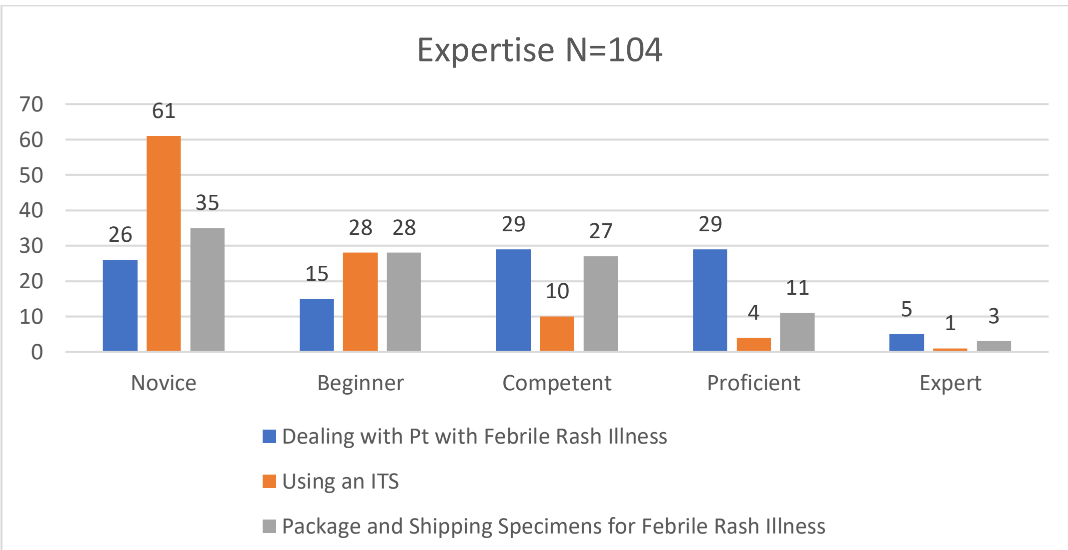


Figure 71: Learner Profile: Expertise (N=104), November 12, 2019

Table 31: Learner Profile: Confidence (N=104), November 12, 2019

	Knowledge about RO Dx Process for Febrile Rash Illness	%	Execute correct lab procedures for rash and fever	%	Willingness to learn about RO Dx Process on an ITS	%	Complete the entire Course on the ITS	%	Return to Platform for Refresher Course	%
Extremely Unconfident	10	0.09615	15	0.14423	3	0.02885	1	0.00962	2	0.01923
Unconfident	18	0.17308	16	0.15385	2	0.01923	1	0.00962	1	0.00962
Slightly Unconfident	10	0.09615	12	0.11538	4	0.03846	2	0.01923	2	0.01923
Neither	8	0.07692	8	0.07692	8	0.07692	10	0.09615	22	0.21154
Slightly Confident	22	0.21154	22	0.21154	11	0.10577	15	0.14423	22	0.21154
Confident	30	0.28846	26	0.25	48	0.46154	47	0.45192	39	0.375
Extremely Confident	6	0.05769	5	0.04808	28	0.26923	28	0.26923	16	0.15385
No Response	75		75		75		75		75	

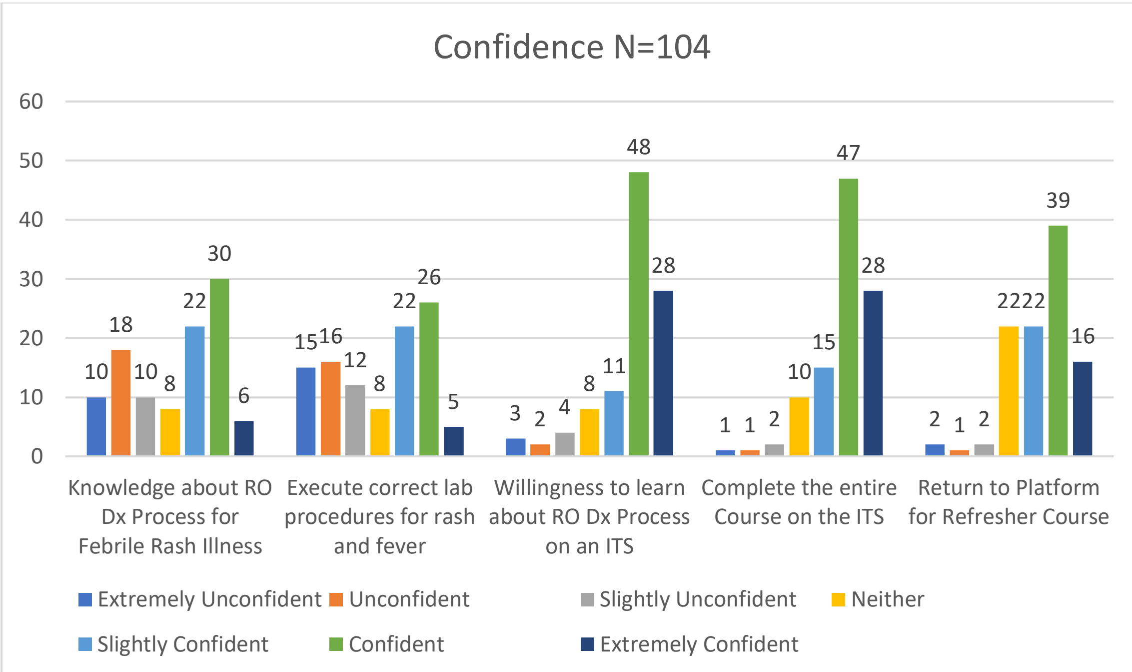


Figure 72: Learner Profile: Confidence Grouped by Question (N=104), November 12, 2019

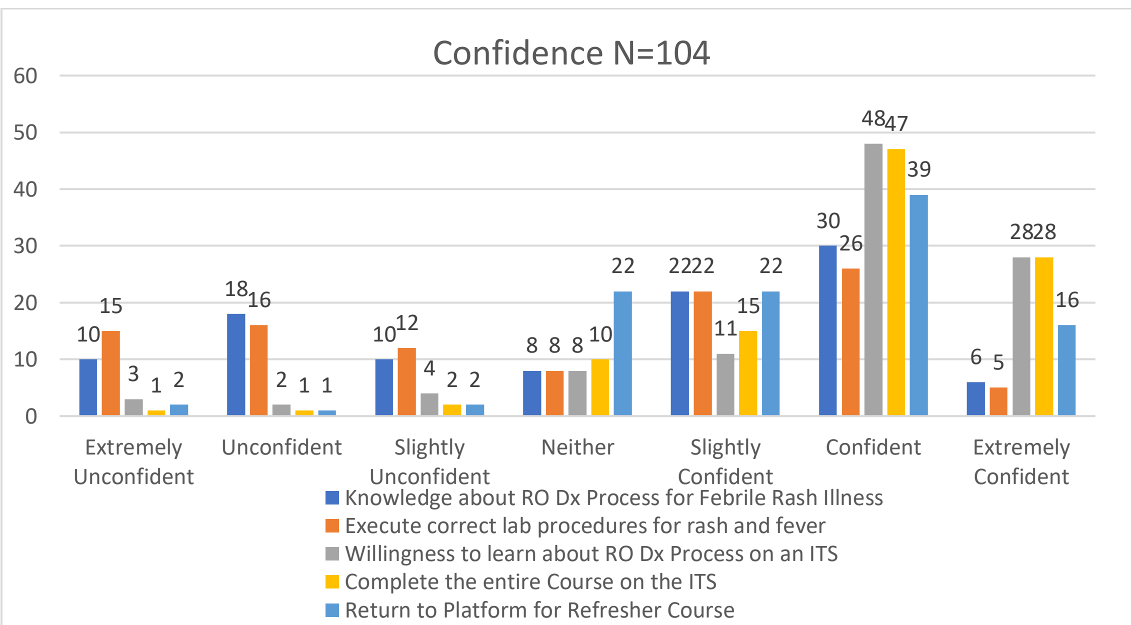


Figure 73: Learner Profile: Confidence Grouped by Response (N=104), November 12, 2019

Timed Sessions

Table 32: Timed Sessions, November 12, 2019

Descriptive Statistics for Session Time (Minutes)											
Completed	**N start**	**N end**	**N left**	**N calculate**	**Mean (min)**	**Median (min)**	**Mode (min)**	**Minimum (min)**	**Maximum (min)**	**Outliers (min)**	**Comments**
Introduction	179	164	15	15	0	0	0	0	0		"Course is Ending"
Informed Consent/Course Expectations	164	129	35	29	2.8	1	1	1	10	19,48,1682,71,723,625	
Course Objectives	129	123	6	5	3	3	5	1	5	1080	
Learner Attributes	123	104	19	15	5.2	4	10	1	14	279,1708,53	1 person had "Course is Ending"
Pre-Test	104	97	7	7	17	11	N/A	6	38	84	
Scenario	97	73	24	17	26.8	25	37	5	55	73,93,128,436,596,1362,1414	
Post-Test	73	72	1	1	10						
TAM/HBM Surveys	72	69	3	3	19.7	19	N/A	15	25		
Course	69	69	0	68	47.1	46	46	11	115	291	

Knowledge and Application Based Assessments

Table 33: Application Based Knowledge Assessment-November 12, 2019

Application Scenario		
Responses	**Frequency**	**%**
Patient's Allergies	16	0.21917808
Sexual Contacts and History	54	0.73972603
The patient's demographics to include name, date of birth, symptoms, and onset dates	1	0.01369863
The patient's travel history	1	0.01369863
The rash progression (e.g. where it started on the body)	1	0.01369863
Total	73	100%

Table 34: Knowledge Assessment November 12, 2019

Knowledge Assessments						
Score	**Frequency Pretest (All)**	**%**	**Frequency Post Test**	**%**	**Frequency Pretest (72)**	**%**
1	0	0	0	0	0	0
2	2	0.020619	0	0	1	0.013889
3	4	0.041237	2	0.027778	2	0.027778
4	12	0.123711	2	0.027778	9	0.125
5	7	0.072165	0	0	4	0.055556
6	18	0.185567	1	0.013889	12	0.166667
7	20	0.206186	7	0.097222	15	0.208333
8	17	0.175258	13	0.180556	14	0.194444
9	7	0.072165	16	0.222222	6	0.083333
10	10	0.103093	31	0.430556	9	0.125
Total	97	100%	72	100%	72	100%
Average Score	6.7		8.7		6.9	

Table 35: t-Test Paired Samples Test on Assessment Performance

	Variable 1 Pre-Test	Variable 2 Post Test	
Descriptive Statistics			
Mean	6.66	8.71	
N	97	72	
Std. Deviation	2.02	1.665	
Paired Sample Statistics			
N	72	72	
Mean	6.9	8.71	
Std. Deviation	2.001	1.665	
Std. Error of Mean	0.236	0.196	
Paired Sample Test			
N			72
Correlation			0.499
Sig.			0
Mean			-1.806
Std. Deviation			1.859
Std. Error Mean			0.219
95% Confidence Interval of the Difference		Lower	-2.242
		Upper	-1.369
t			-8.243
df			71
Sig. (2-tailed)			0.00

Table 36: Wilcoxon-Signed Ranks Test on Assessment Performance

Wilcoxon Signed Ranks Test on Assessment Performance			
	Variable 1 Pre-Test	**Variable 2 Post Test**	
Descriptive Statistics			
N	97	72	
Mean	6.66	8.71	
Std. Deviation	2.02	1.665	
Minimum	2	3	
Maximum	10	10	
Percentiles 25th	5	8	
Percentiles 50th (Median)	7	8	
Percentiles 75th	8	10	
Ranks	**N**	**Mean Rank**	**Sum of Ranks**
Negative Ranks	7[a]	14.36	100.5
Positive Ranks	53[b]	32.63	1729.5
Ties	12[c]		
Total	72		
a. Post Test < Pre-Test			
b. Post Test> Pre-Test			
c. Post Test =Pre-Test			
Test Statistics-Wilcoxon Signed Ranks Test			
Z	-6.04	based on Negative ranks	
Sig. (2-tailed)	0.00		

Table 37: One-Sample Test for Difference in Scores

One-Sample Test for Difference in Scores										
	Statistics				Test Value = 0					
	N	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
									Lower	Upper
delta	72	1.81	1.859	0.219	8.243	71	0	1.806	1.37	2.24

Missing Data-Imputation into Model

Table 38: Parametric Tests for Missing Data Comparison, November 12, 2019

Parametric Tests For Missing Data Comparison				
	TAM		HBM	
	N	N'	N	N'
Paired Samples Statistics				
Years of Experience N	65	65	66	66
Mean	16.08	15.2	15.97	15.98
Std. Deviation	11.375	10.807	11.32	11.298
Std. Error Mean	1.411	1.34	1.393	1.391
Correlation		0.44		0.196
p-value		0.00		0.114
Paired Samples Test				
Mean		0.877		-0.015
Std. Deviation		11.751		14.337
Std. Error of Mean		1.457		1.765
95% Confidence Lower		-2.035		-3.54
95% Confidence Higher		3.789		3.509
t		0.602		-0.009
df		64		65
Sig. (2-tailed)		0.55		0.993
Age N	65	65	66	66
Mean	44.37	43.17	44.29	43.95
Std. Deviation	13.145	12.879	13.061	13.244
Std. Error Mean	1.63	1.597	1.608	1.63
Correlation		0.423		0.175
p-value		0.00		0.16
Paired Samples Test				
Mean		1.2		0.333
Std. Deviation		13.982		16.894
Std. Error of Mean		1.734		2.079
95% Confidence Lower		-2.265		-3.82
95% Confidence Higher		4.665		4.486
t		0.692		0.16
df		64		65
Sig. (2-tailed)		0.491		0.873
Sex N	65	65	66	66
Mean	1.75	1.74	1.76	1.76
Std. Deviation	0.434	0.443	0.432	0.432
Std. Error Mean	0.054	0.055	0.053	0.053
Correlation		0.148		0.258
p-value		0.241		0.037
Paired Samples Test				
Mean		0.015		0
Std. Deviation		0.573		0.526
Std. Error of Mean		0.071		0.065
95% Confidence Lower		-0.127		-0.129
95% Confidence Higher		0.157		0.129
t		0.217		0
df		64		65
Sig. (2-tailed)		0.829		1.00

The chart below shows the 4 questions on the TAM survey that required imputed data. The average of the responses was taken for the imputation.

Table 39: Imputation for Missing Data TAM Surveys-November 12, 2019

Imputation for Missing Data-TAM Survey				
	IU1	**PEOU4**	**PEOU6**	**PEOU2**
1	1	1	0	1
2	4	4	0	0
3	6	15	3	3
4	72	28	8	32
5	70	40	15	30
6	144	180	192	156
7	49	105	210	182
Total	346	373	428	404
Mean	5.088235	5.485294	6.294118	5.941176
Estimate	5	5	6	6

The chart below shows the 14 questions on the TAM survey that required imputed data. The average of the responses was taken for the imputation.

Table 40: Imputation for Missing Data HBM Survey-November 12, 2019

Imputation Data-HBM Survey														
	PT1	**PT2**	**PT3**	**PT4**	**PT5**	**PT6**	**PT7**	**PT8**	**PB1**	**PB2**	**PB3**	**PB4**	**PB5**	**PB6**
1	39	26	26	24	35	24	23	1	0	0	1	6	1	1
2	36	34	40	60	50	50	48	22	0	0	22	28	0	0
3	15	15	33	18	9	27	27	18	0	0	9	3	3	0
4	8	20	12	24	12	8	16	16	0	4	36	72	28	24
5	0	25	15	0	0	20	25	85	0	0	45	25	40	35
6	12	18	12	0	0	12	6	102	72	60	132	78	186	186
7	0	35	7	0	0	0	0	70	378	385	77	63	126	147
SUM	110	173	145	126	106	141	145	314	450	449	322	275	384	393
Mean	1.666667	2.621212	2.19697	1.909091	1.606061	2.136364	2.19697	4.757576	6.818182	6.80303	4.878788	4.166667	5.818182	5.954545
Estimate	2	3	2	2	2	2	2	5	7	7	5	4	6	6

Comparative Preferences to Obtain Knowledge Content

Table 41: Comparative Preferences for Obtaining Knowledge Content

Comparison-Time would have been better spent with Internet search, Knowledgeable Mentor or Class Discussion Group rather than ITS						
	Internet Search	**%**	**Mentor**	**%**	**Class Discussion Group**	**%**
Yes	11	0.15942	25	0.362319	18	0.26087
No	58	0.84058	44	0.637681	51	0.73913
No Response	110		110		110	

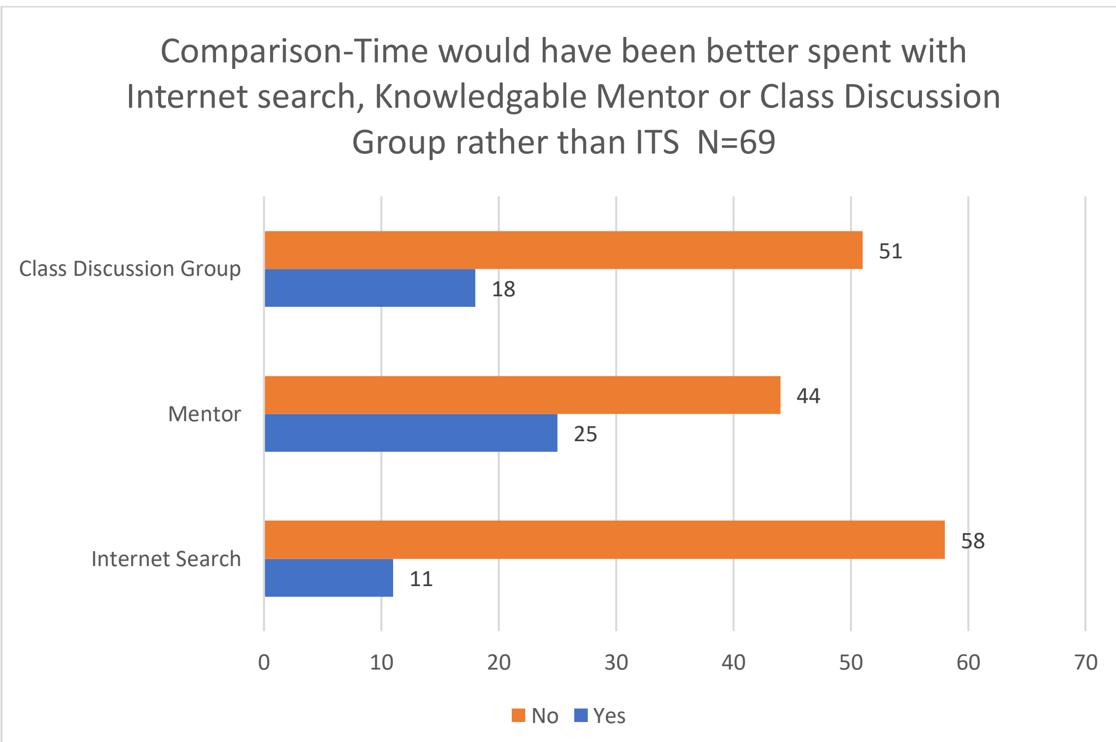


Figure 74: Comparative Preference to Obtain Knowledge Content November 12, 2019

Confirmatory Factor Analysis

Perceived Usefulness (PU)

Table 42: TAM Survey Responses for Perceived Usefulness, November 12, 2019

PU							
	PU1	PU2	PU3	PU4	PU5	PU6	PU7
Extremely Disagree	1	0	1	0	0	0	1
Disagree	2	1	1	2	2	2	5
Slightly Disagree	3	2	8	0	2	4	3
Neither disagree or agree	11	12	11	13	17	5	19
Slightly Agree	20	18	16	18	11	20	15
Agree	27	29	27	29	30	29	21
Extremely Agree	5	7	5	7	7	9	5
No Response	110	110	110	110	110	110	110

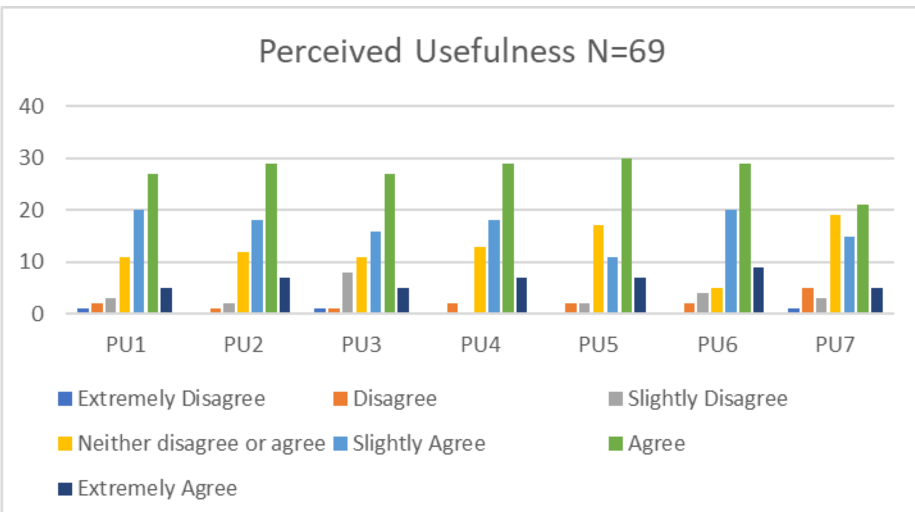


Figure 75: TAM Survey Responses by Question for Perceived Usefulness, November 12, 2019

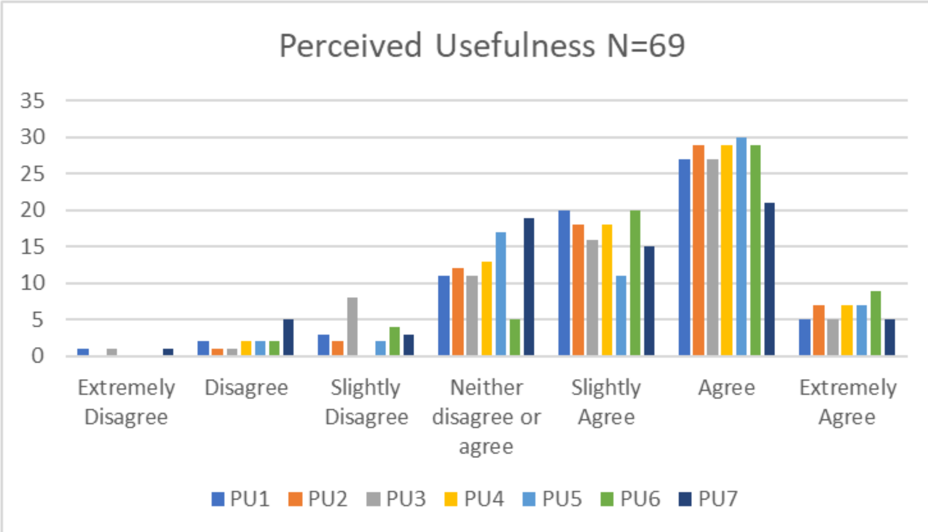


Figure 76: TAM Survey Responses for Perceived Usefulness, November 12, 2019

Table 43: TAM Perceived Usefulness Descriptive Statistics, November 12, 2019

Perceived Usefulness										
	N	Minimum	Maximum	Mean	Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
PU1_Val	69	1	7	5.14	1.228	1.508	-1.07	0.289	1.431	0.57
PU2_Val	69	2	7	5.35	1.069	1.142	-0.669	0.289	0.357	0.57
PU3_Val	69	1	7	5.04	1.3	1.689	-0.786	0.289	0.249	0.57
PU4_Val	69	2	7	5.35	1.082	1.171	-0.813	0.289	0.982	0.57
PU5_Val	69	2	7	5.25	1.193	1.424	-0.656	0.289	-0.046	0.57
PU6_Val	69	2	7	5.41	1.167	1.362	-1.023	0.289	1.06	0.57
PU7_Val	69	1	7	4.81	1.386	1.92	-0.608	0.289	0.004	0.57
Valid N (listwise)	69									

Table 44: Reliability Statistic for PU

Reliability Statistics (PU)		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.958	0.961	7

Table 45: Regression Weights for Generic Model for Perceived Usefulness

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
PU1	.909	.985	.089	11.103	***
PU2	.913	.861	.077	11.200	***
PU3	.872	1.000			
PU4	.904	.863	.079	10.961	***
PU5	.871	.918	.091	10.136	***
PU6	.928	.956	.082	11.648	***
PU7	.778	.951	.116	8.207	***

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 46: Regression Weights for Modified Model for Perceived Usefulness

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
PU1	.913	.957	.078	12.238	***
PU2	.903	.824	.069	11.902	***
PU3	.901	1.000			
PU4	.903	.834	.070	11.882	***
PU5	.862	.878	.083	10.619	***
PU6	.946	.943	.091	10.341	***
PU7	.756	.894	.109	8.194	***
Covariance d6-d3	-.769	-.162	.037	-4.4	***

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 47: Regression Weights for Revised Model for Perceived Usefulness

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
PU1	.923	.970	.077	12.594	***
PU2	.904	.826	.069	11.960	***
PU3	.899	1.000			
PU4	.915	.847	.069	12.292	***
PU5	.870	.888	.082	10.878	***
PU6	.934	.932	.090	10.382	***
PU7	.758	.899	.109	8.250	***
Covariance d6-d3	-.608	-.143	.037	-3.856	***
Covariance d4-d1	-.488	-.099	.031	-3.216	.001

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 48: Correlations, Variances for the Generic, Modified and Revised Models of Perceived Usefulness

Variables	Covariance Estimate	Correlation Estimate	Squared Multiple Correlation Generic	Squared Multiple Correlation Modified	Squared Multiple Correlation Revised	Standar d Errors	Critical Ratio (≥±1.96)	p-value
PU1			.826	.834	.852			
PU2			.833	.816	.817			
PU3			.760	.812	.809			
PU4			.817	.815	.837			
PU5			.759	.742	.756			
PU6			.862	.895	.871			
PU7			.605	.571	.575			
Covariance d6-d3	-.143	-.608				0.37	-3.856	***
Covariance d4-d1	-.099	-.488				.031	-3.216	.001

*** indicated significance smaller than .001
*Statistically significant at <.05

Table 49: Variances for Generic Model of Perceived Usefulness

Variances	Estimate Generic	Standard Errors	Critical Ratio (≥±1.96)	p-value
PU	1.265	.279	4.527	***
d1	.258	.053	4.832	***
d2	.188	.039	4.785	***
d3	.400	.077	5.171	***
d4	.211	.043	4.895	***
d5	.338	.065	5.173	***
d6	.186	.041	4.522	***
d7	.748	.136	5.514	***

*** indicated significance smaller than .001
*Statistically significant at <.05

Table 50: Variances for Modified Model of Perceived Usefulness

Variances	Estimate modified	Standard Errors	Critical Ratio (≥±1.96)	p-value
PU	1.352	.283	4.774	***
d1	.247	.047	5.278	***
d2	.207	.039	5.356	***
d3	3.13	.067	4.679	***
d4	.214	.040	5.361	***
d5	.361	.065	5.550	***
d6	.141	.036	3.907	***
d7	.812	.142	5.713	***

*** indicated significance smaller than .001
*Statistically significant at <.05

Table 51: Variances for Revised Model of Perceived Usefulness

Variances	Estimate on Revised	Standard Errors	Critical Ratio (≥±1.96)	p-value
PU	1.347	.282	4.776	***
d1	.220	.045	4.908	***
d2	.206	.038	5.367	***
d3	.318	.063	5.047	***
d4	.188	.038	5.003	***
d5	.342	.062	5.512	***
d6	.173	.037	4.628	***
d7	.804	.141	5.694	***

*** indicated significance smaller than .001
*Statistically significant at <.05

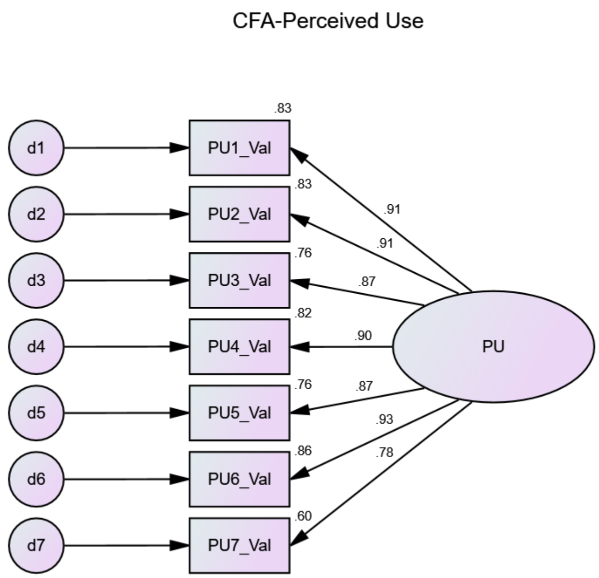


Figure 77: Generic Measurement Model of Perceived Usefulness

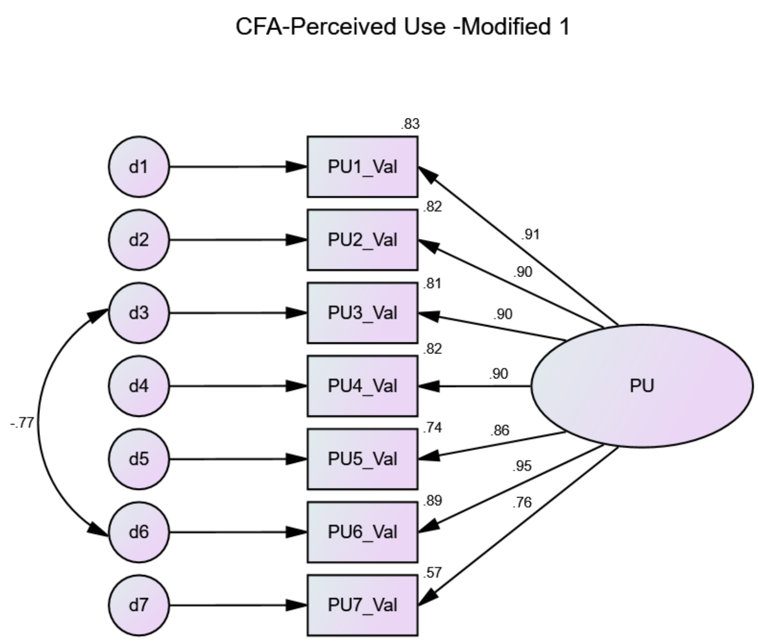


Figure 78: Modified Measurement Model of Perceived Usefulness

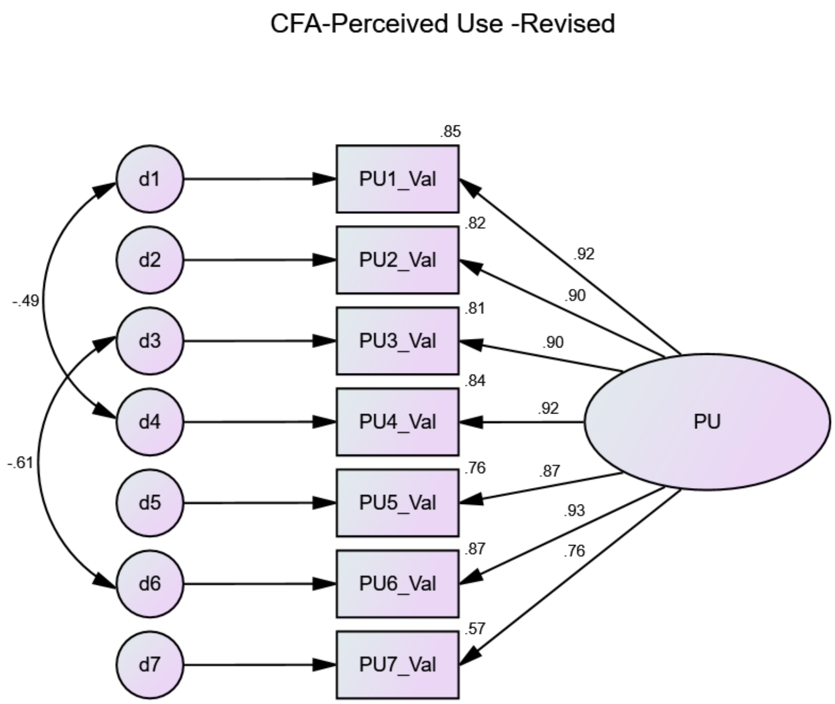


Figure 79: Revised Measurement Model of Perceived Usefulness

Perceived Ease of Use (PEOU)

Evaluation of the measurement models reveal that the revised model has the best model fit statistics for PEOU (Table 53). The CFA Statistics for the revised model is summarized in Table 52. This data reveals that for PEOU1, PEOU2, PEOU3, PEOU5 and PEOU6 the estimates (factor loadings) are very high in the standardized loadings, their standard errors to be low and their critical ratio to be real, strong evidence of their strong statistical significance. The R^2 for these items range is 0.479-0.819 indicating good correlation of the items to the construct. PEOU4 and PEOU7 do not demonstrate strong statistical significance or correlation. Therefore, we may retain the 4 of the 6 observed indicators for construct validity and instrument evaluation.

Table 52: Seven questions that provide input to PEOU observed variables: Summary of Statistics for Best Model Fit

ITEM-Perceived Ease of Use-Revised α=0.857, N=69	Label	Mode	CFA Statistics Standardized Regression Weights (>0.65)	Standard Errors	Critical Ratio (≥±1.96)	p-value	R^2	Retain/ Delete after CFA
Learning to operate the intelligent agent (tutor) system was easy for me.	PEOU1	Extremely Agree	**0.692**	0.095	5.844	***	0.479	Retain
It was easy to get the intelligent agent (tutor) system to do what I want it to do.	PEOU2	Agree/ Extremely Agree	**0.764**				0.584	Retain
My interaction with the intelligent agent (tutor) system was clear and understandable.	PEOU3	Agree	**0.905**	0.106	7.856	***	0.819	Retain
The intelligent agent (tutor) system was flexible to interact with.	PEOU4	Agree	*0.44*	0.17	4.006	***	0.194	Delete
It was easy for me to become skillful at using the intelligent agent (tutor) system	PEOU5	Agree	**0.795**	0.113	6.825	***	0.633	Retain
Overall, the intelligent agent (tutor) system was easy to use.	PEOU6	Agree	**0.904**	0.118	6.754	***	0.816	Retain
Over the last 12 months, I would have found using the intelligent agent (tutor) system easy to us	PEOU7	Agree	*0.581*	0.157	4.833	***	0.338	Delete

*** indicated significance smaller than .001, *Statistically significant at <.05, Scale: 1-7 (Extremely Disagree, Disagree, Slightly Disagree, Neither, Slightly Agree, Agree, Extremely Agree)

PEOU is an exogenous variable in the TAM model and was not contained in the a priori hypothesized model. It is represented by 7 observed indicators that utilize a 7-level measurement scale from Extremely Disagree to Extremely Agree. The Cronbach alpha shows a good level of reliability among the 7 indicators at an α=0.857 (Table 56). Measurement models for PEOU had 3 variations: generic (Figure 83), modified (Figure 84) and revised (Figure 80). The models are recursive with a sample size of 69. The modified measurement model has a covariance link between d9-d13 and shows an improvement in goodness of fit statistics. Therefore, based on the goodness of fit statistics the revised version has the best model fit for PEOU and has a strong fit.

Table 53: Goodness of Fit Statistics for Generic, Modified and Revised Models-Perceived Ease of Use

Model Fit	Statistical Range	Generic Model (Figure 83)	Modified Model (Figure 84)	Revised Model (Figure 80)
Sample Size	-	69	69	69
Sample Moments	-	28	28	28
Distinct Parameters	-	14	15	16
Degrees of Freedom (df)	-	14	13	12
Chi Squared χ^2	Approximates the df	28.460	21.550	13.365
Probability	≥ 0.05	*0.012*	**0.063**	**.343**
Likelihood ratio CMIN/DF	1< CMIN/DF <3 Closer to 1 but not to exceed 3	**2.033**	**1.658**	**1.114**
Normed Fit Index NFI	NFI $\geq$ 0.95	*0.900*	*0.924*	**.953**
Comparative Fit Index CFI	CFI $\geq$ 0.95	*0.945*	**0.967**	**.995**
RMSEA-Root Mean Square Residual	RMSEA < 0.05 Should not exceed 0.1	*0.123*	*0.098*	**.041**
Goodness of fit Index GFI	0.80 < GFI < 1	**0.894**	**0.923**	**.949**
AGFI	0.80 < AGFI < 1	*0.788*	**0.834**	**.881**

Values that fail the standard are in italics. Values that pass are in BOLD.

The frequency data is favored toward agreement on the perceived ease of use of an intelligent tutoring system (Table 54) and Mode is Agree for PEOU3-PEOU7. Mode is equal in the responses of Extremely Agree and Agree for PEOU1 and PEOU2.

In the generic model there were 15 variables in the model: 7 observed variables (PEOU1-PEOU7) and 8 unobserved variables (d8-d14, PEOU). The modified model has 15 variables in the model, 7 of which are observed, (PEOU1-PEOU7) and 8 unobserved, variables (d8-d14, PEOU). There is a covariance link between d11-d9. The revised model has 15 variables in the model: 7 observed, variable (PEOU1-PEOU7) and 8 unobserved variables (d8-d14, PEOU).

There is covariance links between d11-d9 and d13-d9. Based on the regression weights for these links there may be some correlation between PEOU2 and PEOU6 (Table 58-Table 60)

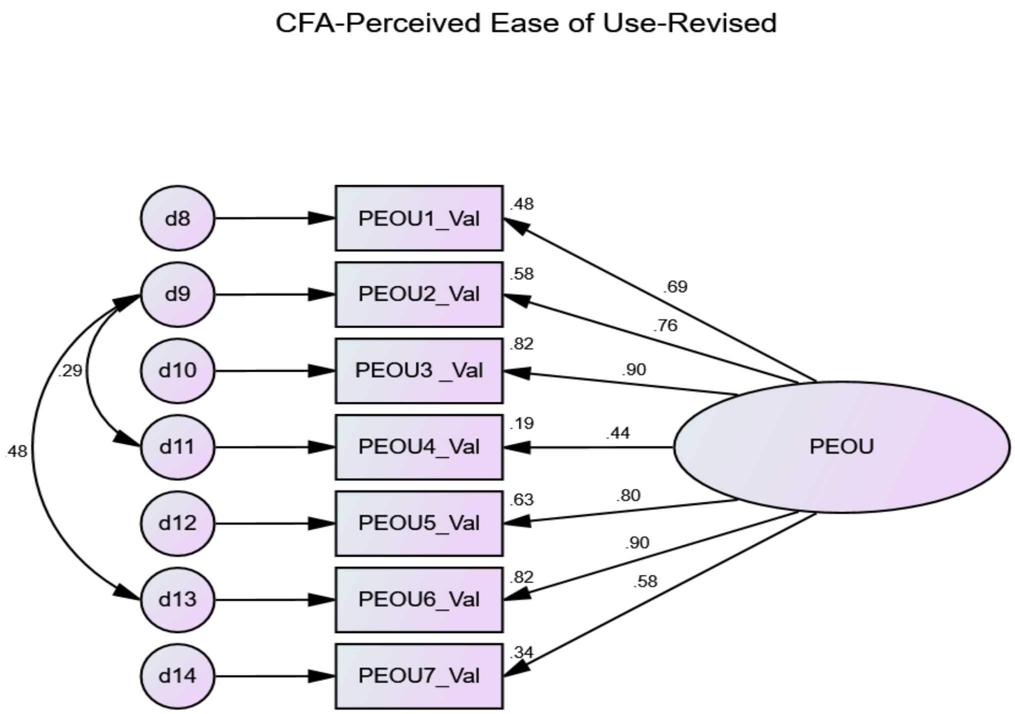


Figure 80: Revised Measurement Model for Perceived Ease of Use

Table 54: TAM Survey Responses for Perceived Ease of Use, November 12, 2019

PEOU							
	PEOU1	**PEOU2**	**PEOU3**	**PEOU4**	**PEOU5**	**PEOU6**	**PEOU7**
Extremely Disagree	0	1	0	1	0	0	0
Disagree	0	0	0	2	0	0	1
Slightly Disagree	0	1	1	5	0	1	1
Neither disagree or agree	3	8	2	7	6	2	12
Slightly Agree	1	6	6	8	6	3	6
Agree	32	26	31	30	33	32	28
Extremely Agree	33	26	29	15	24	30	21
No Response	110	111	110	111	110	111	110

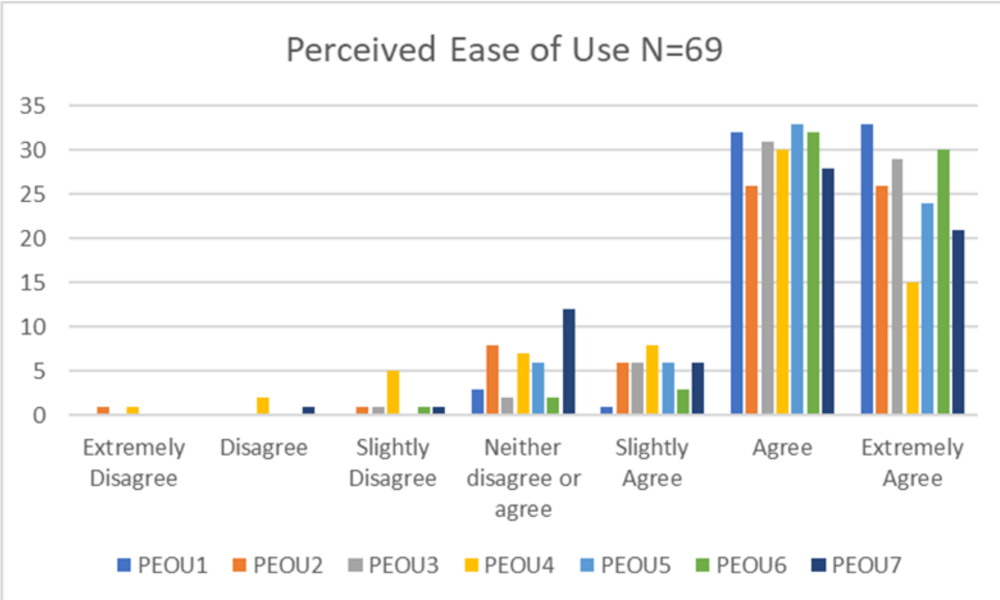


Figure 81: TAM Survey Responses for Perceived Ease of Use, November 12, 2019

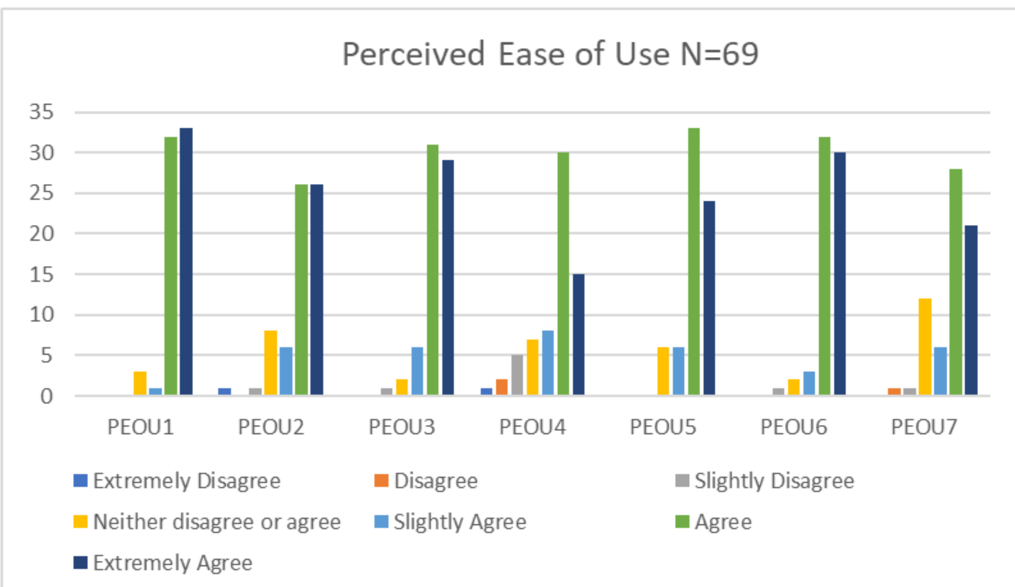


Figure 82: TAM Survey Responses by Question for Perceived Ease of Use, November 12, 2019

Table 55: TAM Perceived Ease of Use Descriptive Statistics, November 12, 2019

Perceived Ease of Use											
	N	Minimum	Maximum	Mean		Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
PEOU1_Val	69	4	7	6.38	0.088	0.73	0.532	-1.428	0.289	2.811	0.57
PEOU2_Val	69	1	7	5.94	0.144	1.199	1.438	-1.572	0.289	3.254	0.57
PEOU3 _Val	69	3	7	6.23	0.101	0.843	0.71	-1.378	0.289	2.683	0.57
PEOU4_Val	69	1	7	5.48	0.17	1.41	1.988	-1.17	0.289	0.926	0.57
PEOU5_Val	69	4	7	6.09	0.107	0.887	0.786	-0.955	0.289	0.47	0.57
PEOU6_Val	69	3	7	6.29	0.097	0.806	0.65	-1.622	0.289	4.021	0.57
PEOU7_Val	69	2	7	5.77	0.143	1.19	1.416	-0.936	0.289	0.293	0.57
Valid N (listwise)	69										

Table 56: Reliability Statistic for PEOU

Reliability Statistics (PEOU)		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.857	0.884	7

Table 57: Inter-Item Correlation Matrix for PEOU

Inter-Item Correlation Matrix							
	PEOU1_Val	PEOU2_Val	PEOU3 _Val	PEOU4_Val	PEOU5_Val	PEOU6_Val	PEOU7_Val
PEOU1_Val	1	0.513	0.597	0.265	0.63	0.637	0.322
PEOU2_Val	0.513	1	0.727	0.521	0.572	0.55	0.351
PEOU3 _Val	0.597	0.727	1	0.45	0.701	0.809	0.524
PEOU4_Val	0.265	0.521	0.45	1	0.343	0.368	0.207
PEOU5_Val	0.63	0.572	0.701	0.343	1	0.725	0.563
PEOU6_Val	0.637	0.55	0.809	0.368	0.725	1	0.562
PEOU7_Val	0.322	0.351	0.524	0.207	0.563	0.562	1

Table 58: Regression Weights for Generic Model for Perceived Ease of Use

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
PEOU1	.691	.577	.103	5.622	***
PEOU2	.729	1.000			
PEOU3	.912	.879	.117	7.488	***
PEOU4	.470	.757	.201	3.773	***
PEOU5	.807	.818	.124	6.613	***
PEOU6	.877	.808	.112	7.212	***
PEOU7	.591	.804	.168	4.775	***

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 59: Regression Weights for Modified Model for Perceived Ease of Use

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
PEOU1	.695	.592	.107	5.545	***
PEOU2	.715	1.000			
PEOU3	.907	.892	.124	7.199	***
PEOU4	.443	.728	.179	4.080	***
PEOU5	.811	.839	.130	6.472	***
PEOU6	.884	.831	.118	7.034	***
PEOU7	.596	.827	.174	4.749	***
d11-d9	.326	.340	.142	2.403	.016

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 60: Regression Weights for Revised Model for Perceived Ease of Use

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
PEOU1	.692	.553	.095	5.844	***
PEOU2	.764	1.000			
PEOU3	.905	.836	.106	7.856	***
PEOU4	.440	.680	.170	4.006	***
PEOU5	.795	.773	.113	6.825	***
PEOU6	.904	.798	.118	6.754	***
PEOU7	.581	.758	.157	4.833	***
d13-d9	-.478	-.125	.043	-2.905	.004
d11-d9	.286	.275	.136	2.024	.043

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 61: Correlations, Variances for the Generic, Modified and Revised Models of Perceived Ease of Use

Variables	Covariance Estimate	Correlation Estimate	Squared Multiple Correlation Generic	Squared Multiple Correlation Modified	Squared Multiple Correlation Revised	Standard Errors	Critical Ratio (≥±1.96)	p-value
PEOU1			.478	.484	.479			
PEOU2			.532	.512	.584			
PEOU3			.832	.823	.819			
PEOU4			.221	.196	.194			
PEOU5			.651	.658	.633			
PEOU6			.769	.781	.816			
PEOU7			.349	.355	.338			
d11-d9	.340	.326				.142	2.403	.016
d13-d9	-.125	-.478				.043	-2.905	.004
d11-d9	.275	.286				.136	2.024	.043

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 62: Variances for Generic Model of Perceived Ease of Use

Variances	Estimate Generic	Standard Errors	Critical Ratio (≥±1.96)	p-value
PEOU	.754	.221	3.414	***
d14	.908	.163	5.589	***
d13	.148	.035	4.238	***
d12	.270	.054	4.966	***
d11	1.527	.268	5.704	***
d10	.117	.033	3.503	***
d9	.663	.125	5.312	***
d8	.274	.051	5.415	***

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 63: Variances for Modified Model of Perceived Ease of Use

Variances	Estimate Modified	Standard Errors	Critical Ratio (≥±1.96)	p-value
PEOU	.725	.218	3.320	***
d14	.899	.161	5.575	***
d13	.140	.034	4.082	***
d12	.265	.054	4.915	***
d11	1.575	.276	5.710	***
d10	.124	.035	3.578	***
d9	.692	.130	5.340	***
d8	.271	.050	5.394	***

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 64: Variances for Revised Model of Perceived Ease of Use

Variances	Estimate Revised	Standard Errors	Critical Ratio (≥±1.96)	p-value
PEOU	.821	.228	3.593	***
d14	.924	.163	5.666	***
d13	.118	.033	3.551	***
d12	.285	.054	5.232	***
d11	1.580	.276	5.717	***
d10	.127	.032	3.951	***
d9	.584	.120	4.879	***
d8	.273	.049	5.526	***

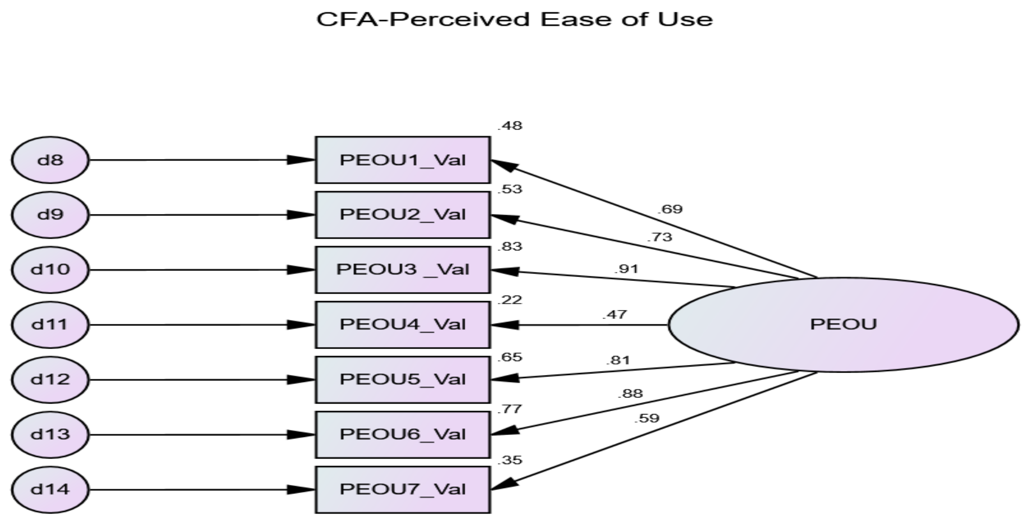


Figure 83: Generic Measurement Model for Perceived Ease of Use

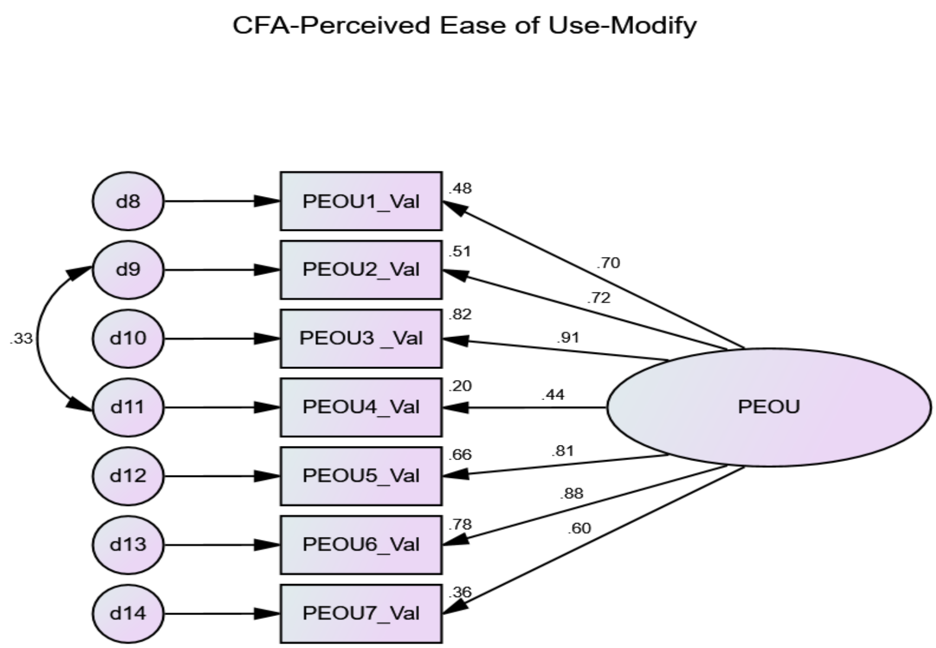


Figure 84: Modified Measurement Model for Perceived Ease of Use

Intention to Use (IU)

Evaluation of the measurement models reveal that the revised model has the best model fit statistics for IU (Table 66). The CFA Statistics for the revised model is summarized in Table 65. This data reveals that the estimates (factor loadings) are high in the standardized loadings (>.7), their standard errors to be low and their critical ratio to be real, strong evidence of their strong statistical significance. The R^2 range from 0.599-0.947 indicating good correlation of the items to the construct. Thus, the 5 observed indicators for Intention to Use were retained for construct validity and instrument validation.

Table 65: Five questions that provide input to IU observed variables: Summary of Statistics for Best Model Fit

ITEM-Intention to Use-Revised α=0.931, N=69	Label	Mode	CFA Statistics Standardized Regression Weights (>0.65)	Standard Errors	Critical Ratio (≥±1.96)	p-value	R^2	Retain/ Delete after CFA
Assuming I have access to an intelligent tutor platform, I intend to use it for training.	IU1	Agree	**0.774**	0.1	7.678	***	0.599	Retain
Given that I now have access to an ITS platform, I predict that I will use it for training.	IU2	Neither	**0.973**	0.104	9.966	***	0.947	Retain
If I get to use an intelligent tutor, I expect that I will use it.	IU3	Agree	**0.796**	0.106	8.011	***	0.633	Retain
Over the next 3 months, I would expect that I would use an intelligent tutoring system.	IU4	Neither	**0.838**				0.702	Retain
Over the next 3 months, I intend to use an intelligent tutoring system for training.	IU5	Neither	**0.798**	0.086	11.231	***	0.637	Retain

*** indicated significance smaller than .001, *Statistically significant at <.05, Scale: 1-7 (Extremely Disagree, Disagree, Slightly Disagree, Neither, Slightly Agree, Agree, Extremely Agree)

The IU variable is an endogenous variable for the TAM model and an intermediate variable in the a priori hypothesized model. It is represented by 5 observed indicators that utilize a 7-level measurement scale from Extremely Disagree to Extremely Agree. The Cronbach alpha shows an excellent level of reliability among the 5 indicators at α=.931 (Table 69). Measurement models for IU had 3 variations: generic (Figure 89), modified (Figure 90) and revised (Figure 85). The models were recursive with a sample size of 69. The modified model has a covariance link between d20-d18. The revised model has 2 covariance links (d20-d18 and d22-d21). Therefore, based on the goodness of fit statistics the revised version has the best model fit for IU.

Table 66: Goodness of Fit Statistics for Generic, Modified and Revised Models for Intention to Use

Model Fit	**Statistical Range**	**Generic Model** (Figure 89**)**	**Modified Model** (Figure 90**)**	**Revised Model 2** (Figure 85**)**
Sample Size	-	69	69	69
Sample Moments	-	15	15	15
Distinct Parameters	-	10	11	12
Degrees of Freedom (df)	-	5	4	3
Chi Squared χ^2	Approximates the df	38.688	16.314	5.614
Probability	≥ 0.05	*.000*	*.003*	**.132**
Likelihood ratio CMIN/DF	1< CMIN/DF <3 Closer to 1 but not to exceed 3	*7.738*	*4.078*	**1.871**
Normed Fit Index NFI	NFI ≥ 0.95	*.877*	*.948*	**.982**
Comparative Fit Index CFI	CFI ≥ 0.95	*.890*	**.960**	**.991**
RMSEA-Root Mean Square Residual	RMSEA < 0.05 Should not exceed 0.1	*.315*	*.213*	*.113*
Goodness of fit Index GFI	0.80 < GFI < 1	**.818**	**.915**	**.969**
AGFI	0.80 < AGFI < 1	*.455*	*.680*	**.847**

Values that fail the standard are in italics. Values that pass are in BOLD.

The frequency data shows that respondents are agreeable to the intention to use the technology in the future. We see a high level of agreement in IU1, IU2 and IU3. In IU4 and IU5, the level of disagreement and neither agree or disagree is almost equal to agreement (Table 67). The free text section gives some indication that some participants were retired and therefore would not be likely to use an ITS in the next 3 months which may account for the responses in IU4 and IU5.

In the generic model there were 11 variables in the model: 5 observed variables (IU1-IU5) and 6 unobserved variables (d18-d22, IU). The modified model has 11 variables in the model: 5 observed and 6 unobserved variables. The revised model has 11 variables in the model: 5, observed variables and 6 unobserved variables.

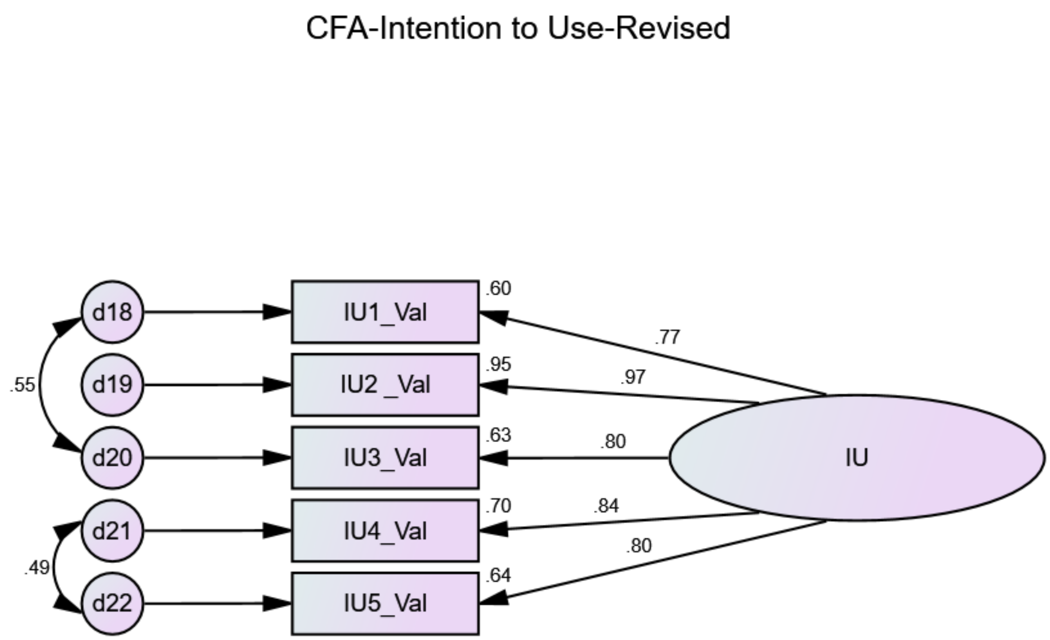


Figure 85: Revised Measurement Model for Intention to Use

We compared the three models based on the Chi-square value and noted that the revised model was the lowest. The revised model's goodness of fit statistics was also much improved when compared to a generic model and modified model, and the probability increased to p=.132 demonstrating a good model fit. The revised model for IU had the best fit indicating that the 5 observed indicators do represent the construct strongly. Based on the regression there may be some correlation between IU1 and IU3 and IU4 and IU5 (Table 71-Table 73).

Table 67: TAM Survey Responses for Intention to Use, November 12, 2019

Intention to Use					
	IU1	IU2	IU3	IU4	IU5
Extremely Disagree	1	0	0	3	4
Disagree	2	5	4	7	9
Slightly Disagree	2	5	5	8	10
Neither disagree or agree	18	23	11	27	25
Slightly Agree	14	12	16	6	6
Agree	24	17	23	13	11
Extremely Agree	7	7	10	5	4
No Response	111	110	110	110	110

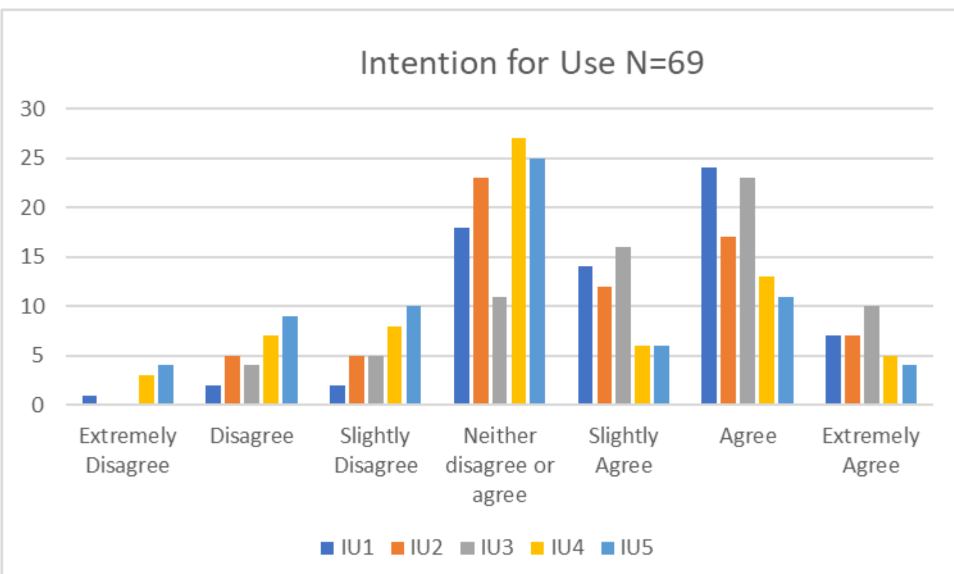


Figure 86: TAM Survey Responses for Intention for Use, November 12, 2019

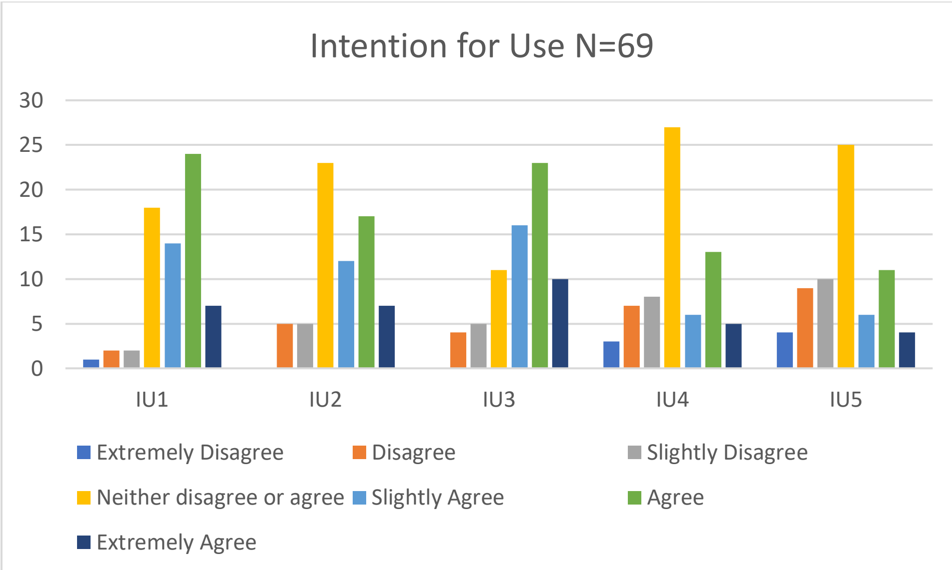


Figure 87: TAM Survey Responses by Question for Intention to Use, November 12, 2019

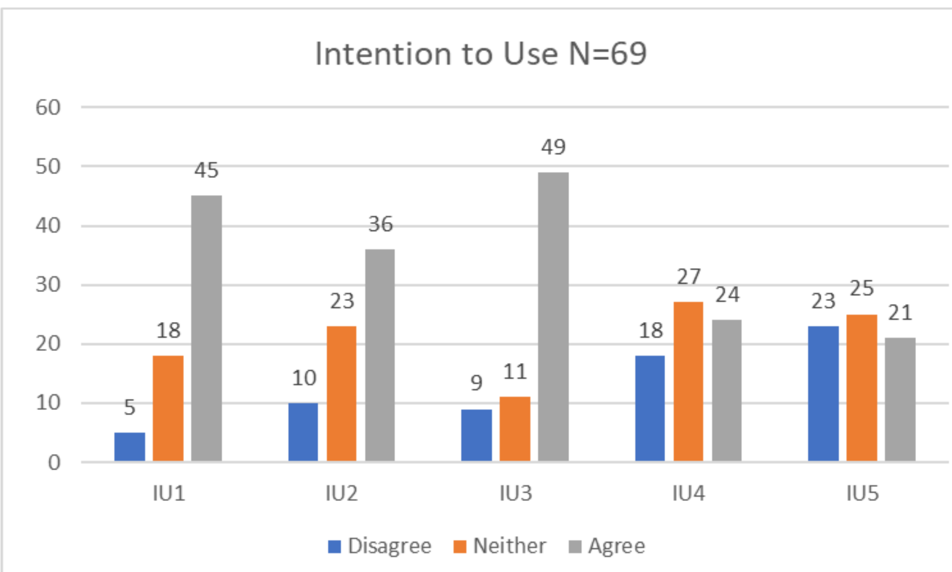


Figure 88: TAM Survey Cumulative Responses for Intention to Use, November 12, 2019

Table 68: TAM Intention to Use Descriptive Statistics, November 12, 2019

Intention to Use											
	N	Minimum	Maximum	Mean		Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
IU1_Val	69	1	7	5.09	0.154	1.28	1.639	-0.73	0.289	0.653	0.57
IU2 _Val	69	2	7	4.75	0.166	1.376	1.894	-0.167	0.289	-0.624	0.57
IU3_Val	69	2	7	5.14	0.166	1.375	1.89	-0.653	0.289	-0.23	0.57
IU4_Val	69	1	7	4.23	0.186	1.545	2.387	-0.057	0.289	-0.48	0.57
IU5_Val	69	1	7	4	0.189	1.572	2.471	0.047	0.289	-0.548	0.57
Valid N (listwise)	69										

Table 69: Reliability Statistic for IU

Reliability Statistics (IU)		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.931	0.933	5

Table 70: Inter-Item Correlation Matrix IU

Inter-Item Correlation Matrix-IU					
	IU1_Val	IU2 _Val	IU3_Val	IU4_Val	IU5_Val
IU1_Val	1	0.755	0.828	0.614	0.65
IU2 _Val	0.755	1	0.773	0.816	0.775
IU3_Val	0.828	0.773	1	0.683	0.626
IU4_Val	0.614	0.816	0.683	1	0.83
IU5_Val	0.65	0.775	0.626	0.83	1

Table 71: Regression Weights for Generic Model for Intention to Use

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
IU1	.811	.772	.090	8.611	***
U2	.930	.952	.085	11.161	***
IU3	.831	.850	.094	9.010	***
IU4	.870	1.000			
IU5	.843	.986	.107	9.249	***

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 72: Regression Weights for Modified Model for Intention to Use

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
IU1	.757	.696	.088	7.934	***
IU2	.918	.908	.078	11.626	***
IU3	.784	.775	.092	8.453	***
IU4	.901	1.000			
IU5	.869	.982	.095	10.379	***
d20-d18	.578	.407	.113	3.616	***

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 73: Regression Weights for Revised Model for Intention to Use

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
IU1	.774	.766	.100	7.678	***
U2	.973	1.035	.104	9.966	***
IU3	.796	.846	.106	8.011	***
IU4	.838	1.000			
IU5	.798	.969	.086	11.231	***
d20-d18	.553	.368	.110	3.329	***
d22-d21	.490	.386	.140	2.753	.006

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 74: Correlations, Variances for the Generic, Modified and Revised Models of Intention to Use

Variables	Covariance Estimate	Correlation Estimate	Squared Multiple Correlation Generic	Squared Multiple Correlatio n Modified	Squared Multiple Correlati on Revised	Standard Errors	Critical Ratio (≥±1.96)	p-value
IU1			.657	.573	.599			
IU2			.864	.842	.947			
IU3			.691	.615	.633			
IU4			.757	.812	.702			
IU5			.711	.756	.637			
Covariance d20-d18	.407	.578				.113	3.616	***
Covariance d20-d18 revised	.368	.553				.110	3.329	***
Covariance d22-d21 revised	.386	.490				.140	2.753	.006

*** indicated significance smaller than .001
*Statistically significant at <.05

Table 75: Variances for Generic Model of Intention to Use

Variances	Estimate on Generic	Standard Errors	Critical Ratio (≥±1.96)	p-value
IU	1.782	.398	4.472	***
d22	.703	.143	4.903	***
d21	.570	.123	4.639	***
d20	.575	.115	4.991	***
d19	.253	.074	3.430	***
d18	.554	.108	5.116	***

*** indicated significance smaller than .001
*Statistically significant at <.05

Table 76: Variances for Modified Model of Intention to Use

Variances	Estimate modified	Standard Errors	Critical Ratio (≥±1.96)	p-value
IU	1.909	.404	4.720	***
d22	.594	.131	4.526	***
d21	.443	.111	3.976	***
d20	.717	.139	5.163	***
d19	.294	.083	3.550	***
d18	.690	.131	5.262	***

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 77: Variances for Revised Model of Intention to Use

Variances	Estimate Revised	Standard Errors	Critical Ratio (≥±1.96)	p-value
IU	1.650	.397	4.158	***
d22	.885	.180	4.923	***
d21	.702	.154	4.546	***
d20	.683	.136	5.006	***
d19	.100	.102	.978	.328
d18	.647	.126	5.139	***

*** indicated significance smaller than .001

*Statistically significant at <.05

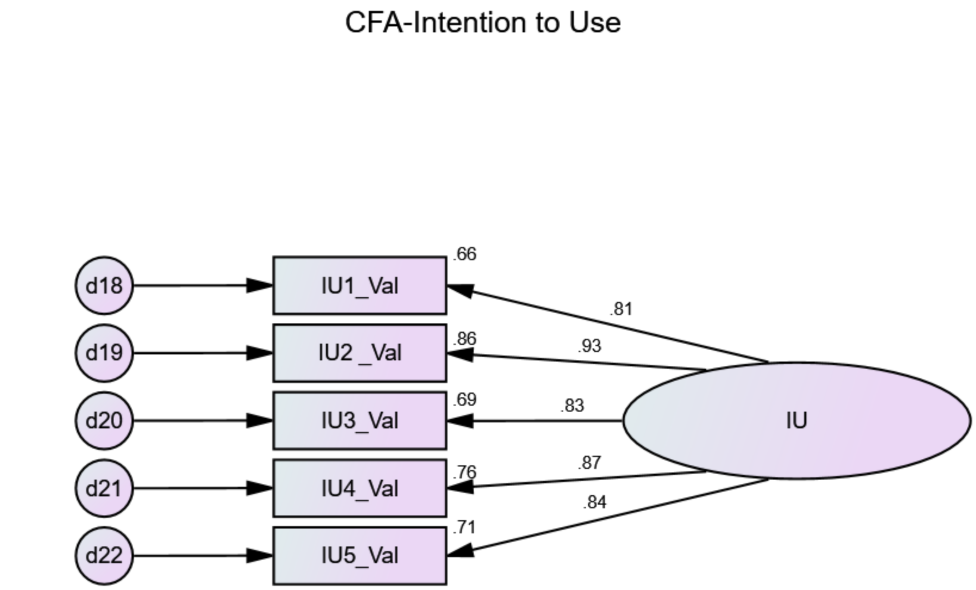


Figure 89: Generic Measurement Model for Intention to Use

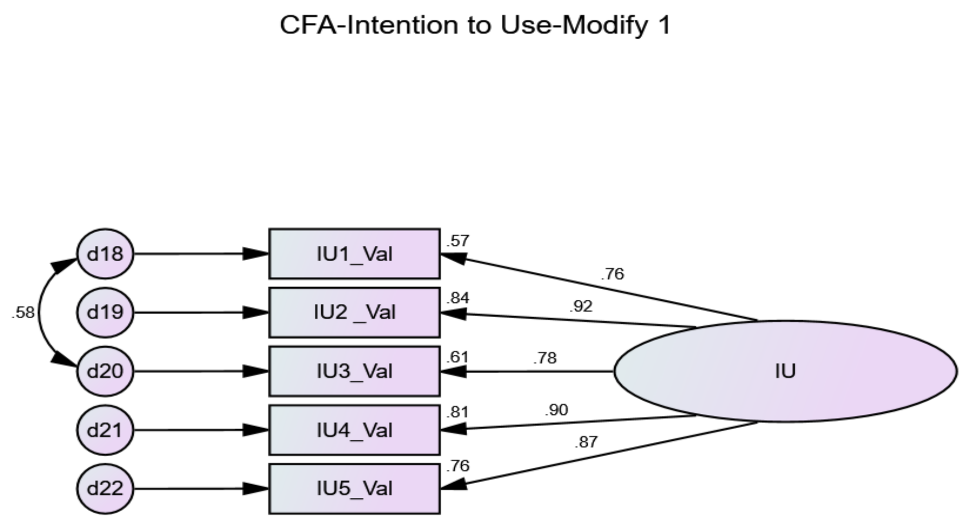


Figure 90: Modified Measurement Model for Intention to Use

Attitude (ATT)

Attitude is an identified model. The CFA Statistics for the revised model is summarized in Table 79. This data reveals that the estimates (factor loadings) are very high in the standardized loadings, their standard errors to be low and their critical ratio to be real, strong evidence of their strong statistical significance. The R^2 range from 0.666-0.954 indicating good correlation of the items to the construct. Therefore, the 3 observed indicators for Attitude represent the construct strongly and were retained for construct validity and instrument evaluation.

Table 78: Three questions that provide input to ATT observed variables: Summary of Statistics for Best Model Fit

ITEM-Attitude α=0.9, N=69	Label	Mode	CFA Statistics: Standardized Regression Weights (>0.65)	Standard Errors	Critical Ratio (≥±1.96)	p-value	R^2	Retain/ Delete after CFA
Using an ITS platform for remedial training on febrile rash illness is a good idea	ATT1	Agree	**0.826**	0.097	8.195	***	0.682	Retain
I like the idea of using an intelligent tutor system for getting health information on febrile rash illn	ATT2	Agree	**0.977**	0.121	9.195	***	0.954	Retain
Using an ITS platform for remedial training on febrile rash illness is a pleasant experience.	ATT3	Agree	**0.816**	-	-	-	0.666	Retain

*** indicated significance smaller than .001, *Statistically significant at <.05, Scale: 1-7 (Extremely Disagree, Disagree, Slightly Disagree, Neither, Slightly Agree, Agree, Extremely Agree)

The ATT variable is an intermediate variable in the TAM model. It is represented by 3 observed indicators that utilize a 7-level measurement scale from Extremely Disagree to Extremely Agree. The frequency data shows that respondents agree on their attitude toward using the ITS platform (Table 80). The Cronbach alpha shows an excellent level of reliability among the 3 indicators at α=.900 (Table 82).

Table 79: Goodness of Fit Statistics for Generic Model for Attitude

Model Fit	Statistical Range	Generic Model (Figure 91)
Sample Size	-	69
Sample Moments	-	6
Distinct Parameters	-	6
Degrees of Freedom (df)	-	0
Chi Squared χ^2	Approximates the df	0.00
Probability	≥ 0.05	Cannot be calculated
Likelihood ratio CMIN/DF	1< CMIN/DF <3 Closer to 1 but not to exceed 3	Not calculated
Normed Fit Index NFI	NFI ≥ 0.95	1.0
Comparative Fit Index CFI	CFI ≥ 0.95	1.0
RMSEA-Root Mean Square Residual	RMSEA < 0.05 Should not exceed 0.1	.822
Goodness of fit Index GFI	0.80 < GFI < 1	
AGFI	0.80 < AGFI < 1	

Values that fail the standard are in italics. Values that pass are in BOLD.

The generic model has 7 variables in the model. There are 3 observed variables (ATT1-ATT3) and 4 unobserved variables (d15-d17, ATT). The measurement model for ATT fit statistics could not be calculated because the DF is 0. This is an identified model.

A review of the regression weights of the generic model reveals that the estimates (factor loadings) are high in the standardized loadings (>.8), their standard errors to be low and their critical ratio to be real, strong evidence of their strong statistical significance (Table 84). The variance on d16 is not significant at p=.459 and may be attributed to the poor fit of the model.

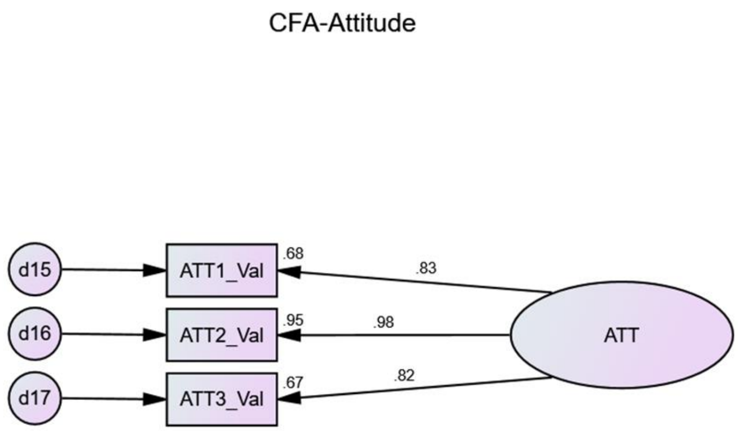


Figure 91: Measurement Model for Attitude

Table 80: TAM Survey Responses for Attitude, November 12, 2019

Attitude			
	ATT1	**ATT2**	**ATT3**
Extremely Disagree	0	0	0
Disagree	1	2	4
Slightly Disagree	0	3	1
Neither disagree or agree	5	6	7
Slightly Agree	10	8	11
Agree	32	34	34
Extremely Agree	21	17	12
No Reponses	110	110	110

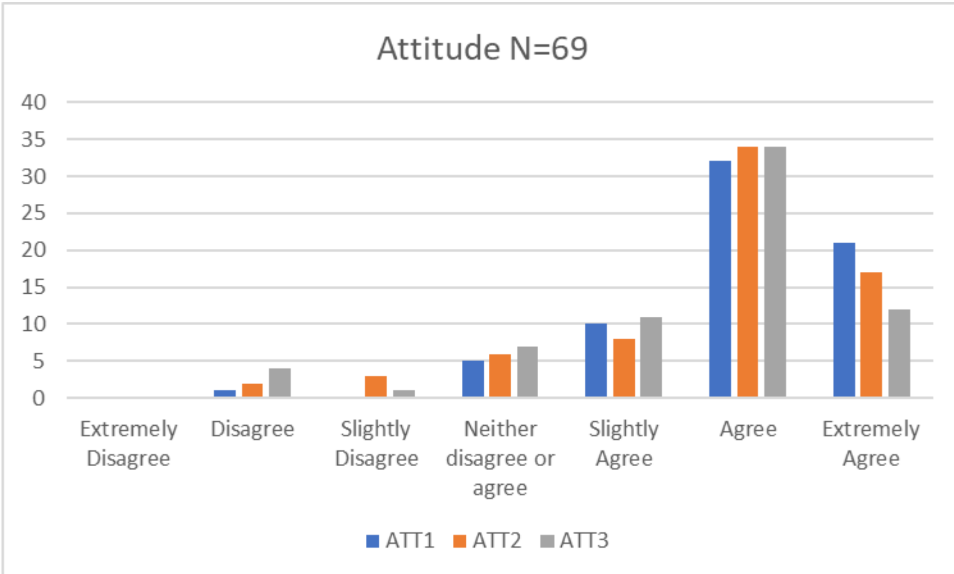


Figure 92: TAM Survey Responses for Attitude, November 12, 2019

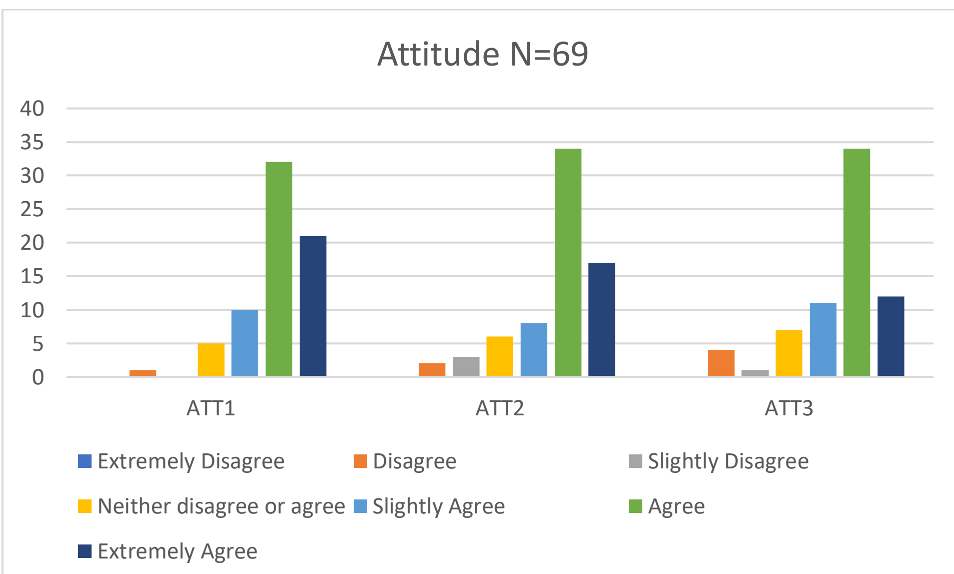


Figure 93: TAM Survey Responses by Question for Attitude, November 12, 2019

Table 81: TAM Attitude Descriptive Statistics, November 12, 2019

Attitude											
	N	Minimum	Maximum	Mean		Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
ATT1_Val	69	2	7	5.96	0.119	0.992	0.983	-1.309	0.289	2.703	0.57
ATT2_Val	69	2	7	5.75	0.142	1.181	1.394	-1.379	0.289	1.924	0.57
ATT3_Val	69	2	7	5.54	0.153	1.267	1.605	-1.335	0.289	1.622	0.57
Valid N (listwise)	69										

Table 82: Reliability Statistics Attitude

Reliability Statistics (ATT)		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.9	0.905	3

Table 83: Inter-Item Correlation Matrix for Attitude

Inter-Item Correlation Matrix-ATT			
	ATT1_Val	ATT2_Val	ATT3_Val
ATT1_Val	1	0.807	0.674
ATT2_Val	0.807	1	0.797
ATT3_Val	0.674	0.797	1

Table 84: Regression Weights for Generic Model for Attitude

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value	Squared Multiple Correlations
ATT1	.826	.792	.097	8.195	***	.682
ATT2	.977	1.115	.121	9.195	***	.954
ATT3	.816	1.000				.666

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 85:Variances for Generic Model of Attitude

Variances	Estimate Generic	Standard Errors	Critical Ratio (≥±1.96)	p-value
ATT	1.054	.265	3.984	***
d17	.528	.113	4.674	***
d16	.063	.085	.740	.459
d15	.308	.068	4.546	***

*** indicated significance smaller than .001
*Statistically significant at <.05

Perceived Susceptibility (PS)

Evaluation of the measurement models reveal that the modified model has the best model fit statistics for PS (Table 87). The CFA Statistics for the modified model is summarized in Table 86. This data reveals that for PS2, PS3 and PS5 the estimates (factor loadings) are very high in the standardized loadings, their standard errors to be low and their critical ratio to be real, strong evidence of their strong statistical significance. The R^2 range from 0.501-0.989 indicating good correlation of the items to the construct. PS1 and PS4 do not demonstrate strong statistical significance or correlation. Thus, 3 of the 5 observed indicators for Perceived Susceptibility (remove PS1 and PS4) were retained for construct validity and instrument evaluation.

Table 86: Five questions that provide input to PS observed variables: Summary of Statistics for Best Model Fit

ITEM-Perceived Susceptibility-Modified α=0.65, N=69	Label	Mode	CFA Statistics: Standardized Regression Weights (>0.65)	Standard Errors	Critical Ratio (≥±1.96)	p-value	R^2	Retain/ Delete after CFA
Taking all possible factors into consideration, how likely do you think your chances of getting a febrile rash illness are?	PS1	Unlikely	*-0.001*	0.135	-0.006	*0.995*	0	Delete
How likely do you think your community will have a febrile rash illness outbreak in the future?	PS2	Likely	**0.995**				0.989	Retain
What is the likelihood that your community would be exposed to an outbreak of febrile rash illness as compared to other communities?	PS3	Likely	**0.708**	0.126	5.866	***	0.501	Retain
Over the last 12 months, I consider myself susceptible to a febrile rash-like illness.	PS4	Unlikely	*-0.044*	0.119	-0.364	*0.716*	0.002	Delete
Over the last 12 months, I consider my community susceptible to a febrile rash-like illness outbreak.	PS5	Likely	**0.712**	0.149	5.896	***	0.507	Retain

*** indicated significance smaller than .001, *Statistically significant at <.05, Scale: 1-7 (Extremely Unlikely, Unlikely, Slightly Unlikely, Neither, Slightly Likely, Likely, Extremely Likely)

PS is an exogenous variable in the HBM model and the a priori hypothesized model. It is represented by 5 observed indicators that utilize a 7-level measurement scale from Extremely Unlikely to Extremely Likely.

The Cronbach alpha shows questionable reliability among the 5 indicators at an $\alpha=0.650$ (Table 90). The questionable reliability statistic, spurred a re-evaluation of the indicators by looking at the inter-item correlation matrix and re-calculating the Cronbach alphas statistic for indicators PS5, PS2 and PS3, the alpha was boosted to $\alpha=0.853$ (Table 91;Table 92).

Measurement models for PS had 2 variations, generic (Figure 97) and modified (Figure 94). The modified model has one covariance link between d4-d1. The modified model shows the best fit statistics when comparing the Chi-squared, likelihood ratio, NFI, CFI, RMSEA, GFI and AGFI (Table 87).

Both models are recursive with a sample size of 69. In the generic and modified model there were 11 variables in the model: 5 observed variables (PS1-PS5), 6 unobserved variables (d1-d5, PS). The modified model has a covariance link between d1 and d4.

Table 87: Goodness of Fit Statistics for Generic and Modified Models for Perceived Susceptibility

Model Fit	Statistical Range	Generic Model (Figure 97)	Modified Model (Figure 94)
Sample Size	-	69	69
Sample Moments	-	15	15
Distinct Parameters	-	10	11
Degrees of Freedom (df)	-	2	4
Chi Squared χ^2	Approximates the df	51.641	1.608
Probability	≥ 0.05	*.000*	**.807**
Likelihood ratio CMIN/DF	1< CMIN/DF <3 Closer to 1 but not to exceed 3	*10.328*	*.402*
Normed Fit Index NFI	NFI ≥ 0.95	*.646*	**.989**
Comparative Fit Index CFI	CFI ≥ 0.95	*.656*	**1.0**
RMSEA-Root Mean Square Residual	RMSEA < 0.05 Should not exceed 0.1	*.370*	**.000**
Goodness of fit Index GFI	0.80 < GFI < 1	**.822**	**.991**
AGFI	0.80 < AGFI < 1	*.465*	**.965**

Values that fail the standard are in italics. Values that pass are in BOLD.

The frequency data shows that participants believe themselves to not be susceptible but believe their community has greater susceptibility (Table 88).

A review of the regression weights of the modified model reveals that the estimates (factor loadings) are negative for PS1 and PS4 with p-values not significant. The other estimates are high with their standard errors to be low and their critical ratio to be real, strong evidence of their strong statistical significance.

CFA-Perceived Susceptibility-Modified

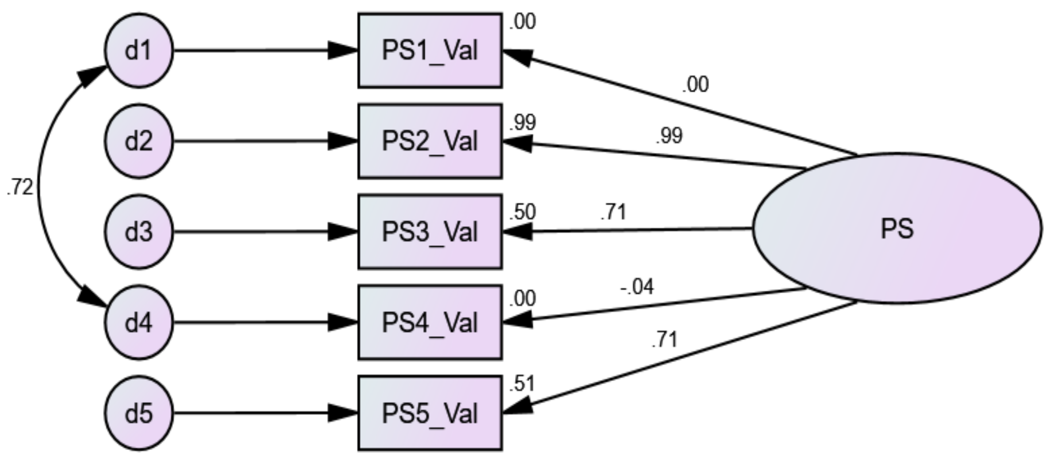


Figure 94: Modified Measurement Model for Perceived Susceptibility

In the measurement model for PS removal of items 1 and 4 in the model results in 0 df, thus calculations could not be done. Removal of one or the other results in a high probability value. Question 1 & 4 are centered around self while 1, 2 and 5 are around community.

Table 88: HBM Survey Responses for Perceived Susceptibility, November 12, 2019

Perceived Susceptibility					
	PS1	**PS2**	**PS3**	**PS4**	**PS5**
Extremely Unlikely	22	1	1	22	3
Unlikely	26	0	0	29	5
Slightly Unlikely	6	8	10	5	5
Neither	4	3	14	7	3
Slightly Likely	8	16	12	4	18
Likely	3	24	21	2	22
Extremely Likely	0	17	11	0	13
No Response	110	110	110	110	110

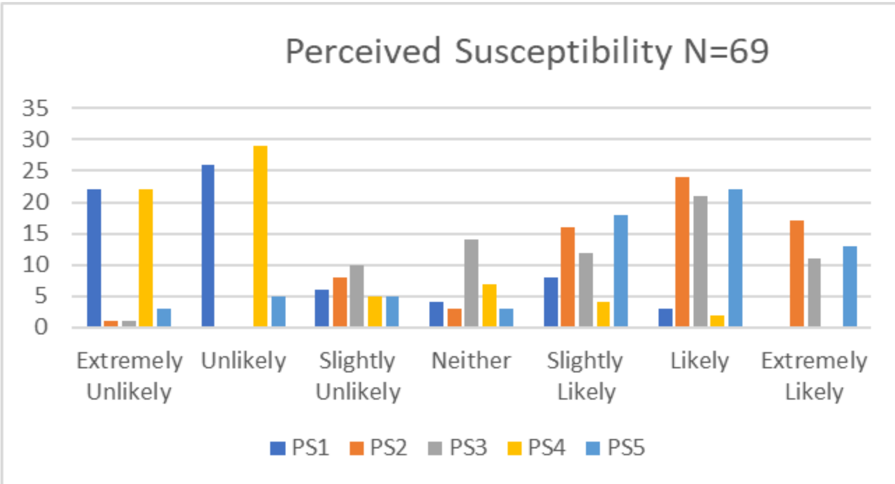


Figure 95: HBM Survey Responses for Perceived Susceptibility, November 12, 2019

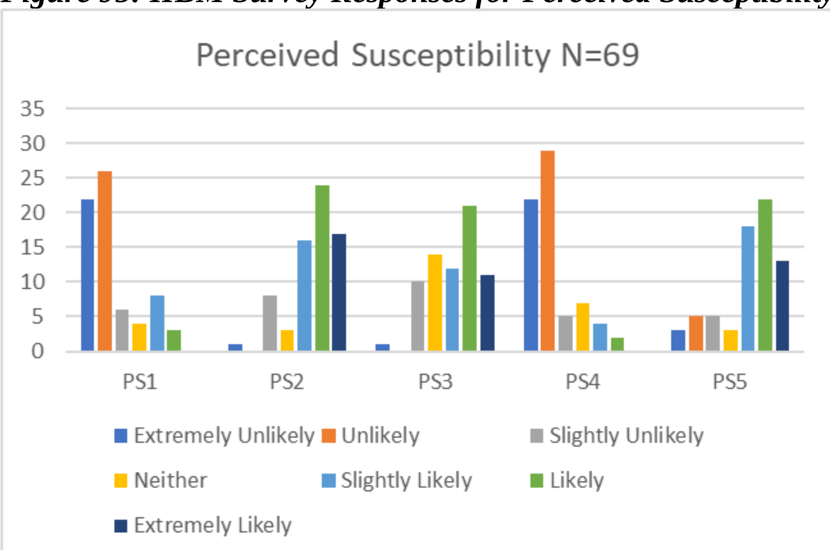


Figure 96: HBM Survey Responses by Question for Perceived Susceptibility, November 12, 2019

Table 89: HBM Perceived Susceptibility Descriptive Statistics, November 12, 2019

Perceived Susceptibility											
	N	Min	Max	Mean		Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
PS1_Val	69	1	6	2.41	0.18	1.498	2.245	1.052	0.289	-0.025	0.57
PS2_Val	69	1	7	5.51	0.163	1.357	1.842	-1.034	0.289	0.799	0.57
PS3_Val	69	1	7	5.07	0.169	1.407	1.98	-0.426	0.289	-0.492	0.57
PS4_Val	69	1	6	2.25	0.159	1.322	1.747	1.221	0.289	0.799	0.57
PS5_Val	69	1	7	5.12	0.201	1.667	2.78	-1.012	0.289	0.217	0.57
Valid N (listwise)	69										

Table 90: Reliability Statistic for PS

Reliability Statistics PS		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.65	0.651	5

Table 91: Inter-Item Correlation Matrix for PS

Inter-Item Correlation Matrix PS					
	PS1_Val	PS2_Val	PS3_Val	PS4_Val	PS5_Val
PS1_Val	1	-0.001	0.014	0.721	0.034
PS2_Val	-0.001	1	0.704	-0.046	0.708
PS3_Val	0.014	0.704	1	0.03	0.51
PS4_Val	0.721	-0.046	0.03	1	0.04
PS5_Val	0.034	0.708	0.51	0.04	1

Looking at the inter-item correlation matrix, I ran the Cronbach Alpha statistic (PS5, PS2, PS3) and it was boosted to .853. These indicators are directed to the community, while PS1 and PS4 are self-directed.

Table 92: Reliability Statistic for PS-3 items

Reliability Statistics	
Cronbach's Alpha	N of Items
.835	3

Table 93: Regression Weights for Generic Model for Perceived Susceptibility

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
PS1	-.001	-.001	.136	-.007	.994
PS2	.992	1.000			***
PS3	.710	.741	.126	5.886	***
PS4	-.044	-.043	.120	-.357	.721
PS5	.713	.883	.149	5.916	***

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 94: Regression Weights for Modified Model for Perceived Susceptibility

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
PS1	-.001	-.001	.135	-.006	.995
PS2	.995	1.000			
PS3	.708	.738	.126	5.866	***
PS4	-.044	-.043	.119	-.364	.716
PS5	.712	.879	.149	5.896	***
Covariance d4-d1	.722	1.407	.292	4.826	***

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 95: Correlations, Variances for the Generic, Modified and Revised Models of Perceived Susceptibility

Variables	Covariance Estimate	Correlation Estimate	Squared Multiple Correlation Generic	Squared Multiple Correlation Modified	Squared Multiple Correlation Revised	Standard Errors	Critical Ratio (≥±1.96)	p-value
PS1			.000	.000				
PS2			.985	.989				
PS3			.504	.501				
PS4			.002	.002				
PS5			.509	.507				
Covariance d4-d1	1.407	.722				.292	4.826	***

*** indicated significance smaller than .001
*Statistically significant at <.05

Table 96: Variances for Generic Model of Perceived Susceptibility

Variances	Estimate on Generic	Standard Errors	Critical Ratio (≥±1.96)	p-value
PS	1.788	.378	4.731	***
d1	2.212	.379	5.831	***
d2	.027	.214	.127	.899
d3	.968	.204	4.756	***
d4	1.719	.295	5.831	***
d5	1.346	.285	4.722	***

*** indicated significance smaller than .001
*Statistically significant at <.05

Table 97: Variances for Modified Model of Perceived Susceptibility

Variances	Estimate Modified	Standard Errors	Critical Ratio (≥±1.96)	p-value
PS	1.796	.379	4.742	***
d1	2.212	.379	5.831	***
d2	.019	.216	.089	.929
d3	.973	.204	4.766	***
d4	1.719	.295	5.831	***
d5	1.352	.286	4.733	***

*** indicated significance smaller than .001
*Statistically significant at <.05

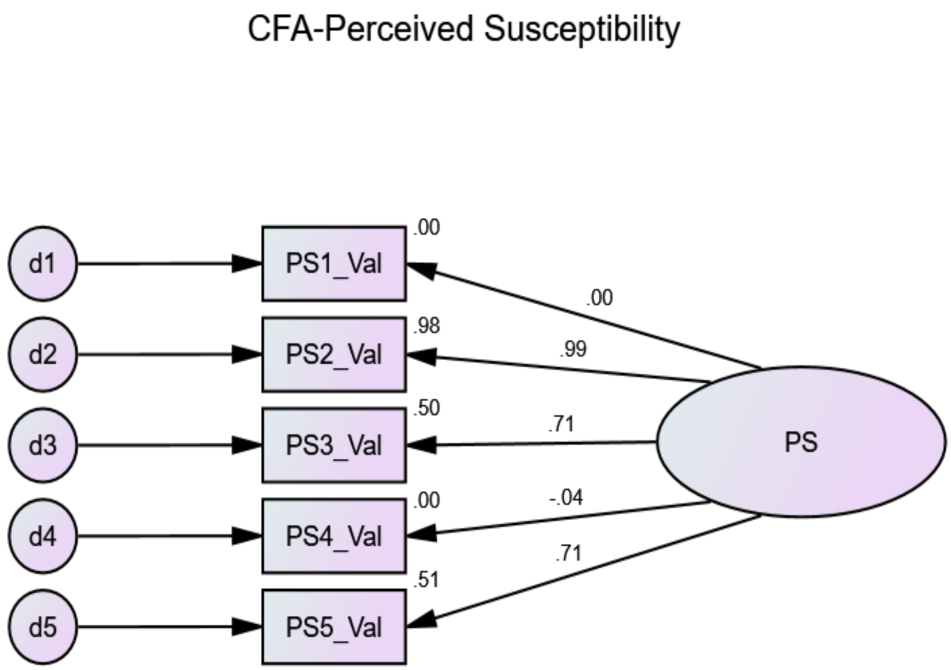


Figure 97: Generic Measurement Model for Perceived Susceptibility

Perceived Severity (PSV)

Evaluation of the measurement models reveal that the modified model has the best model fit statistics for PU (Table 99). The CFA Statistics for the modified model is summarized in Table 98. This data reveals that PSV3, PSV4 and PSV5 the estimates (factor loadings) are very high in the standardized loadings, their standard errors to be low and their critical ratio to be real, strong evidence of their strong statistical significance. The R^2 range from 0.567-0.898 indicating good correlation of the items to the construct. Thus, we retained 3 of the 5 observed indicators for Perceived Severity (remove PSV1 and PSV2) for construct validity and instrument evaluation.

Table 98: Five questions that provide input to PSV observed variables: Summary of Statistics for Best Model Fit

ITEM-Perceived Severity-Modified α=0.753, N=69	Label	Mode	CFA Statistics Standardized Regression Weights (>0.65)	Standard Errors	Critical Ratio (≥±1.96)	p-value	R^2	Retain/ Delete after CFA
Over the last 12 months, if you were infected with a febrile rash illness, how likely are you to have a serious infection?	PSV1	Unlikely	*0.266*	0.168	2.157	0.031	0.071	Delete
Over the last 12 months, if you were infected with a febrile rash illness, how likely do you think that you would experience long term problems from that infection?	PSV2	Unlikely	*0.289*	0.146	2.355	0.019	0.084	Delete
If your community were to experience a febrile rash illness, how likely would the severity of the illness be on your community?	PSV3	Slightly Likely	**0.753**	0.097	7.254	***	0.567	Retain
If your community experienced a febrile rash illness outbreak, how likely do you think that the community would experience long term problems from that outbreak?	PSV4	Slightly Likely	**0.81**	0.106	7.953	***	0.656	Retain
Over the last 12 months, if my community was infected with a febrile rash-like illness outbreak it would be severe?	PSV5	Slightly Likely	**0.948**			***	0.898	Retain

*** indicated significance smaller than .001, *Statistically significant at <.05, Scale: 1-7 (Extremely Unlikely, Unlikely, Slightly Unlikely, Neither, Slightly Likely, Likely, Extremely Likely)

PSV is an exogenous variable in the HBM model. Questions PSV3, 4 and 5 are community centered, while questions PSV1 and 2 are centered around self. It is represented by 5 observed indicators that utilize a 7-level measurement scale from Extremely Unlikely to Extremely Likely. The Cronbach alpha shows an acceptable reliability among the 5 indicators at an α= .753 (Table 102). Measurement models for PSV had 3 variations: generic (Figure 101), modified (Figure 98) and revised (Figure 102). The models are recursive with a sample size of 69.

Table 99: Goodness of Fit Statistics for Generic, Modified and Revised Models for Perceived Severity

Model Fit	Statistical Range	Generic Model (Figure 101)	Modified Model (Figure 98)	Revised Model 2 (Figure 102)
Sample Size	-	69	69	69
Sample Moments	-	15	15	15
Distinct Parameters	-	10	11	12
Degrees of Freedom (df)	-	5	4	3
Chi Squared χ^2	Approximates the df	20.623	4.642	4.570
Probability	≥ 0.05	*.001*	**.326**	**.206**
Likelihood ratio CMIN/DF	1< CMIN/DF <3 Closer to 1 but not to exceed 3	*4.125*	**1.160**	**1.523**
Normed Fit Index NFI	NFI ≥ 0.95	*.854*	**.967**	**.968**
Comparative Fit Index CFI	CFI ≥ 0.95	*.881*	**.918**	**.988**
RMSEA-Root Mean Square Residual	RMSEA < 0.05 Should not exceed 0.1	*.214*	**.049**	*.088*
Goodness of fit Index GFI	0.80 < GFI < 1	**.908**	**.967**	**.975**
AGFI	0.80 < AGFI < 1	*.725*	**.995**	**.873**

Values that fail the standard are in italics. Values that pass are in BOLD.

The frequency data shows that respondents did not feel that if they were to be infected by a rash illness that it would be serious, but that perceived severity increased in the community centered questions (Table 100).

The generic model is composed of 11 variables: 5 observed variables (PSV1-PSV5) and 6 unobserved variables (d6-d10, PSV). The modified model has a covariance link between d7-d6. The modified model is composed of 11 variables: 5 observed variables (PSV1-PSV5) and 6 unobserved variables (d6-d10, PSV). The revised model has two covariance links (d7-d6 and d8-d9). It is composed of 11 variables: 5 observed variables (PSV1-PSV5) and 6 unobserved variables (d6-d10, PSV).

We compared the three models based on the Chi-square value and probability and noted that the modified model had the best fit. The modified model also had the best RMSEA (.049).

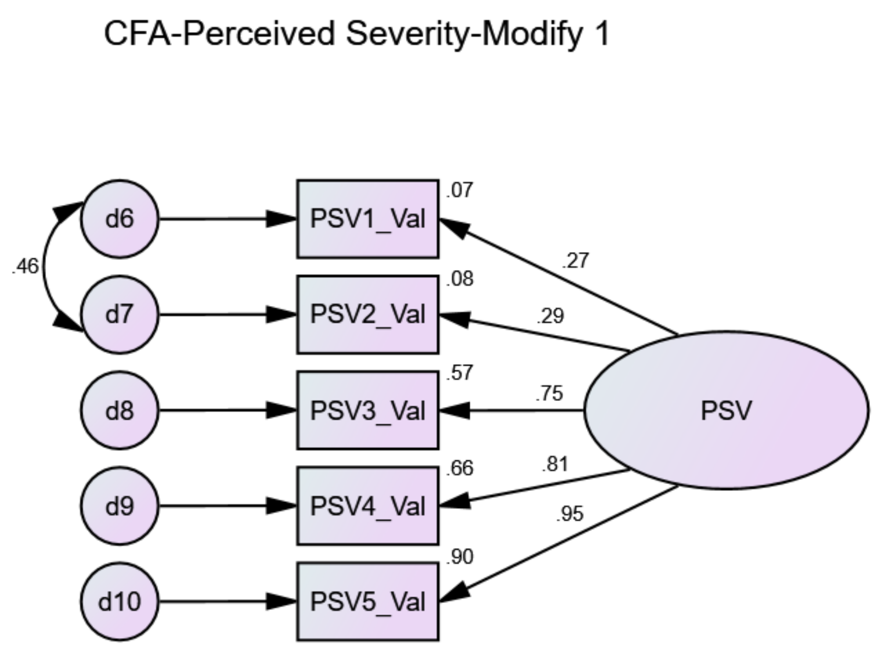


Figure 98: Modified Measurement Model for Perceived Severity

Table 100: HBM Survey Responses for Perceived Severity, November 12, 2019

Perceived Severity					
	PSV1	**PSV2**	**PSV3**	**PSV4**	**PSV5**
Extremely Unlikely	7	10	1	3	1
Unlikely	22	29	3	14	13
Slightly Unlikely	10	10	13	14	14
Neither	9	7	13	16	14
Slightly Likely	11	8	27	18	19
Likely	6	4	10	2	8
Extremely Likely	4	1	1	1	0
No Response	110	110	111	111	110

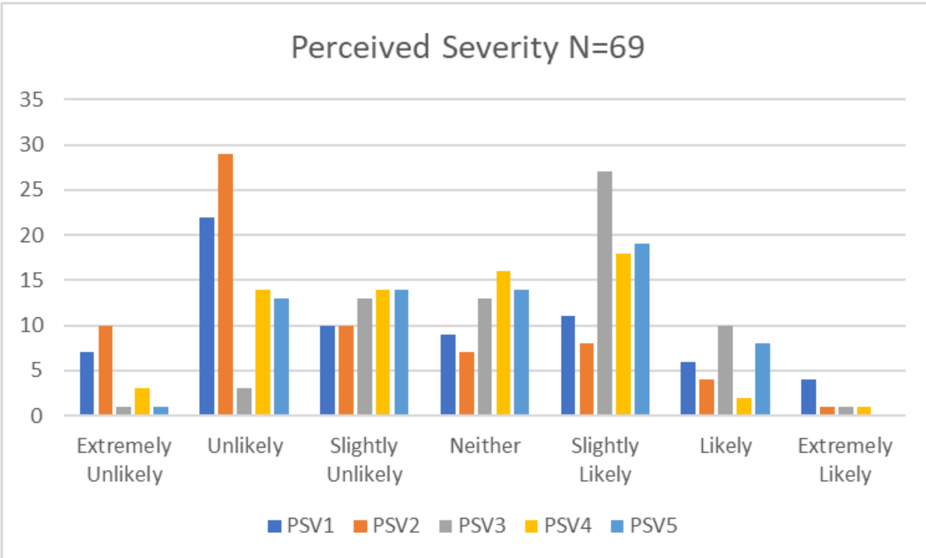


Figure 99: HBM Survey Responses for Perceived Severity, November 12, 2019

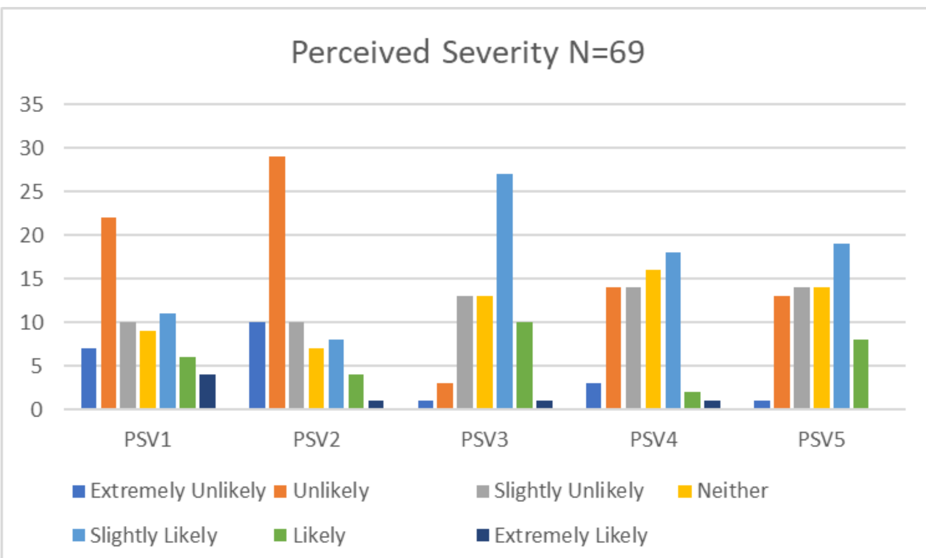


Figure 100: HBM Survey Responses by Question for Perceived Severity, November 12, 2019

Table 101: HBM Perceived Severity Descriptive Statistics, November 12, 2019

	Perceived Severity											
	N	Minimum	Maximum	Mean		Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
PSV1_Val	69	1	7	3.42	0.211	1.752	3.071	0.475	0.289	-0.885	0.57
PSV2_Val	69	1	7	2.86	0.184	1.527	2.332	0.864	0.289	-0.177	0.57
PSV3_Val	69	1	7	4.41	0.145	1.204	1.451	-0.474	0.289	-0.088	0.57
PSV4_Val	69	1	7	3.62	0.161	1.341	1.797	-0.026	0.289	-0.649	0.57
PSV5_Val	69	1	6	3.88	0.163	1.356	1.839	-0.112	0.289	-1.089	0.57
Valid N (listwise)	69										

Table 102: Reliability Statistic for PSV

Reliability Statistics PSV		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.753	0.771	5

Table 103: Inter-Item Correlation Matrix for PSV

Inter-Item Correlation Matrix					
	PSV1_Val	PSV2_Val	PSV3_Val	PSV5_Val	PSV4_Val
PSV1_Val	1	0.501	0.294	0.25	0.156
PSV2_Val	0.501	1	0.192	0.269	0.275
PSV3_Val	0.294	0.192	1	0.713	0.606
PSV5_Val	0.25	0.269	0.713	1	0.768
PSV4_Val	0.156	0.275	0.606	0.768	1

Table 104: Regression Weights for Generic Model for Perceived Severity

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
PSV1	.280	.384	.169	2.269	.023
PSV2	.302	.361	.147	2.461	.014
PSV3	.757	.714	.097	7.340	***
PSV4	.812	.853	.106	8.045	***
PSV5	.942	1.000			***

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 105: Regression Weights for Modified Model for Perceived Severity

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
PSV1	.266	.363	.168	2.157	.031
PSV2	.289	.344	.146	2.355	.019
PSV3	.753	.706	.097	7.254	***
PSV4	.810	.845	.106	7.953	***
PSV5	.948	1.000			***
Covariance d7-d6		1.119	.328	3.415	***

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 106: Regression Weights for Revised Model for Perceived Severity

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
PSV1	.269	.377	.180	2.097	.036
PSV2	.294	.359	.157	2.287	.022
PSV3	.776	.749	.190	3.933	***
PSV4	.834	.895	.221	4.054	***
PSV5	.921	1.000			***
Covariance d7-d6	.459	1.114	.327	3.401	***
Covariance d9-d8	-.117	-.065	.244	-.266	.790

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 107: Correlations, Variances for the Generic, Modified and Revised Models of Perceived Severity

Variables	Covariance Estimate	Correlation Estimate	Squared Multiple Correlation Generic	Squared Multiple Correlation Modified	Squared Multiple Correlation Revised	Standard Errors	Critical Ratio (≥±1.96)	p-value
PSV1			.078	.071	.072			
PSV2			.091	.084	.086			
PSV3			.573	.567	.603			
PSV4			.660	.656	.695			
PSV5			.887	.898	.848			
Covariance d7-d6	1.119	.460				.328	3.415	***
Covariance d7-d6 revised	1.114	.459				.327	3.401	***
Covariance d9-d8 revised	-.065	-.117				.244	-.266	.790

*** indicated significance smaller than .001
*Statistically significant at <.05

Table 108: Variances for Generic Model of Perceived Severity

Variances	Estimate Generic	Standard Errors	Critical Ratio (≥±1.96)	p-value
PSV	1.607	.336	4.779	***
d10	.205	.138	1.492	.136
d9	.602	.142	4.225	***
d8	.611	.126	4.851	***
d7	2.088	.361	5.778	***
d6	2.789	.482	5.786	***

*** indicated significance smaller than .001
*Statistically significant at <.05

Table 109: Variances for Modified Model of Perceived Severity

Variances	Estimate Modified	Standard Errors	Critical Ratio (≥±1.96)	p-value
PSV	1.627	.339	4.804	***
d10	.185	.142	1.305	***
d9	.609	.144	4.219	***
d8	.619	.127	4.861	***
d7	2.105	.364	5.785	***
d6	2.812	.485	5.793	***

*** indicated significance smaller than .001
*Statistically significant at <.05

Table 110: Variances for Revised Model of Perceived Severity

Variances	Estimate Revised	Standard Errors	Critical Ratio (≥±1.96)	p-value
PSV	1.536	.466	3.300	***
d10	.276	.353	.783	.434
d9	.540	.300	1.799	.072
d8	.568	.226	2.510	.012
d7	2.100	.364	5.775	***
d6	2.807	.485	5.784	***

*** indicated significance smaller than .001
*Statistically significant at <.05

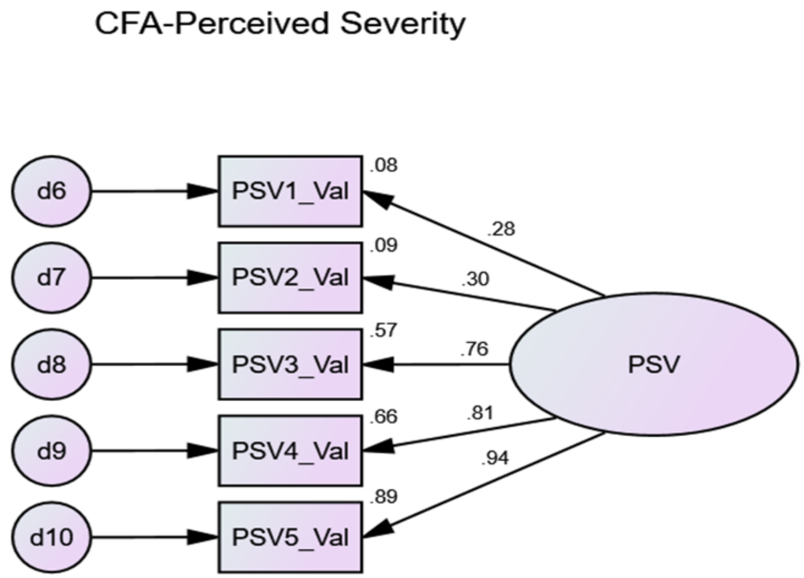


Figure 101: Generic Measurement Model for Perceived Severity

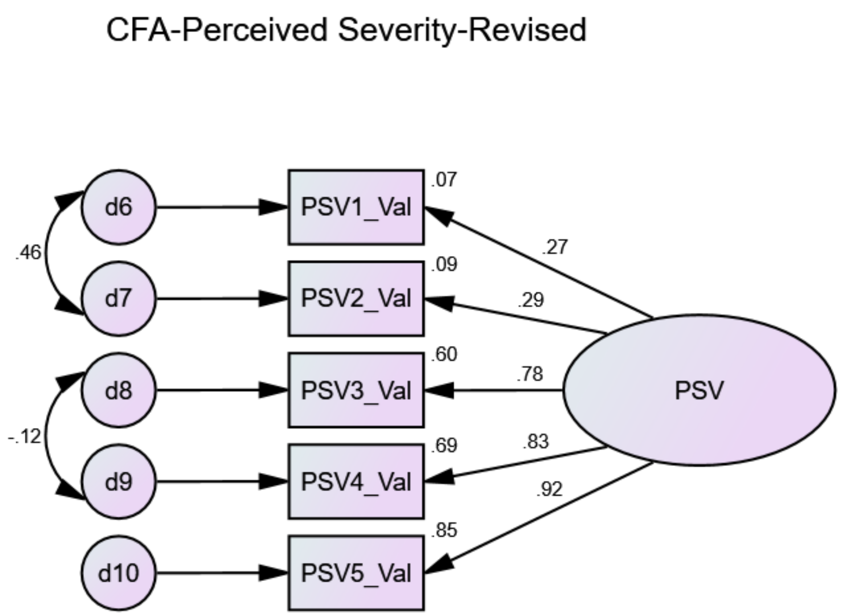


Figure 102: Revised Measurement Model for Perceived Severity

Perceived Threat (PT)

Evaluation of the measurement models reveal that the revised model has the best model fit statistics for PU (Table 112). The CFA Statistics for the revised model is summarized in Table 111. This data reveals considerable variability in the estimates (factor loadings) in the standardized loadings. The standard errors to be low and their critical ratio to be real which indicate evidence of their statistical significance. The R^2 range also have a board range indicating correlation of the items to the construct. We retained four of the 8 observed indicators for Perceived Threat (remove PT1, PT2, PT7, PT8) for construct validity and instrument validation. However, the lower loadings on these on PT3, PT4 and PT6 suggests these questions should be revised as the loadings are all below the expected 0.65 to show good correlation (Table 111).

Table 111: Eight questions that provide input to PT observed variables: Summary of Statistics for Best Model Fit

ITEM-Perceived Threat α=0.545, N=69	Label	Mode	CFA Statistics: Standardized Regression Weights (>0.65)	Standard Errors	Critical Ratio (≥±1.96)	p-value	R^2	Retain/ Delete after CFA
Over the last 12 months, I would be afraid for myself to have the laboratory testing done for febrile rash illness.	PT1	Extremely Disagree	*0.328*	0.212	2.309	0.021	0.108	Delete
Over the last 12 months, I would be afraid to perform the laboratory testing for persons in my community for febrile rash illness.	PT2	Extremely Disagree	*0.134*	0.32	1.121	*0.262*	0.018	Delete
I do not know the accurate laboratory tests required for febrile rash illness.	PT3	Extremely Disagree	*0.513*				0.263	Retain
The laboratory tests required for febrile rash illnesses are not reliable.	PT4	Disagree	*0.574*	0.205	3.483	***	0.329	Retain
Preventing febrile rash illness is next to impossible for myself?	PT5	Extremely Disagree	0.919	0.251	3.952	***	0.844	Retain
Preventing febrile rash illness is next to impossible for the community?	PT6	Disagree	*0.547*	0.287	3.379	***	0.299	Retain
Over the last12 months, I consider that there was a threat to myself to be infected with a febrile rash-like illness?	PT7	Disagree	*0.436*	0.266	2.893	0.004	0.19	Delete
Over the last 12 months, I consider that there was a threat to my community to be infected with a febrile rash-like illness outbreak.	PT8	Slightly Agree/Agree	_	_	_	_	_	Delete

*** indicated significance smaller than .001, *Statistically significant at <.05, Scale: 1-7 (Extremely Disagree, Disagree, Slightly Disagree, Neither, Slightly Agree, Agree, Extremely Agree)

Perceived Threats (PT) is an exogenous variable in the HBM model and the hypothesized model. It is represented by 8 observed indicators that utilize a 7-level measurement scale from Extremely Disagree to Extremely Agree. The Cronbach alpha shows poor reliability among the

8 indicators at an α=0.545 (Table 115). A review of the inter-item correlation matrix was done, and the Cronbach alpha was calculated to only include questions PT1,3,4,5,7 which increased the alpha to questionable reliability at α= .638 (Table 116). Cronbach alpha with questions PT3, 4, 5,6 increased α=.679.

Measurement models for PT has 5 variations: generic (Figure 106), generic without PT8 (Figure 107), modified (Figure 108), revised (Figure 103) and revised 2 (Figure 109). The models were recursive with a sample size of 69.

Table 112: Goodness of Fit Statistics for Generic, Modified and Revised Models for Perceived Threat

Model Fit	Statistical Range	Generic Model (Figure 106)	Generic 2 Model (Figure 107)	Modified Model 2 (Figure 108)	Revised Model (Figure 103)	Revised Model 2 (Figure 109)
Sample Size	-	69	69	69	69	69
Sample Moments	-	36	28	28	28	36
Distinct Parameters	-	16	14	15	16	17
Degrees of Freedom (df)	-	20	14	13	12	19
Chi Squared χ^2	Approximates the df	37.537	30.975	19.572	12.227	25.994
Probability	≥ 0.05	*.011*	*.006*	**.106**	**.428**	**.130**
Likelihood ratio CMIN/DF	1< CMIN/DF <3 Closer to 1 but not to exceed 3	**1.869**	**2.212**	**1.506**	**1.019**	**1.368**
Normed Fit Index NFI	NFI ≥ 0.95	*.684*	*.723*	*.825*	*.891*	*.781*
Comparative Fit Index CFI	CFI ≥ 0.95	*.808*	*.813*	*.928*	**.998**	*.923*
RMSEA-Root Mean Square Residual	RMSEA < 0.05 Should not exceed 0.1	*.113*	*.134*	*.086*	**.017**	*.074*
Goodness of fit Index GFI	0.80 < GFI < 1	**.884**	**.894**	**.926**	**.952**	**.915**
AGFI	0.80 < AGFI < 1	*.791*	*.788*	**.840**	**.888**	**.838**

Values that fail the standard are in italics. Values that pass are in BOLD.

In the frequency data, PT for self and community are skewed toward disagreement with more perceived threat toward the community (PT2, PT6, PT8) than self (PT1, PT3, PT4, PT5 and PT7) (Table 113).

The generic model is composed of 17 variables. There are 8 observed variables (PT1-PT8) and 9 unobserved variables (d11-d18, PT). The generic without PT8 has 15 variables: 7 observed variables (PT1-PT7) and 8 unobserved variables (d11-d17, PT). The modified model is composed of 15 variables: 7 observed variables (PT1-PT7) and 8 unobserved variables. There is a covariance link between d12-d13. The revised model is composed of 15 variables: 7 observed variables (PT1-PT7) and 8 unobserved variables. There are two covariance links one between d12-d13 and one between d11-d12. The revised 2 model is composed of 17 variables. There are 8 observed variables (PT1-PT8) and 9 unobserved variables (d11-d18, PT). There is a covariance link between d12-d13.

We compared the five models based on the Chi-square value and noted that the revised model was the lowest and the RMSEA is 0.017 indicative of a good fit (Table 112).

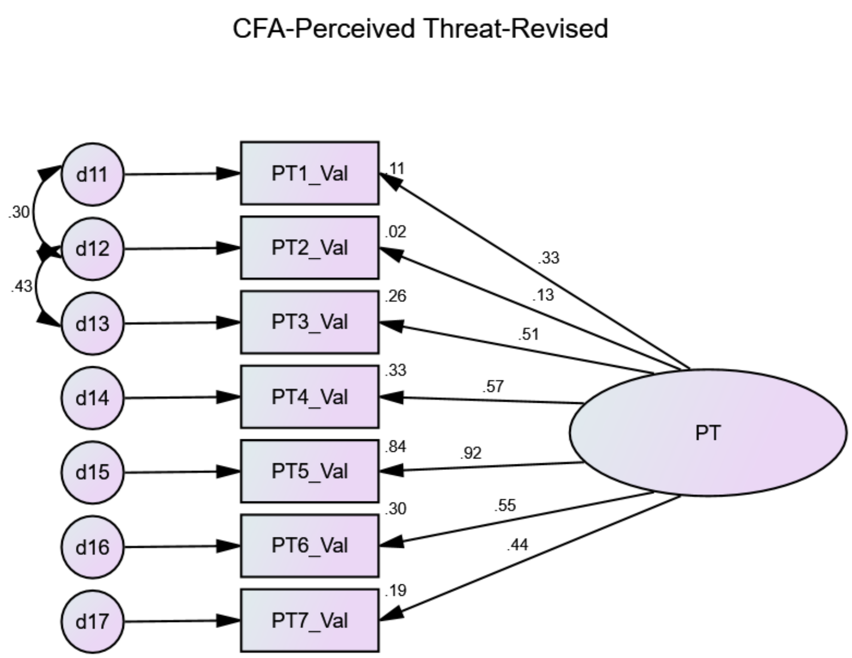


Figure 103: Revised Measurement Model for Perceived Threat

Review of the regression weights and PT2 and PT8 are consistently not significant (Table 117-Table 121).

Table 113:HBM Survey Responses for Perceived Threat, November 12, 2019

Perceived Threats								
	PT1	PT2	PT3	PT4	PT5	PT6	PT7	PT8
Extremely Disagree	39	26	26	24	35	24	23	1
Disagree	18	17	20	30	25	25	24	11
Slightly Disagree	5	5	11	6	3	9	9	6
Neither disagree or agree	2	5	3	6	3	2	4	4
Slightly Agree	0	5	3	0	0	4	5	17
Agree	2	3	2	0	0	2	1	17
Extremely Agree	0	5	1	0	0	0	0	10
No Response	113	113	113	113	113	113	113	113

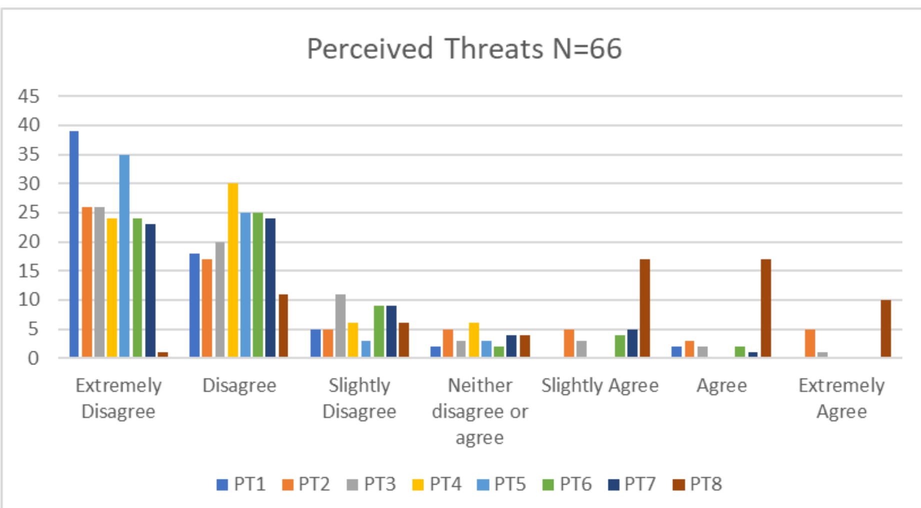


Figure 104: HBM Survey Responses for Perceived Threats, November 12, 2019

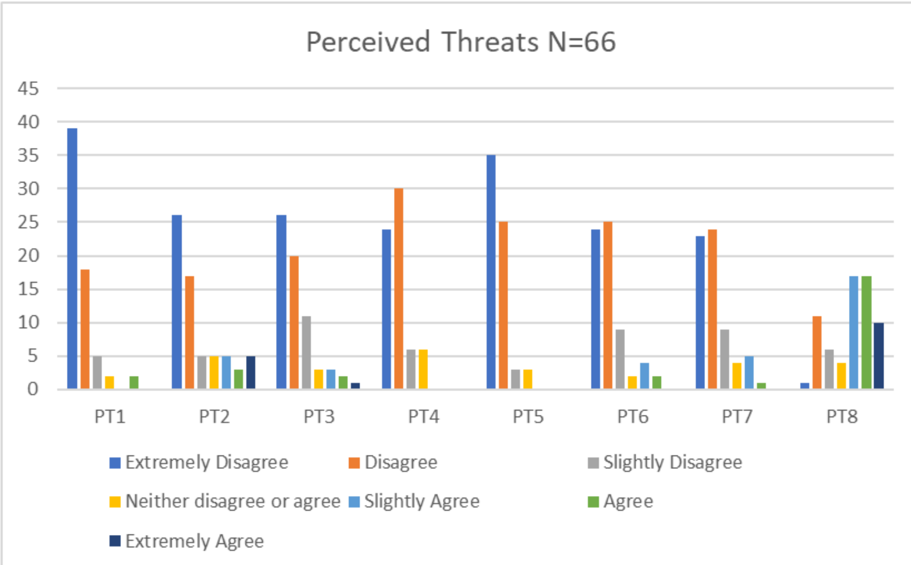


Figure 105: HBM Survey Responses by Question for Perceived Threats, November 12, 2019

Table 114: HBM Perceived Threat Descriptive Statistics, November 12, 2019

Perceived Threat											
	N	Minimum	Maximum	Mean		Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
PT1_Val	69	1	6	1.68	0.128	1.064	1.132	2.337	0.289	6.605	0.57
PT2_Val	69	1	7	2.64	0.228	1.894	3.587	1.091	0.289	0.054	0.57
PT3_Val	69	1	7	2.19	0.167	1.386	1.92	1.53	0.289	2.243	0.57
PT4_Val	69	1	4	1.91	0.107	0.887	0.786	0.955	0.289	0.47	0.57
PT5_Val	69	1	4	1.62	0.093	0.769	0.591	1.371	0.289	2.027	0.57
PT6_Val	69	1	6	2.13	0.152	1.259	1.586	1.476	0.289	1.9	0.57
PT7_Val	69	1	6	2.19	0.151	1.252	1.567	1.207	0.289	0.896	0.57
PT8_Val	69	1	7	4.77	0.205	1.699	2.887	-0.551	0.289	-0.834	0.57
Valid N (listwise)	69										

Table 115: Reliability Statistic for PT

Reliability Statistics PT		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.545	0.647	8

Table 116: Inter-Item Correlation Matrix for PT

Inter-Item Correlation Matrix								
	PT1_Val	PT2_Val	PT3_Val	PT4_Val	PT5_Val	PT6_Val	PT7_Val	PT8_Val
PT1_Val	1	0.299	0.121	0.344	0.282	0.207	0.123	0.032
PT2_Val	0.299	1	0.419	0.165	0.137	-0.005	-0.076	-0.159
PT3_Val	0.121	0.419	1	0.337	0.482	0.18	0.225	-0.156
PT4_Val	0.344	0.165	0.337	1	0.512	0.405	0.134	-0.053
PT5_Val	0.282	0.137	0.482	0.512	1	0.507	0.426	-0.045
PT6_Val	0.207	-0.005	0.18	0.405	0.507	1	0.133	0.145
PT7_Val	0.123	-0.076	0.225	0.134	0.426	0.133	1	0.097
PT8_Val	0.032	-0.159	-0.156	-0.053	-0.045	0.145	0.097	1

Table 117: Regression Weights for Generic Model for Perceived Threat

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
PT1	.341	.495	.207	2.392	.017
PT2	.196	.506	.348	1.454	.146
PT3	.529	1.000			
PT4	.586	.709	.198	3.576	***
PT5	.906	.951	.235	4.047	***
PT6	.544	.935	.274	3.408	***
PT7	.423	.722	.254	2.842	.004
PT8	-.040	-.092	.303	-.303	.762

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 118: Regression Weights for Generic 2 Model for Perceived Threat

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
PT1	.342	.497	.208	2.394	.017
PT2	.195	.505	.349	1.448	.148
PT3	.528	1.000			
PT4	.586	.710	.199	3.570	***
PT5	.906	.952	.236	4.038	***
PT6	.545	.938	.275	3.408	***
PT7	.423	.724	.255	2.841	.004

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 119: Regression Weights for Modified Model for Perceived Threat

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
PT1	.315	.476	.211	2.258	.024
PT2	.148	.399	.316	1.262	.207
PT3	.508	1.000			
PT4	.561	.706	.204	3.460	***
PT5	.938	1.024	.261	3.917	***
PT6	.539	.963	.286	3.373	***
PT7	.434	.771	.265	2.906	.004
Covariance d13-d12	.403	.888	.295	3.008	.003

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 120: Regression Weights for Revised Model for Perceived Threat

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
PT1	.328	.491	.212	2.309	.021
PT2	.134	.359	.320	1.121	.262
PT3	.513	1.000			
PT4	.574	.716	.205	3.483	***
PT5	.919	.993	.251	3.952	***
PT6	.547	.968	.287	3.379	***
PT7	.436	.768	.266	2.893	.004
Covariance d12-d13	.425	.942	.288	3.275	.001
Covariance d12-d11	.292	.553	.218	2.537	.011

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 121: Regression Weights for Revised 2 Model for Perceived Threat

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
PT1	.314	.475	.211	2.254	.024
PT2	.149	.400	.316	1.267	.205
PT3	.508	1.000			
PT4	.559	.705	.204	3.461	***
PT5	.940	1.027	.262	3.920	***
PT6	.537	.960	.285	3.373	***
PT7	.433	.770	.265	2.908	.004
PT8	-.037	-.088	.309	-.286	.775
Covariance d12-d13	.403	.887	.295	3.009	.003

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 122: Correlations, Variances for the Generic, Modified and Revised Models of Perceived Threat

Variables	Covariance Estimate	Correlation Estimate	Squared Multiple Correlation Generic	Squared Multiple Correlation Modified	Squared Multiple Correlation Revised	Squared Multiple Correlation Revised 2	Standard Errors	Critical Ratio (≥±1.96)	p-value
PT1			.116	.117	.108	.099			
PT2			.038	.038	.018	.022			
PT3			.280	.279	.263	.258			
PT4			.343	.343	.329	.313			
PT5			.821	.820	.844	.883			
PT6			.296	.297	.299	.288			
PT7			.179	.179	.190	.188			
PT8			.002	-	-	.001			
Covariance d12-d13 (revised 2)	.887	.403					.295	3.009	.003
Covariance d12-d13 (revised)	.942	.425					.288	3.275	.001
Covariance d12-d11 (revised)	.553	.292					.218	2.537	.011

*** indicated significance smaller than .001
*Statistically significant at <.05

Table 123: Variances for Generic Model of Perceived Threat

Variances	Estimate Generic	Standard Errors	Critical Ratio (≥±1.96)	p-value
PT	.529	.245	2.157	.031
d18	2.840	.487	5.830	***
d17	1.268	.226	5.602	***
d16	1.101	.206	5.336	***
d15	.104	.070	1.477	.140
d14	.509	.098	5.182	***
d13	1.363	.253	5.381	***
d12	3.400	.587	5.793	***
d11	.986	.173	5.699	***

*** indicated significance smaller than .001
*Statistically significant at <.05

Table 124: Variances for Generic 2 Model of Perceived Threat

Variances	Estimate Generic 2	Standard Errors	Critical Ratio (≥±1.96)	p-value
PT	.528	.245	2.153	.031
d18	-	-	-	-
d17	1.268	.226	5.600	***
d16	1.098	.206	5.329	***
d15	.105	.070	1.488	.137
d14	.509	.098	5.179	***
d13	1.365	.254	5.382	***
d12	3.401	.587	5.793	***
d11	.985	.173	5.698	***

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 125: Variances for Modified Model of Perceived Threat

Variances	Estimate Modified	Standard Errors	Critical Ratio (≥±1.96)	p-value
PT	.489	.234	2.085	.037
d17	1.254	.223	5.626	***
d16	1.109	.205	5.401	***
d15	.070	.075	.938	.348
d14	.531	.100	5.327	***
d13	1.404	.256	5.484	***
d12	3.458	.595	5.815	***
d11	1.005	.175	5.747	***

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 126: Variances for Revised Model of Perceived Threat

Variances	Estimate Revised 2	Standard Errors	Critical Ratio (≥±1.96)	p-value
PT	.488	.234	2.086	.037
d18	2.841	.487	5.830	***
d17	1.254	.223	5.630	***
d16	1.112	.206	5.410	***
d15	.068	.075	.905	.366
d14	.533	.100	5.337	***
d13	1.404	.256	5.488	***
d12	3.457	.594	5.815	***
d11	1.006	.175	5.749	***

*** indicated significance smaller than .001
*Statistically significant at <.05

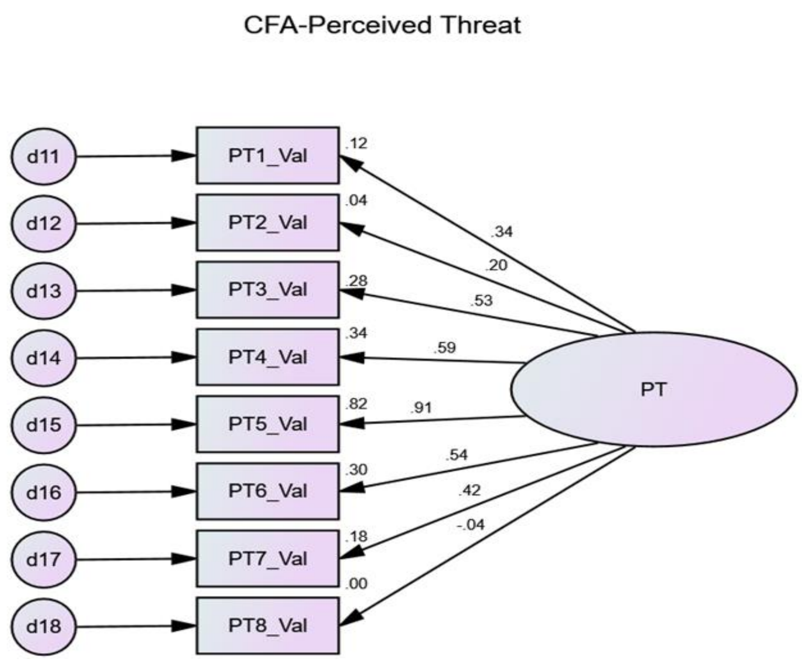


Figure 106: Generic Measurement Model for Perceived Threat

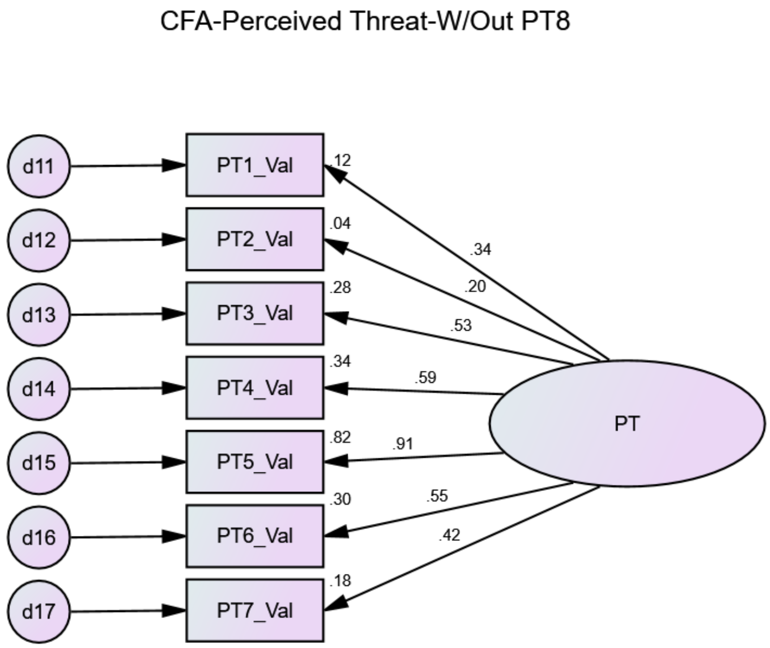


Figure 107: Generic 2 Measurement Model for Perceived Threat

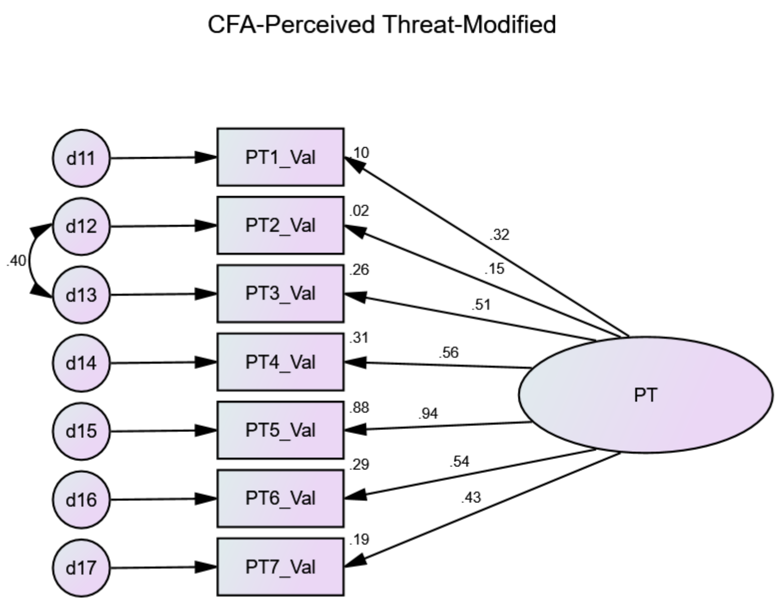


Figure 108: Modified Measurement Model for Perceived Threat

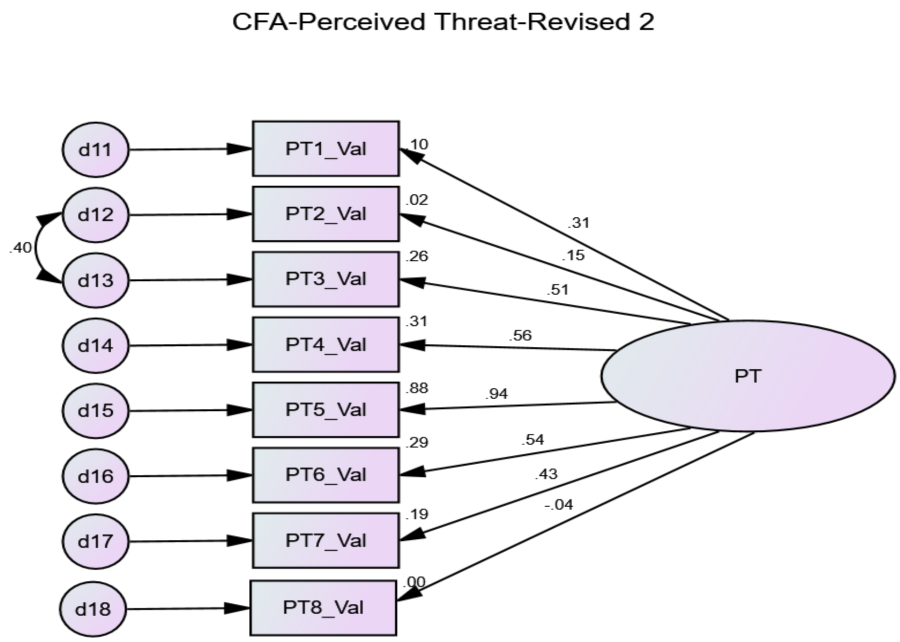


Figure 109: Revised 2 Measurement Model for Perceived Threat

Perceived Benefits (PB)

Evaluation of the measurement models reveal that the revised model has the best model fit statistics for PB (Table 128). The CFA Statistics for the revised model is summarized in Table 127. This data reveals that the estimates (factor loadings) are very high in the standardized loadings, their standard errors to be low and their critical ratio to be real, strong evidence of their strong statistical significance for PB5 and PB6. The R^2 for these items indicating good correlation of the items to the construct. To maintain enough indicators per construct, we retained these 2 items and PB4 for construct validity and instrument evaluation.

Table 127: Six questions that provide input to PB observed variables: Summary of Statistics for Best Model Fit

ITEM-Perceived Benefits α=0.63, N=69	Label	Mode	CFA Statistics: Standardized Regression Weights (>0.65)	Standard Errors	Critical Ratio (≥±1.96)	p-value	R^2	Retain/ Delete after CFA
I think it is important to know how to stay healthy.	PB1	Extremely Agree	0.046	0.054	0.346	0.73	0.002	Delete
I think it is important that my community knows how to stay healthy	PB2	Extremely Agree	0.067	0.069	0.501	0.617	0.004	Delete
Understanding the need for an accurate laboratory test for a febrile rash illness will decrease the chances of exposure for my community?	PB3	Agree	0.267	0.25	1.932	0.053	0.071	Delete
Understanding the need for an accurate laboratory test for a febrile rash illness will decrease the chances of exposure for myself?	PB4	Neither	0.303	0.28	2.177	0.029	0.092	Retain
Over the last 12 months, I consider that training myself on febrile rash-like illness will be a benefit to me.	PB5	Agree	0.843				0.711	Retain
Over the last 12 months, I consider that training myself on febrile rash-like illness would be a benefit to my community.	PB6	Agree	0.839	0.323	2.912	0.004	0.703	Retain

*** indicated significance smaller than .001, *Statistically significant at <.05, Scale: 1-7 (Extremely Disagree, Disagree, Slightly Disagree, Neither, Slightly Agree, Agree, Extremely Agree)

PB is an exogenous variable in the HBM model and the a priori hypothesized model. It is represented by 6 observed indicators that utilize a 7-level measurement scale from Extremely Disagree to Extremely Agree. PB2, 3 and 6 are indicators that relate to the perceived benefits toward community while PB1, 4, 5 are toward self.

The Cronbach alpha shows questionable reliability among the 6 indicators at an α=0.630 (Table 131). A review of the inter-item correlation to retained indicators PB3, 4, 5, 6 which increased alpha to .698 (Table 132). Measurement models for PB had 4 variations: generic (Figure 113), modified (Figure 114), revised (Figure 110) and revised 2 (Figure 115). The models are recursive with a sample size of 69.

The generic model has 13 variables: 6 observed variables (PB1-PB6) and 7 unobserved variables. The modified model has 13 variables: 6 observed variables (PB1-PB6) and 7 unobserved variables with a covariance link between d19-d20. The revised model 13 variables: 6 observed variables (PB1-PB6) and 7 unobserved variables with a covariance link between d19-d20 and d22-d21. The revised 2 model has 9 variables: 4 observed variables (PB3-PB6) and 5 unobserved variables (d21-d24, PB), there is a covariance link between d21-d22.

Table 128: Goodness of Fit Statistics for Generic, Modified and Revised Models for Perceived Benefits

Model Fit	Statistical Range	Generic Model (Figure 113)	Modified Model (Figure 114)	Revised Model (Figure 110)	Revised 2 Model (Figure 115)
Sample Size	-	69	69	69	69
Sample Moments	-	21	21	21	10
Distinct Parameters	-	12	13	14	9
Degrees of Freedom (df)	-	9	8	7	1
Chi Squared χ^2	Approximates the df	98.99	40.482	5.997	.229
Probability	≥ 0.05	*.000*	*.000*	**.540**	**.632**
Likelihood ratio CMIN/DF	1< CMIN/DF <3 Closer to 1 but not to exceed 3	*10.999*	*5.060*	*.857*	*.229*
Normed Fit Index NFI	NFI ≥ 0.95	*.372*	*.743*	**.962**	**.998**
Comparative Fit Index CFI	CFI ≥ 0.95	*.369*	*.772*	1.0	1.00
RMSEA-Root Mean Square Residual	RMSEA < 0.05 Should not exceed 0.1	*.383*	*.244*	.000	.000
Goodness of fit Index GFI	0.80 < GFI < 1	*.747*	**.869**	**.973**	**.998**
AGFI	0.80 < AGFI < 1	*.409*	*.656*	**.920**	**.983**

Values that fail the standard are in italics. Values that pass are in BOLD.

The frequency data shows that respondents had agreement for self and community as it relates to perceived benefits. Indicators PB3 and PB4 had the highest disagreement among respondents (Table 129).

The measurement model for PB needed improvement in the fit statistics so a link between d20-d19 on the modified model which improved the statistics. Another link was made between d22-d21 on the revised model with improvement to the model fit. Three of the indicators on the revised model were also not significant. Indicators 1 and 2 were removed from the model which did not result in any improvement to the fit statistics for the Revised 2 Model.

A review of the regression weights of all 4 models reveals that the estimates (factor loadings) are higher in the standardized loadings for questions PB5 and PB6 and not significant for 2 of the indicators (PB1, PB2) (Table 133-Table 136). The revised 2 model regression weights had standardized loadings that were significant although they were not high, all the indicators standard errors are low and their critical ratio to be real, which is evidence of their strong statistical significance (Table 136).

We compared the four models based on the Chi-square value and noted that the revised model was the lowest. Based on a significant probability and review of the other fit statistics the revised model has the best fit (Table 128).

The modified model shows that of the six observed indicators for Perceived Benefits, 3 could be retained (remove PB1, PB2, PB3) but with a revision on PB4 considered in construct validity and instrument evaluation. There may also be some correlation between PB1 and PB2 and/or PB3 and PB4.

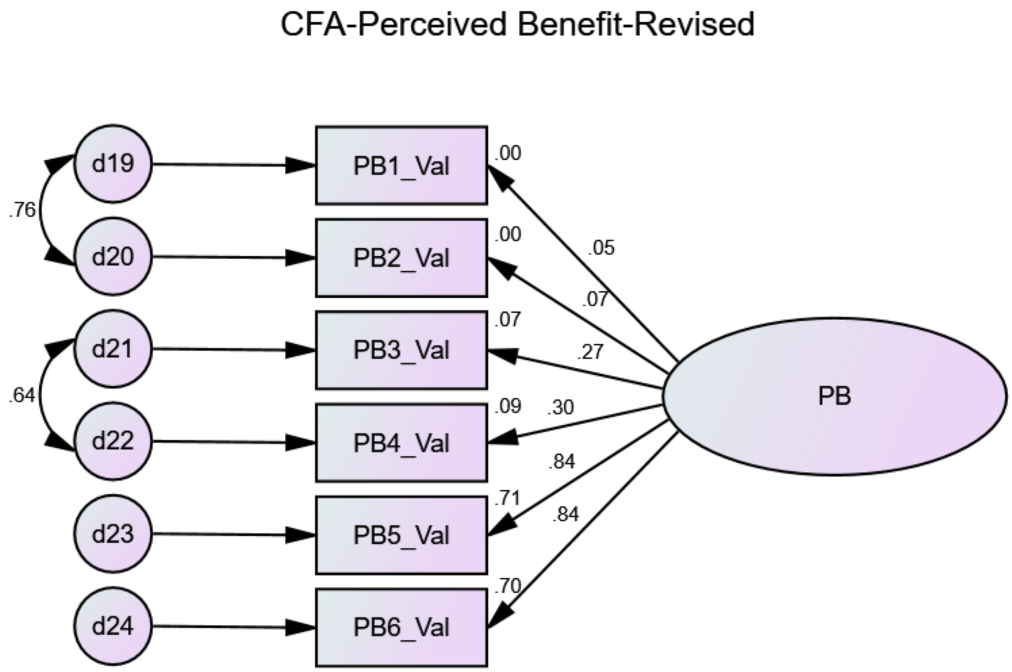


Figure 110: Revised Measurement Model for Perceived Benefit

Table 129: HBM Survey Responses for Perceived Benefits, November 12, 2019

Perceived Benefits						
	PB1	**PB2**	**PB3**	**PB4**	**PB5**	**PB6**
Extremely Disagree	0	0	1	6	1	1
Disagree	0	0	11	14	0	0
Slightly Disagree	0	0	3	1	1	0
Neither disagree or agree	0	1	9	18	7	6
Slightly Agree	0	0	9	5	8	7
Agree	12	10	22	13	31	31
Extremely Agree	54	55	11	9	18	21
No Reponses	113	113	113	113	113	113

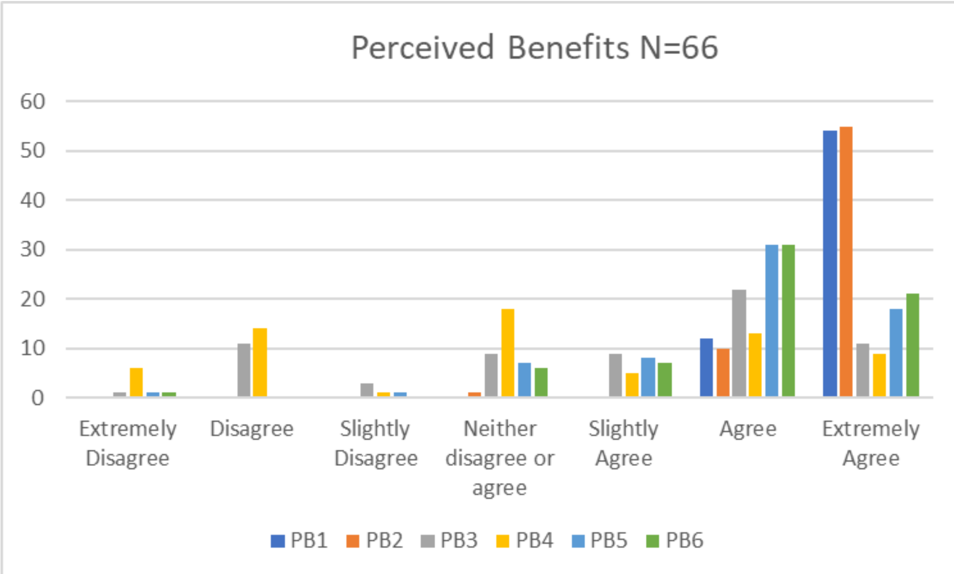


Figure 111: HBM Survey Responses for Perceived Benefits, November 12, 2019

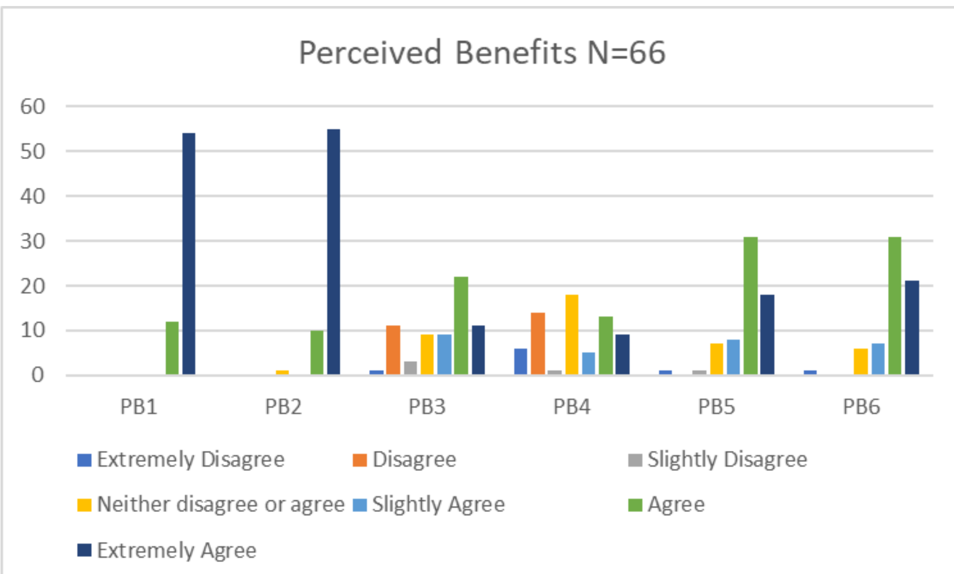


Figure 112: HBM Survey Responses by Question for Perceived Benefits, November 12, 2019

Table 130: HBM Perceived Benefits Descriptive Statistics, November 12, 2019

	Perceived Benefits										
	N	Minimum	Maximum	Mean		Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
PB1_Val	69	6	7	6.83	0.046	0.382	0.146	-1.759	0.289	1.126	0.57
PB2_Val	69	4	7	6.81	0.059	0.493	0.243	-3.429	0.289	15.003	0.57
PB3_Val	69	1	7	4.88	0.207	1.72	2.957	-0.637	0.289	-0.774	0.57
PB4_Val	69	1	7	4.16	0.23	1.907	3.636	-0.091	0.289	-1.142	0.57
PB5_Val	69	1	7	5.83	0.135	1.124	1.263	-1.63	0.289	4.129	0.57
PB6_Val	69	1	7	5.96	0.128	1.063	1.13	-1.877	0.289	5.941	0.57
Valid N (listwise)	69										

Table 131: Reliability Statistic for PB

Reliability Statistics PB		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.63	0.63	6

Table 132: Inter-Item Correlation Matrix for PB

Inter-Item Correlation Matrix PB						
	PB1_Val	PB2_Val	PB3_Val	PB4_Val	PB5_Val	PB6_Val
PB1_Val	1	0.76	0.081	-0.103	0.031	0.054
PB2_Val	0.76	1	0.061	-0.014	0.073	0.04
PB3_Val	0.081	0.061	1	0.665	0.233	0.214
PB4_Val	-0.103	-0.014	0.665	1	0.246	0.265
PB5_Val	0.031	0.073	0.233	0.246	1	0.707
PB6_Val	0.054	0.04	0.214	0.265	0.707	1

Table 133: Regression Weights for Generic Model for Perceived Benefits

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
PB1	.058	.023	.054	.433	.665
PB2	.076	.040	.070	.574	.566
PB3	.317	.580	.247	2.350	.019
PB4	.346	.703	.274	2.562	.010
PB5	.835	1.000			
PB6	.834	.944	.236	3.999	****

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 134: Regression Weights for Modified Model for Perceived Benefits

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
PB1	.045	.018	.054	.341	.733
PB2	.068	.035	.070	.508	.612
PB3	.316	.578	.247	2.342	.019
PB4	.348	.705	.274	2.570	.010
PB5	.837	1.000			
PB6	.832	.940	.236	3.978	***
Covariance d20-d19	.760	.141	.028	4.985	***

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 135: Regression Weights for Revised Model for Perceived Benefits

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
PB1	.046	.019	.054	.346	.730
PB2	.067	.035	.069	.501	.617
PB3	.267	.484	.250	1.932	.053
PB4	.303	.610	.280	2.177	.029
PB5	.843	1.000			
PB6	.839	.941	.323	2.912	.004
Covariance d20-d19	.760	.141	.028	4.985	***
Covariance d22-d21	.636	1.888	.436	4.332	***

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 136: Regression Weights for Revised 2 Model for Perceived Benefits

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
PB3	.265	.488	.252	1.935	.053
PB4	.304	.622	.282	2.204	.028
PB5	.830	1.000			
PB6	.852	.970	.339	2.859	.004
Covariance d22-d21	.636	1.889	.436	4.333	***

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 137: Correlations, Variances for the Generic, Modified and Revised Models of Perceived Benefits

Variables	Covariance Estimate	Correlation Estimate	Squared Multiple Correlation Generic	Squared Multiple Correlation Modified	Squared Multiple Correlation Revised	Squared Multiple Correlation Revised 2	Standard Errors	Critical Ratio (≥±1.96)	p-value
PB1			.003	.002	.002	-			
PB2			.006	.005	.004	-			
PB3			.100	.100	.071	.070			
PB4			.120	.121	.092	.093			
PB5			.698	.701	.711	.690			
PB6			.696	.693	.703	.725			
Covariance d2-d19 modified	.141	.760					.028	4.985	***
Covariance d20-d19 revised 2	.141	.760					.028	4.985	***
Covariance d22-d21 revised 2	1.888	.636					.436	4.332	***

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 138: Variances for Generic Model of Perceived Benefits

Variances	Estimate Generic	Standard Errors	Critical Ratio (≥±1.96)	p-value
PB	.869	.285	3.052	.002
d19	.143	.025	5.827	***
d20	.238	.041	5.824	***
d21	2.622	.460	5.696	***
d22	3.154	.557	5.665	***
d23	.376	.209	1.796	.072
d24	.339	.187	1.812	.070

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 139: Variances for Modified Model of Perceived Benefits

Variances	Estimate on Modified	Standard Errors	Critical Ratio (≥±1.96)	p-value
PB	.873	.286	3.048	.002
d19	.143	.025	5.828	***
d20	.239	.041	5.825	***
d21	2.623	.460	5.696	***
d22	3.150	.556	5.663	***
d23	.372	.211	1.761	.078
d24	.342	.187	1.824	.068

*** indicated significance smaller than .001
*Statistically significant at <.05

Table 140: Variances for Revised Model of Perceived Benefits

Variances	Estimate on Revised	Standard Errors	Critical Ratio (≥±1.96)	p-value
PB	.885	.356	2.488	.013
d19	.143	.025	5.828	***
d20	.239	.041	5.826	***
d21	2.707	.472	5.739	***
d22	3.254	.570	5.710	***
d23	.360	.298	1.208	.227
d24	.330	.264	1.251	.211

*** indicated significance smaller than .001
*Statistically significant at <.05

Table 141: Variances for Revised 2 Model of Perceived Benefits

Variances	Estimate on Revised 2	Standard Errors	Critical Ratio (≥±1.96)	p-value
PB	.859	.353	2.436	.015
d21	2.710	.472	5.741	***
d22	3.251	.570	5.709	***
d23	.386	.296	1.306	.191
d24	.306	.276	1.108	.268

*** indicated significance smaller than .001
*Statistically significant at <.05

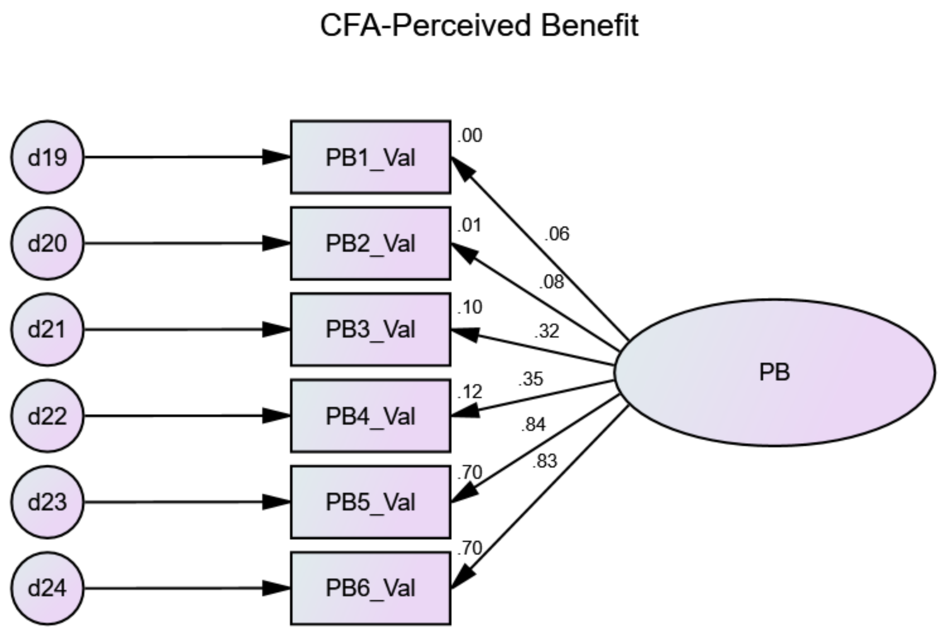


Figure 113: Generic Measurement Model for Perceived Benefit

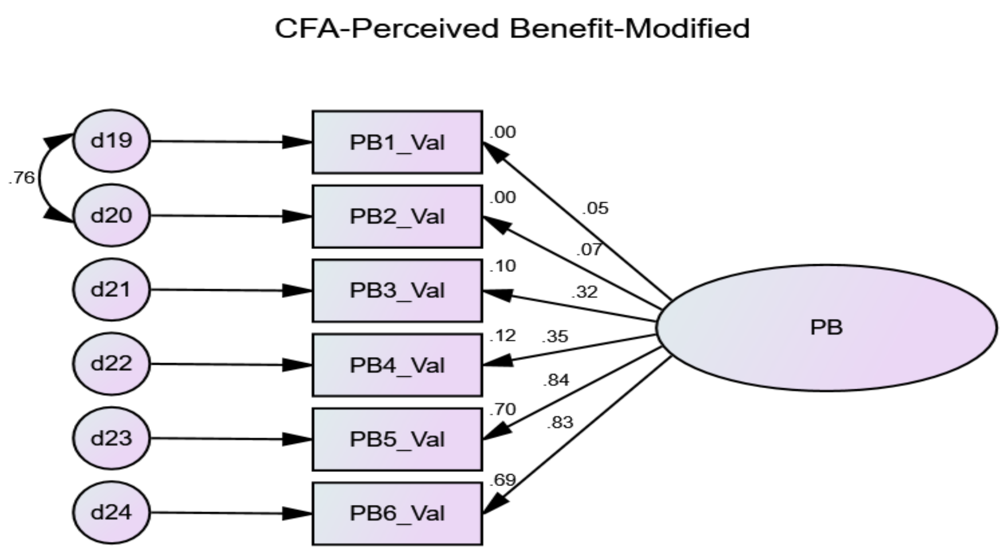


Figure 114: Modified Measurement Model for Perceived Benefit

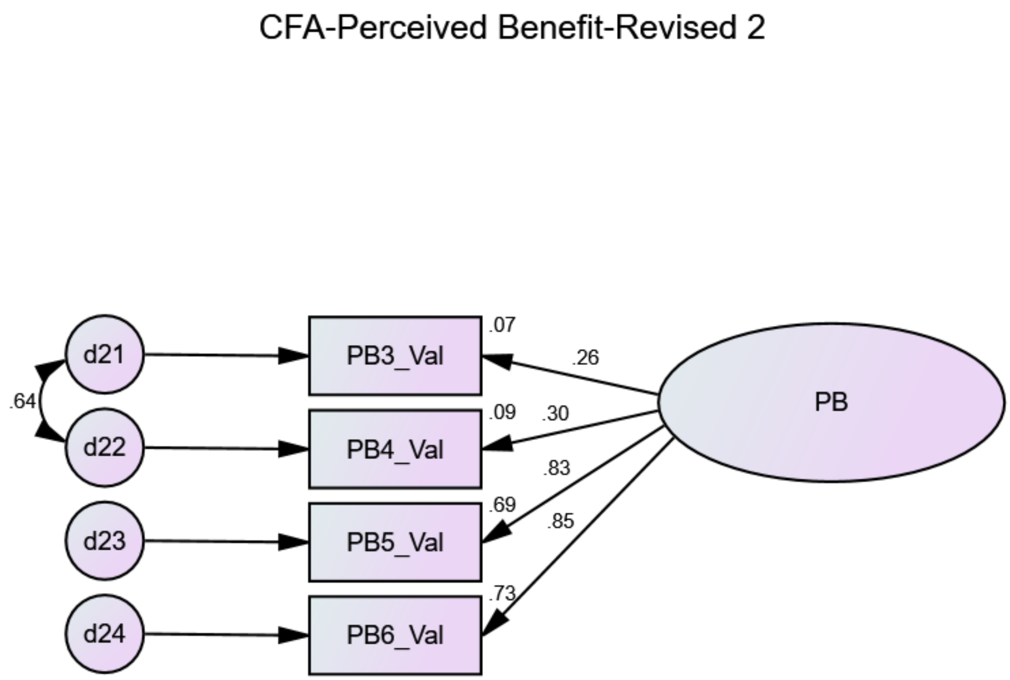


Figure 115: Revised 2 Measurement Model for Perceived Benefit

Cues to Action (CA)

Evaluation of the measurement models reveal that the generic model has the best model fit statistics for CA (Table 143). The CFA Statistics for the generic model is summarized in Table 142. This data reveals that the estimates (factor loadings) are very high in the standardized loadings, their standard errors to be low and their critical ratio to be real, strong evidence of their strong statistical significance for CA2, CA3 and CA4. CA1 is not as high in its loadings but still is statistically significant. Thus, the generic model shows that the 4 observed indicators for Cues to Action could be retained but a revision of CA1 might be warranted for construct validity and instrument evaluation.

Table 142: Four questions that provide input to CA observed variables: Summary of Statistics for Best Model Fit

ITEM-Cues to Action-Generic α=0.805, N=69	Label	Mode	CFA Statistics: Standardized Regression Weights (>0.65)	Standard Errors	Critical Ratio (≥±1.96)	p-value	R^2	Retain/ Delete after CFA
Gaining more knowledge on a topic, such as laboratory tests for febrile rash illnesses, would improve my confidence to perform the tests?	CA1	Agree	*0.441*	0.18	3.491	***	0.195	Retain
Learning about technology from others influences my use of it.	CA2	Agree	**0.901**	0.132	7.499	***	0.812	Retain
Learning in a self-paced environment would influence my use of technology.	CA3	Agree	**0.804**				0.646	Retain
Receiving communication from colleagues about technology such as an intelligent tutor would influence my use.	CA4	Agree	**0.801**	0.12	6.937	***	0.641	Retain

*** indicated significance smaller than .001, *Statistically significant at <.05, Scale: 1-7 (Extremely Disagree, Disagree, Slightly Disagree, Neither, Slightly Agree, Agree, Extremely Agree)

The CA variable is an intermediate variable in the HBM. It is represented by 4 observed indicators that utilize a 7-level measurement scale from Extremely Disagree to Extremely Agree. The Cronbach alpha shows good reliability among the 4 indicators at an α=0.805 (Table 146).

Measurement models for CA has 2 variations: generic (Figure 116) and modified (Figure 119). The measurement models are recursive with a sample size of 69. There are some missing values in the dataset. Missing values does not allow for modification indices to be calculated.

Table 143: Goodness of Fit Statistics for Generic and Modified Models for Cues to Action

Model Fit	Statistical Range	Generic Model (Figure 116)	Modified Model (Figure 119)
Sample Size	-	69	69
Sample Moments	-	14	14
Distinct Parameters	-	12	13
Degrees of Freedom (df)	-	2	1
Chi Squared χ^2	Approximates the df	3.8	3.540
Probability	≥ 0.05	**.150**	**.060**
Likelihood ratio CMIN/DF	1< CMIN/DF <3 Closer to 1 but not to exceed 3	**1.9**	*3.540*
Normed Fit Index NFI	NFI ≥ 0.95	**.967**	**.970**
Comparative Fit Index CFI	CFI ≥ 0.95	**.983**	**.976**
RMSEA-Root Mean Square Residual	RMSEA < 0.05 Should not exceed 0.1	*.115*	*.193*

Values that fail the standard are in italics. Values that pass are in BOLD.

The frequency data shows the respondents agreed with internal (CA1, CA 3) and externals (CA2, CA4) cues to act toward the use of the technology (Table 144).

The generic model is composed of 9 variables: 4 observed variables (CA1-CA4) and 5 unobserved variables (d25-d28, CA). The modified model is composed of 9 variables; 4 observed variables (CA1-CA4) and 5 unobserved variables (d25-d28, CA) and consists of a covariance link between d25-d26.

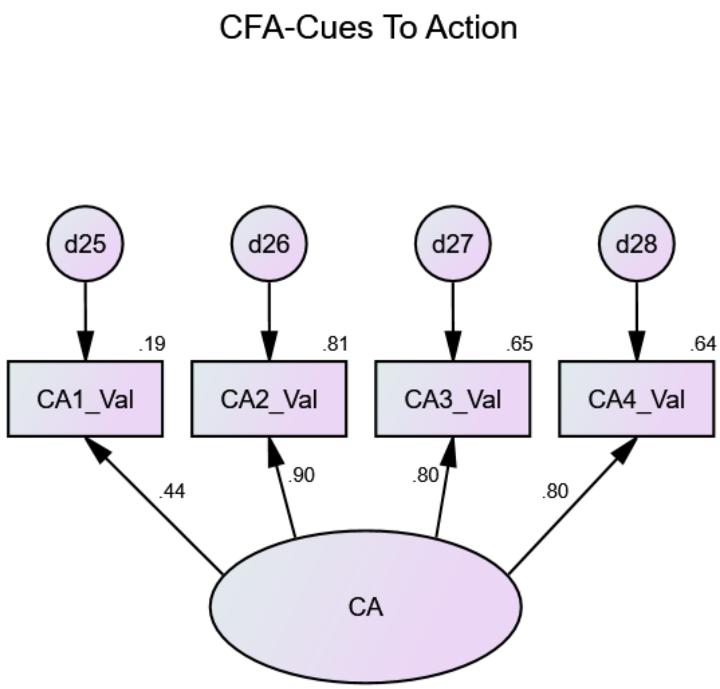


Figure 116: Generic Measurement Model for Cues to Action

The generic measurement model for CA has more acceptable fit statistics when compared to the modified. The GFI and AGFI were not given because this variable has missing data associated with it (Table 143).

Table 144: HBM Survey Responses for Cues to Action, November 12, 2019

Cue to Action				
	CA1	**CA2**	**CA3**	**CA4**
Extremely Disagree	3	1	1	1
Disagree	3	1	3	1
Slightly Disagree	0	0	1	1
Neither disagree or agree	6	10	7	7
Slightly Agree	9	17	12	14
Agree	26	23	26	33
Extremely Agree	19	14	16	9
No Response	113	113	113	113

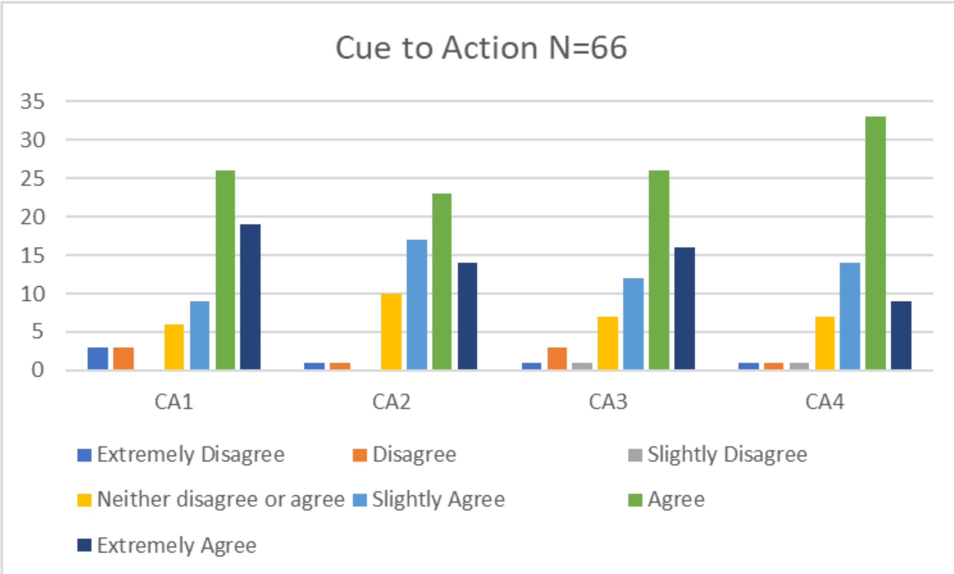


Figure 117: HBM Survey Responses by Question for Cues to Action, November 12, 2019

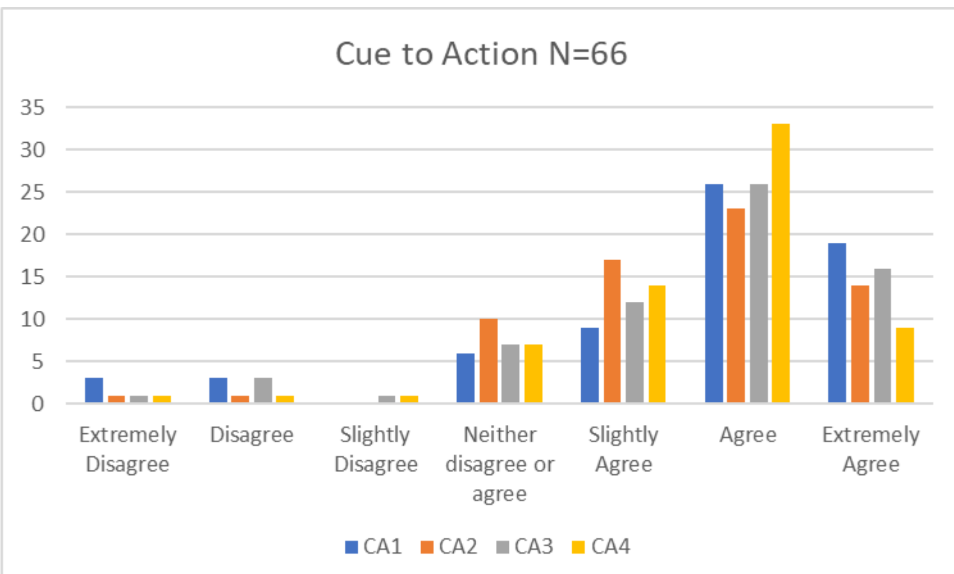


Figure 118: HBM Survey Responses for Cues to Action, November 12, 2019

Table 145: HBM Cues to Action Descriptive Statistics, November 12, 2019

Cues to Action											
	N	Minimum	Maximum	Mean		Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
CA1_Val	66	1	7	5.56	0.194	1.58	2.496	-1.551	0.295	1.998	0.582
CA2_Val	66	1	7	5.52	0.15	1.218	1.484	-1.089	0.295	2.152	0.582
CA3_Val	66	1	7	5.55	0.17	1.383	1.913	-1.32	0.295	1.727	0.582
CA4_Val	66	1	7	5.53	0.142	1.153	1.33	-1.535	0.295	3.541	0.582
Valid N (listwise)	66										

Table 146: Reliability Statistic for CA

Reliability Statistics CA		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.805	0.821	4

Table 147: Inter-Item Correlation Matrix for CA

Inter-Item Correlation Matrix-CA				
	CA1_Val	CA2_Val	CA3_Val	CA4_Val
CA1_Val	1	0.383	0.456	0.282
CA2_Val	0.383	1	0.716	0.733
CA3_Val	0.456	0.716	1	0.636
CA4_Val	0.282	0.733	0.636	1

Table 148: Regression Weights for Generic Model for Cues to Action

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
CA1	.441	.628	.180	3.491	***
CA2	.901	.988	.132	7.499	***
CA3	.804	1.000			
CA4	.801	.831	.120	6.937	***

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 149: Regression Weights for Modified Model for Cues to Action

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
CA1	.466	.663	.194	3.418	***
CA2	.908	.997	.136	7.333	***
CA3	.803	1.000			
CA4	.792	.822	.119	6.910	***
Covariance d25-d26	-.109	-.077	.146	-.527	.598

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 150: Correlations, Variances for the Generic, Modified and Revised Models of Cues to Action

Variables	Covariance Estimate	Correlation Estimate	Squared Multiple Correlation Generic	Squared Multiple Correlation Modified	Standard Errors	Critical Ratio (≥±1.96)	p-value
CA1			.195	.217			
CA2			.812	.825			
CA3			.646	.645			
CA4			.641	.627			
Covariance d25-d26	-.077	-.109			.146	-.527	.598

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 151: Variances for Generic Model of Cues to Action

Variances	Estimate Generic	Standard Errors	Critical Ratio (≥±1.96)	p-value
CA	1.217	.327	3.718	***
d25	1.949	.358	5.531	***
d26	.274	.113	2.419	.016
d27	.667	.159	4.193	***
d28	.470	.111	4.231	***

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 152: Variances for Modified Model of Cues to Action

Variances	Estimate Modified	Standard Errors	Critical Ratio (≥±1.96)	p-value
CA	1.215	.328	3.701	***
d25	1.924	.365	5.268	***
d26	.255	.122	2.101	.036
d27	.669	.162	4.142	***
d28	.489	.114	4.291	***
Covariance d25-d26				

*** indicated significance smaller than .001

*Statistically significant at <.05

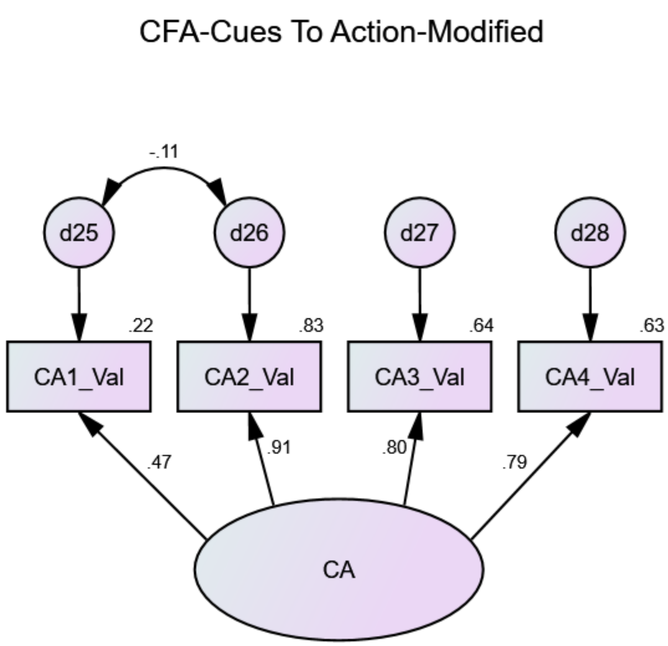


Figure 119: Modified Measurement Model for Cues to Action

Motivations (M)

Evaluation of the measurement models reveal that the modified model has the best model fit statistics for M (Table 154). The CFA Statistics for the modified model is summarized in Table 153. This data for M4, M5 and M6 reveals that the estimates (factor loadings) are high in the standardized loadings, their standard errors to be low and their critical ratio to be real, strong evidence of their strong statistical significance. The R^2 for M4 and M6 indicate good correlation of the items to the construct.

Thus, the modified model shows that of the six observed indicators for Motivations, 3 could be retained (remove M1, M2, M3) and revision to M5 could be considered to improve loading for construct validity and instrument evaluation.

Table 153: Six questions that provide input to M observed variables: Summary of Statistics for Best Model Fit

ITEM-Motivations-Modified α=0.731, N=69	Label	Mode	CFA Statistics: Standardized Regression Weights (>0.65)	Standard Errors	Critical Ratio (≥±1.96)	p-value	R^2	Retain/ Delete after CFA
I have a general concern about my health.	M1	Agree	*0.216*	0.176	1.722	0.085	0.047	Delete
I have a general concern for the health of the community	M2	Agree	*0.233*	0.117	1.849	0.064	0.054	Delete
I frequently do things to improve my health	M3	Agree	*0.35*	0.092	2.868	0.004	0.122	Delete
I frequently do things to improve the health of the community	M4	Agree	**0.951**	0.095	9.954	***	0.904	Retain
I search for new information related to my health	M5	Agree	**0.619**	0.105	5.734	***	0.383	Retain
I search for new information related to keeping the community healthy	M6	Agree	**0.916**				0.84	Retain

*** indicated significance smaller than .001, *Statistically significant at <.05, Scale: 1-7 (Extremely Disagree, Disagree, Slightly Disagree, Neither, Slightly Agree, Agree, Extremely Agree)

M is an exogenous variable in the HBM model. It is represented by 6 observed indicators that utilize a 7-level measurement scale from Extremely Disagree to Extremely Agree. Indicators M2, M4, M6 are community centered and indicators M1, M3, M5 are self-centered.

The Cronbach alpha shows acceptable reliability among the 6 indicators at an α=0.731 (Table 157).

Measurement models for M has 3 variations: generic (Figure 123), modified (Figure 120) and revised (Figure 124). The measurement models are recursive with a sample size of 69. There are missing values in the dataset. Missing values does not allow for modification indices to be calculated.

Table 154: Goodness of Fit Statistics for Generic, Modified and Revised Models for Motivations

Model Fit	**Statistical Range**	**Generic Model (**Figure 123**)**	**Modified Model (**Figure 120**)**	**Revised Model 2 (**Figure 124**)**
Sample Size	-	69	69	69
Sample Moments	-	27	27	27
Distinct Parameters	-	18	19	19
Degrees of Freedom (df)	-	9	8	8
Chi Squared χ^2	Approximates the df	31.679	3.509	31.675
Probability	≥ 0.05	*.000*	**.899**	*.000*
Likelihood ratio CMIN/DF	1< CMIN/DF <3 Closer to 1 but not to exceed 3	*3.520*	*.439*	*3.959*
Normed Fit Index NFI	NFI ≥ 0.95	*.811*	**.979**	*.811*
Comparative Fit Index CFI	CFI ≥ 0.95	*.845*	1.000	*.838*
RMSEA-Root Mean Square Residual	RMSEA < 0.05 Should not exceed 0.1	*.193*	.000	*.209*
Goodness of fit Index GFI	0.80 < GFI < 1	Not calculated-missing data		
AGFI	0.80 < AGFI < 1	Not calculated-missing data		

Values that fail the standard are in italics. Values that pass are in BOLD.

The frequency data shows that respondents Agree for motivation indicators. Highest disagreement is seen in question M1 about concerns about one's own health (Table 155).

The generic model has 13 variables in the model: 6 observed variables (M1-M6) and 7 unobserved variables (d29-d34, M). The modified model has a covariance link between d29-d30 and has 13 variables in the model: 6 observed variables (M1-M6) and 7 unobserved variables (d29-d34, M). The revised model has a covariance link between d30-d33 and has 13 variables in the model: 6 observed variables (M1-M6) and 7 unobserved variables (d29-d34, M).

The generic measurement model for M has a high CMIN/DF at 3.5 and high RMSEA value at .193, a CFI of .845 and NFI of .811 which all indicate a poor fit. The revised model has similar values and indicate a weak fit for model.

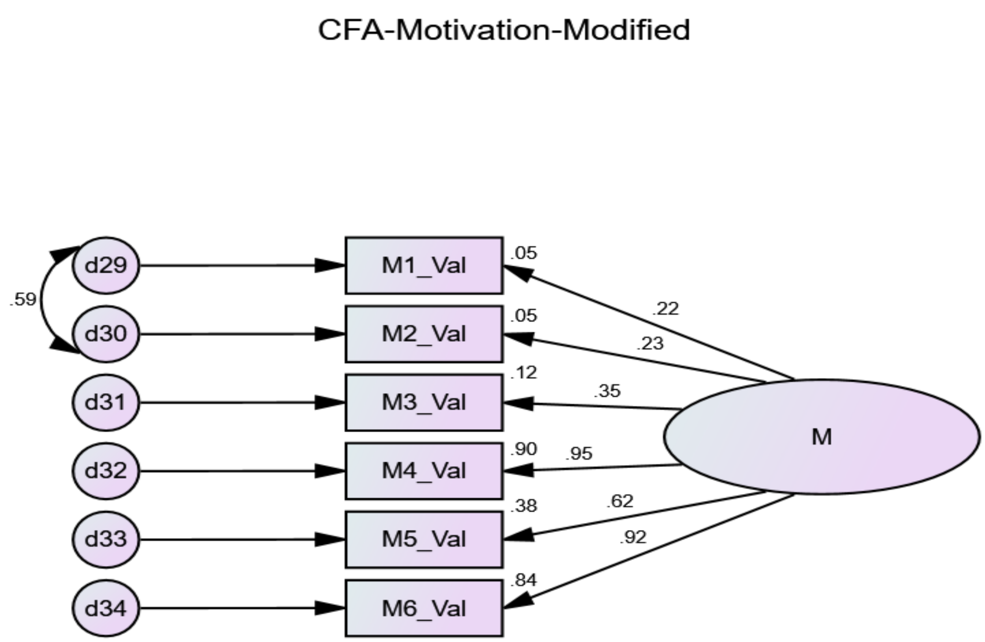


Figure 120: Modified Measurement Model for Motivations

Table 155: HBM Survey Responses for Motivations, November 12, 2019

Motivations						
	M1	**M2**	**M3**	**M4**	**M5**	**M6**
Extremely Disagree	2	0	1	1	0	1
Disagree	12	1	0	2	4	5
Slightly Disagree	4	5	0	2	1	1
Neither disagree or agree	8	3	4	7	6	5
Slightly Agree	10	7	9	9	7	6
Agree	18	29	36	32	34	36
Extremely Agree	12	20	16	13	14	12
No Reponses	113	114	113	113	113	113

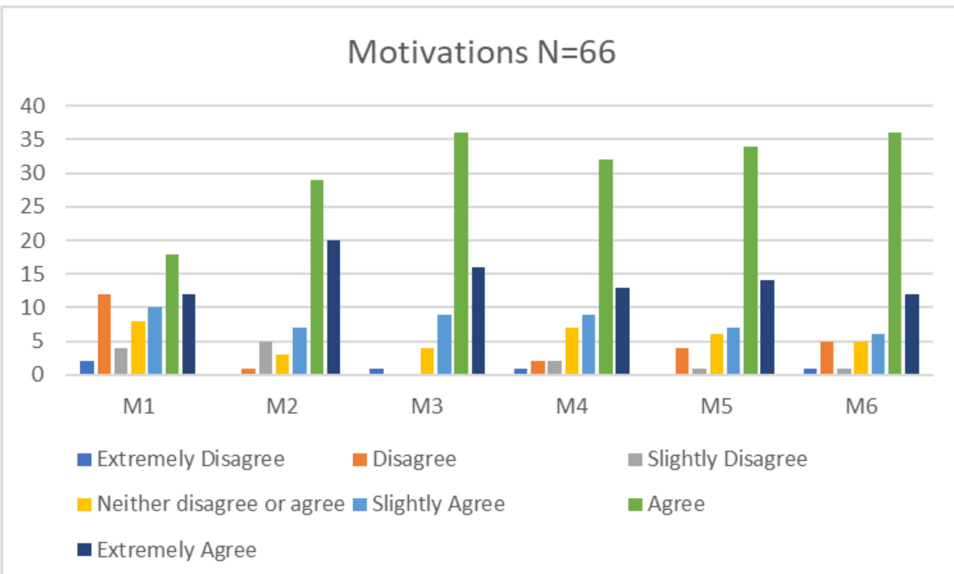


Figure 121: HBM Survey Responses by Question for Motivations, November 12, 2019

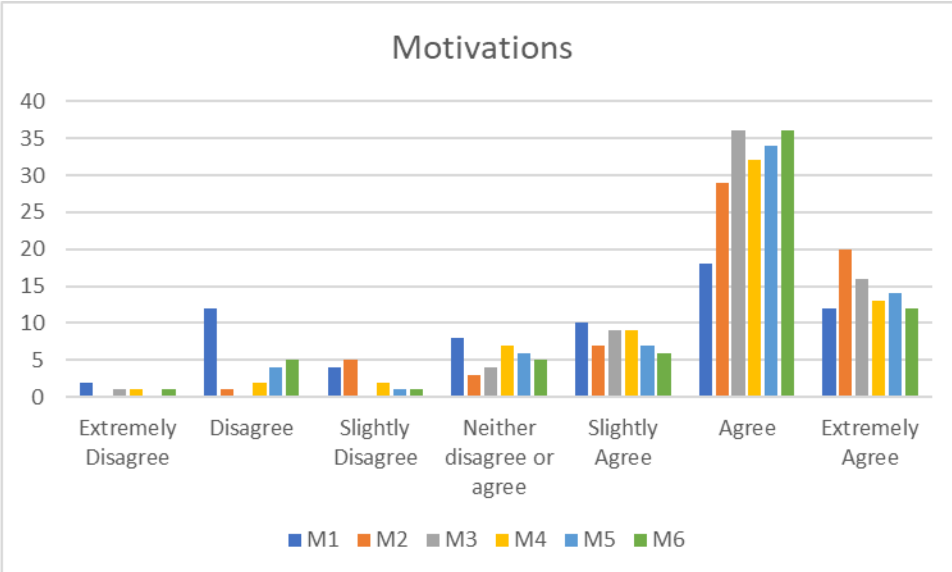


Figure 122: HBM Survey Responses for Motivations, November 12, 2019

Table 156: HBM Motivations Descriptive Statistics, November 12, 2019

Motivations											
	N	Minimum	Maximum	Mean		Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
M1_Val	66	1	7	4.73	0.229	1.861	3.463	-0.474	0.295	-1.096	0.582
M2_Val	65	2	7	5.82	0.153	1.236	1.528	-1.327	0.297	1.273	0.586
M3_Val	66	1	7	5.91	0.124	1.003	1.007	-2.074	0.295	7.883	0.582
M4_Val	66	1	7	5.56	0.162	1.314	1.727	-1.436	0.295	2.171	0.582
M5_Val	66	2	7	5.64	0.16	1.297	1.681	-1.468	0.295	1.877	0.582
M6_Val	66	1	7	5.52	0.178	1.449	2.1	-1.564	0.295	1.855	0.582
Valid N (listwise)	65										

Table 157: Reliability Statistic for Motivations

Reliability Statistics- M		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.731	.742	6

Table 158: Inter-Item Correlation Matrix for M

Inter-Item Correlation Matrix M						
	M1_Val	M2_Val	M3_Val	M4_Val	M5_Val	M6_Val
M1_Val	1.000	.618	.047	.209	.109	.205
M2_Val	.618	1.000	.102	.228	.156	.205
M3_Val	.047	.102	1.000	.327	.353	.287
M4_Val	.209	.228	.327	1.000	.582	.874
M5_Val	.109	.156	.353	.582	1.000	.559
M6_Val	.205	.205	.287	.874	.559	1.000

Table 159: Regression Weights for Generic Model for Motivations

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
M1	.226	.317	.176	1.800	.072
M2	.243	.226	.117	1.930	.054
M3	.350	.364	.092	2.867	.004
M4	.950	.939	.093	10.090	***
M5	.619	.604	.105	5.736	***
M6	.917	1.000			

*** indicated significance smaller than .001
*Statistically significant at <.05

Table 160: Regression Weights for Modified Model for Motivations

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
M1	.216	.303	.176	1.722	.085
M2	.233	.216	.117	1.849	.064
M3	.350	.264	.092	2.868	.004
M4	.951	.941	.095	9.954	***
M5	.619	.604	.105	5.734	***
M6	.916	1.000			

*** indicated significance smaller than .001
*Statistically significant at <.05

Table 161: Regression Weights for Revised Model for Motivations

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
M1	.226	.316	.176	1.798	.072
M2	.243	.226	.117	1.925	.054
M3	.350	.264	.092	2.867	.004
M4	.950	.940	.093	10.077	***
M5	.619	.604	.105	5.734	***
M6	.917	1.000			

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 162: Correlations, Variances for the Generic, Modified and Revised Models of Motivations

Variables	Covariance Estimate	Correlation Estimate	Squared Multiple Correlation Generic	Squared Multiple Correlation Modified	Squared Multiple Correlation Revised	Standard Errors	Critical Ratio (≥±1.96)	p-value
M1			.051	.047	.051			
M2			.059	.054	.059			
M3			.122	.122	.122			
M4			.902	.904	.902			
M5			.383	.383	.383			
M6			.840	.840	.840			
Covariance d30-d29 (modified)	1.275	.595				.312	4.091	***
Covariance d30-d33 (revised)	.010	.008				.154	.065	.948

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 163: Variances for Generic Model of Motivations

Variances	Estimate Generic	Standard Errors	Critical Ratio (≥±1.96)	p-value
M	1.738	.381	4.565	***
d34	.330	.142	2.328	.020
d33	1.021	.187	5.455	***
d32	.167	.118	1.418	.156
d31	.870	.154	5.650	***
d30	1.415	.251	5.636	***
d29	3.236	.570	5.683	***

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 164: Variances for Modified Model of Motivations

Variances	Estimate Modified	Standard Errors	Critical Ratio (≥±1.96)	p-value
M	1.736	.382	4.549	***
d34	.332	.145	2.289	.022
d33	1.022	.187	5.455	***
d32	.164	.121	1.359	.174
d31	.870	.154	5.650	***
d30	1.414	.251	5.644	***
d29	3.251	.572	5.685	***

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 165: Variances for Revised Model of Motivations

Variances	Estimate Revised	Standard Errors	Critical Ratio (≥±1.96)	p-value
M	1.738	.381	4.564	***
d34	.330	.142	2.324	.020
d33	1.022	.187	5.454	***
d32	.167	.118	1.413	.158
d31	.871	.154	5.650	***
d30	1.415	.251	5.635	***
d29	3.237	.570	5.683	***

*** indicated significance smaller than .001

*Statistically significant at <.05

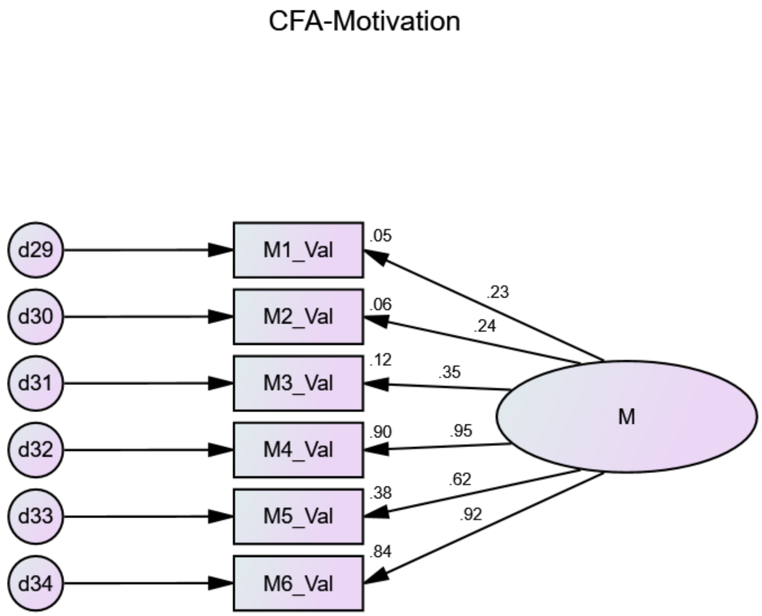


Figure 123: Generic Measurement Model for Motivations

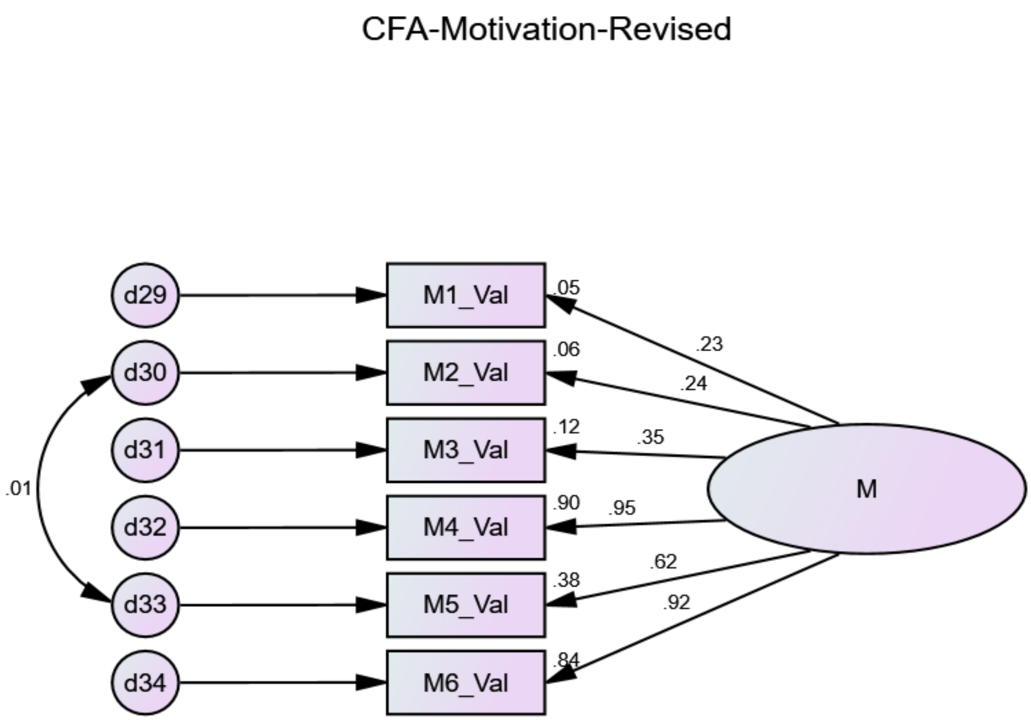


Figure 124: Revised Measurement Model for Motivations

Actual Use (AU)

Evaluation of the measurement models reveal that the modified model has the best model fit statistics for AU (Table 167). The CFA Statistics for the modified model is summarized in Table 166. A review of the regression weights reveals that the estimates (factor loadings) are very high in the standardized loadings, their standard errors to be low and their critical ratio to be real, strong evidence of their strong statistical significance. Thus, the modified model shows that the 4 observed indicators for Actual Use represent the construct and should be retained for construct validity and instrument evaluation. AU4 has the lowest loading below the 0.65 expectation and could be considered for revision, however this is a temporal question which may attribute to the low loading.

Table 166: Four questions that provide input to AU observed variables: Summary of Statistics for Best Model Fit

ITEM-Actual Use-Modified α=0.857, N=69	Label	Mode	CFA Statistics: Standardized Regression Weights (>0.65)	Standard Errors	Critical Ratio (≥±1.96)	p-value	R^2	Retain/ Delete after CFA
Would you recommend the implementation of an intelligent tutoring system (ITS) for training of public health professionals in your organization?	AU1	Agree	**1.011**				1.022	Retain
Would you be to recommend the continuous use of ITS technology for training of public health professionals?	AU2	Agree	**1.029**	0.102	9.503	***	1.059	Retain
Would you recommend the using of ITS technology for performing training tasks?	AU3	Agree	**0.811**	0.109	6.057	***	0.657	Retain
Over the next 3 months, I would likely use ITS technology.	AU4	Neither	*0.478*	0.15	3.573	***	0.228	Retain

*** indicated significance smaller than .001, *Statistically significant at <.05, Scale: 1-7 (Extremely Disagree, Disagree, Slightly Disagree, Neither, Slightly Agree, Agree, Extremely Agree)

The AU variable is an endogenous variable for the TAM, HBM and for the a priori hypothesized model. It is represented by 4 observed indicators that utilize a 7-level measurement scale from Extremely Disagree to Extremely Agree.

The Cronbach alpha shows good reliability among the 4 indicators at an α=0.857 (Table 170). Using the inter-item correlation matrix, AU4 has the lowest correlation among the other indicators and with its removal improved the Cronbach alpha. Removal of AU4 and the alpha was increased to .917 which is excellent (Table 171).

Table 167: Goodness of Fit Statistics for Generic, Modified Models for Actual Use

Model Fit	Statistical Range	Generic Model (Figure 128)	Modified Model (Figure 125)
Sample Size	-	69	69
Sample Moments	-	14	14
Distinct Parameters	-	12	13
Degrees of Freedom (df)	-	2	1
Chi Squared χ^2	Approximates the df	9.584	1.794
Probability	≥ 0.05	*.008*	**.180**
Likelihood ratio CMIN/DF	1< CMIN/DF <3 Closer to 1 but not to exceed 3	*4.792*	**1.794**
Normed Fit Index NFI	NFI ≥ 0.95	*.946*	**.990**
Comparative Fit Index CFI	CFI ≥ 0.95	**.955**	**.995**
RMSEA-Root Mean Square Residual	RMSEA < 0.05 Should not exceed 0.1	*.236*	*.108*

Values that fail the standard are in italics. Values that pass are in BOLD.

The frequency data shows respondents agree for actual use of the ITS should it be offered to them for training tasks (Table 168).

Measurement models for AU had 2 variations: generic (Figure 128) and modified (Figure 125). Both models are recursive with a sample size of 69. The generic model has 9 variables: 4 observed variables (AU1-AU4) and 5 unobserved variables (e35-e38, AU). The modified model has a covariance link between e36-e35 and has 9 variables: 4 observed variables (AU1-AU4) and 5 unobserved variables (e35-e38, AU).

The modified measurement model for AU was improved in the RMSEA and CMIN/DF statistics when compared to the generic model. AU has missing values in the dataset so modification indices could not be consulted for recommended modifications. Adding additional covariances causes the model to become unidentified. The generic model shows a RMSEA (0.236) and CMIN/DF (4.792) that reflect an unsatisfactory model fit. The CFI (.955) and NFI (.946) reflect a satisfactory model fit. A comparison of the Chi-squared value indicates that the modified model would be the better fitted model (Table 167).

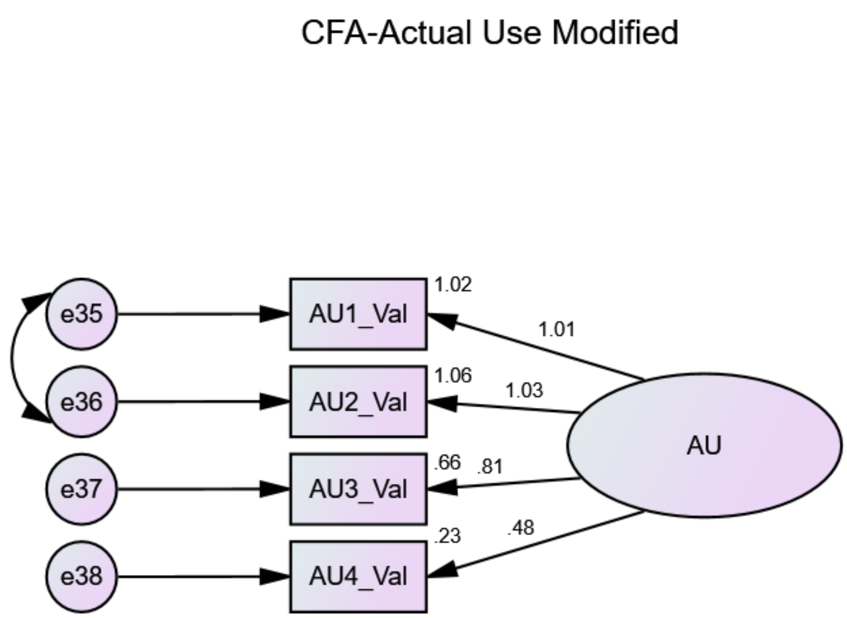


Figure 125: Modified Measurement Model for Actual Use

Table 168: HBM Survey Responses for Actual Use, November 12, 2019

Actual Use				
	AU1	AU2	AU3	AU4
Extremely Disagree	0	0	0	2
Disagree	4	3	1	5
Slightly Disagree	0	1	1	4
Neither disagree or agree	6	5	6	24
Slightly Agree	14	13	12	16
Agree	32	34	35	11
Extremely Agree	10	10	11	4
No Response	113	113	113	113

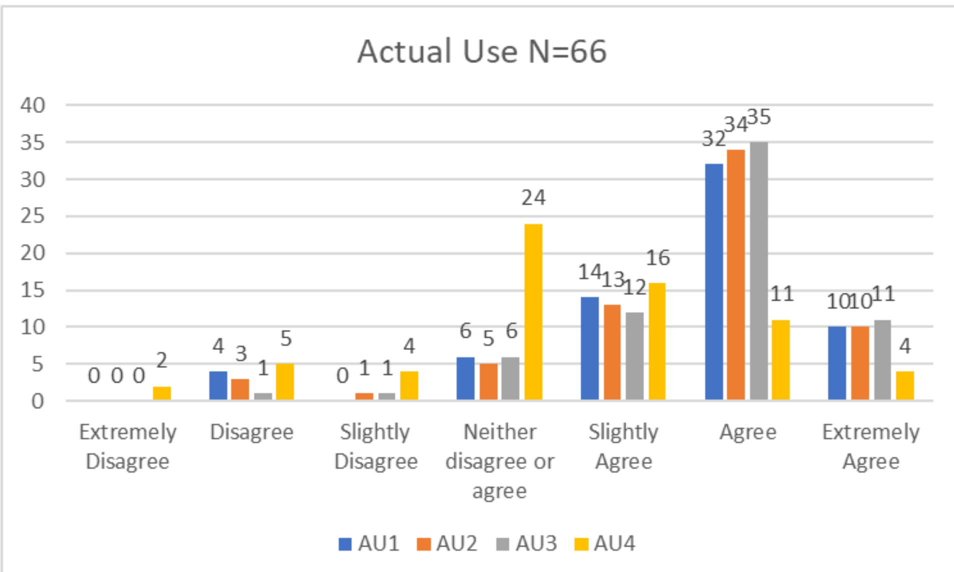


Figure 126: HBM Survey Responses for Actual Use, November 12, 2019

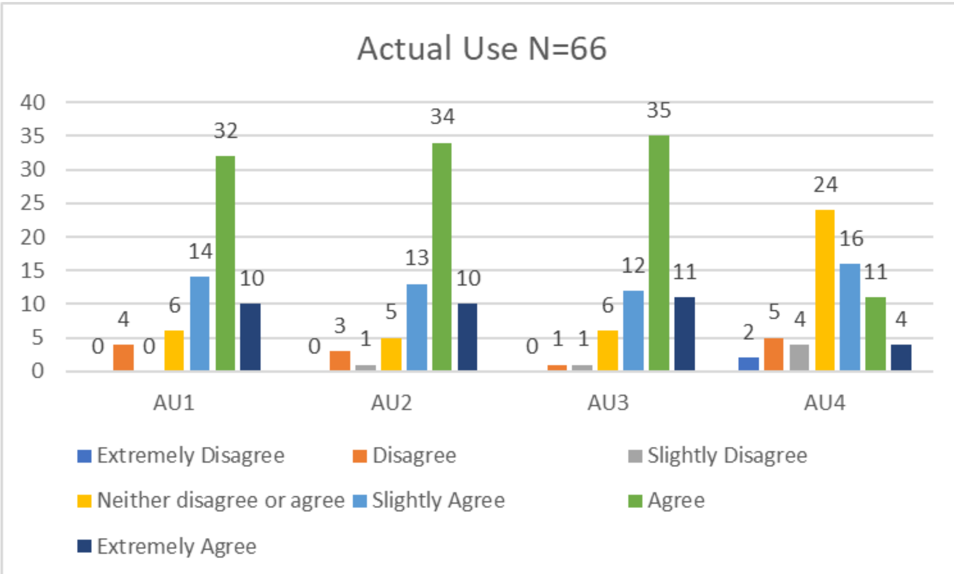


Figure 127: HBM Survey Responses by Question for Actual Use, November 12, 2019

Table 169: HBM Actual Use Descriptive Statistics, November 12, 2019

Actual Use											
	N	Minimum	Maximum	Mean		Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
AU1_Val	66	2	7	5.52	0.15	1.218	1.484	-1.405	0.295	2.168	0.582
AU2_Val	66	2	7	5.58	0.143	1.164	1.356	-1.455	0.295	2.447	0.582
AU3_Val	66	2	7	5.7	0.124	1.007	1.014	-1.215	0.295	2.173	0.582
AU4_Val	66	1	7	4.45	0.17	1.383	1.913	-0.37	0.295	0.163	0.582
Valid N (listwise)	66										

Table 170: Reliability Statistic for Actual Use

Reliability Statistics-AU		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.857	.871	4

Table 171: Inter-Item Correlation Matrix for AU

Inter-Item Correlation Matrix-AU	AU1_Val	AU2_Val	AU3_Val	AU4_Val
AU1_Val	1	0.742	0.806	0.534
AU2_Val	0.742	1	0.846	0.446
AU3_Val	0.806	0.846	1	0.388
AU4_Val	0.534	0.446	0.388	1

Table 172: Regression Weights-Generic Model Actual Use

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
AU1	.855	1.000			
AU2	.893	.909	.103	9.642	***
AU3	.940	.998	.088	10.291	***
AU4	.477	.633	.158	4.010	***

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 173: Regression Weights-Modified Model Actual Use

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
AU1	1.011	1.000			
AU2	1.029	.973	.102	9.503	***
AU3	.811	.663	.109	6.057	***
AU4	.478	.537	.150	3.573	***
Covariance d36-d35		-.417	.198	-2.103	.035

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 174:Correlations and Variances, Generic and Modified Models Actual Use

Variables	Covariance Estimate	Correlation Estimate	Squared Multiple Correlation Generic	Squared Multiple Correlation Modified	Squared Multiple Correlation Revised	Standard Errors	Critical Ratio (≥±1.96)	p-value
AU1			.732	1.022				
AU2			.797	1.059				
AU3			.884	.657				
AU4			.228	.228				
Covariance d36-d35	-.417					.198	-2.103	.035

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 175: Variances for Generic Model Actual Use

Variances	Estimate Generic	Standard Errors	Critical Ratio (≥±1.96)	p-value
AU	1.069	.253	4.231	***
d35	.392	.088	4.484	***
d36	.271	.071	3.804	***
d37	.116	.048	2.420	0.16
d38	1.455	.261	5.586	***

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 176: Variances for Modified Model Actual Use

Variances	Estimate on Modified	Standard Errors	Critical Ratio (≥±1.96)	p-value
AU	1.494	.336	4.443	***
d35	-.032	.218	-.147	.883
d36	-.079	.202	-.391	.696
d37	.342	.105	3.255	.001
d38	1.454	.261	5.567	***

*** indicated significance smaller than .001

*Statistically significant at <.05

CFA-Actual Use

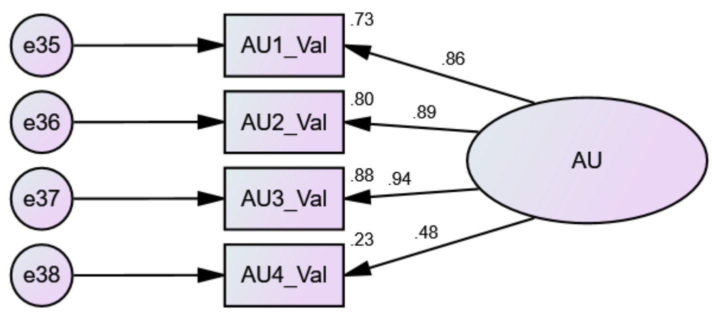


Figure 128: Generic Measurement Model for Actual Use

TAM-CFA

Table 177: Reliability Statistic for TAM

Reliability Statistics-TAM	
Cronbach's Alpha	N of Items
.951	22

Table 178: Correlations, Variances for the TAM Revised Model

Variables	Covariance Estimate	Correlation Estimate	Standard Errors	Critical Ratio (≥±1.96)	p-value
PU-PEOU	.359	.358	.142	2.522	.012
ATT-IU	1.063	.831	.240	4.428	***
PEOU-ATT	.395	.423	.141	2.797	.005
PU-ATT	1.046	.827	.216	4.833	***
PEOU-IU	.469	.462	.162	2.900	.004
PU-IU	1.061	.772	.248	4.283	***
d1-d4	-.071	-.295	.031	-2.318	.020
d3-d6	-.163	-.831	.035	-4.681	***
d9-d11	.260	.256	.132	1.967	.049
d18-d20	.064	.170	.088	.727	.467
d21-d22	.407	.480	.133	3.050	.002
d9-d10	.079	.249	.066	1.201	.230
d9-d13	-.098	-.368	.051	-1.934	.053
d1-d5	.106	.327	.044	2.415	.016
d20-d22	-.237	-.464	.081	-2.929	.003
d19-d21	.240	.390	.090	2.650	.008
d18-d21	-.039	-.063	.070	-.560	.575
d2-d7	.056	.147	.054	1.046	.296
d3-d7	-.198	-.439	.064	-3.081	.002

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 179: Variances for TAM Revised Measurement Model

Variances	Estimate Generic	Standard Errors	Critical Ratio (≥±1.96)	p-value
PU	1.357	.281	4.830	***
PEOU	.740	.234	3.166	.002
ATT	1.177	.238	4.940	***
IU	1.392	.374	3.725	***
d1	.272	.050	5.457	***
d2	.212	.039	5.439	***
d3	.293	.062	4.713	***
d4	.212	.038	5.497	***
d5	.388	.068	5.689	***
d7	.693	.127	5.440	***
d6	.132	.034	3.896	***
d8	.260	.048	5.371	***
d9	.655	.150	4.378	***
d10	.154	.040	3.862	***
d11	1.572	.275	5.708	***
d12	.284	.057	4.997	***
d13	.108	.034	3.184	.001
d15	.253	.055	4.632	***
d16	.197	.060	3.303	***
d17	.450	.094	4.772	***
d18	.436	.103	4.252	***
d19	.424	.096	4.395	***
d20	.323	.107	3.019	.003
d21	.892	.172	5.191	***
d22	.806	.173	4.667	***

*** indicated significance smaller than .001

*Statistically significant at <.05

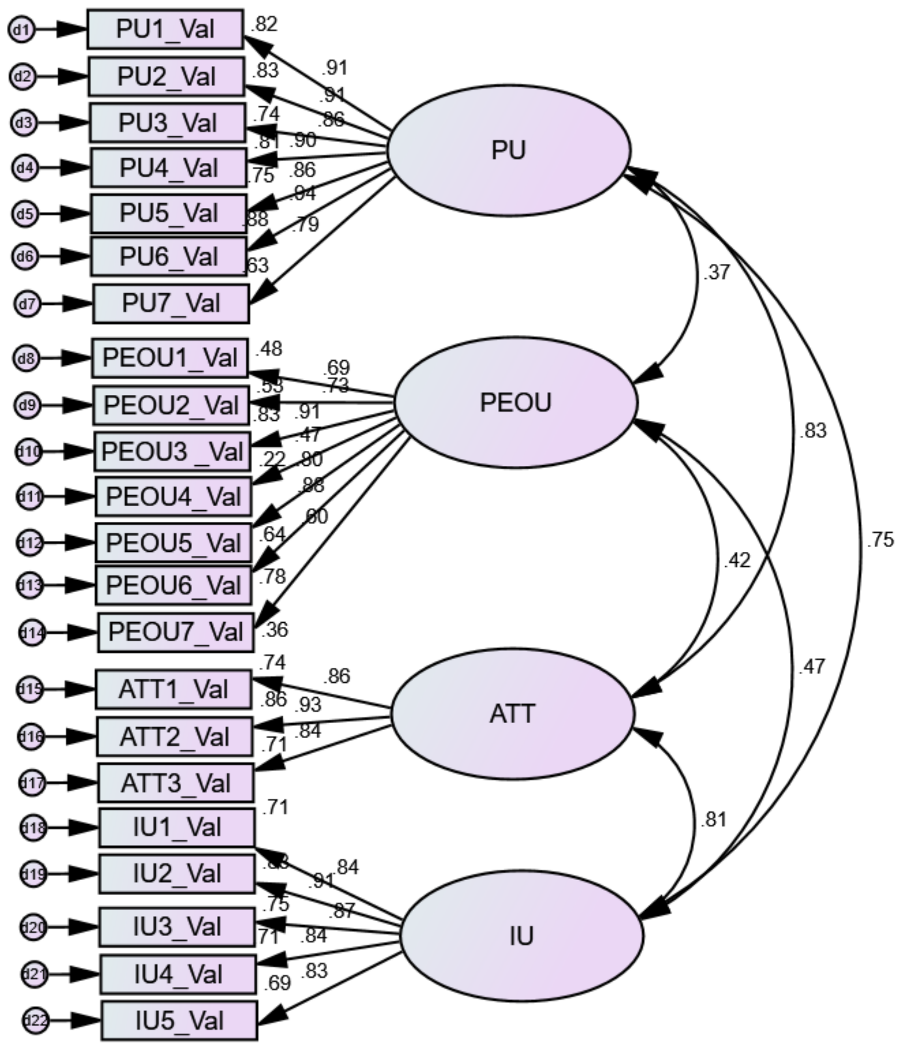


Figure 129: Measurement Model for TAM

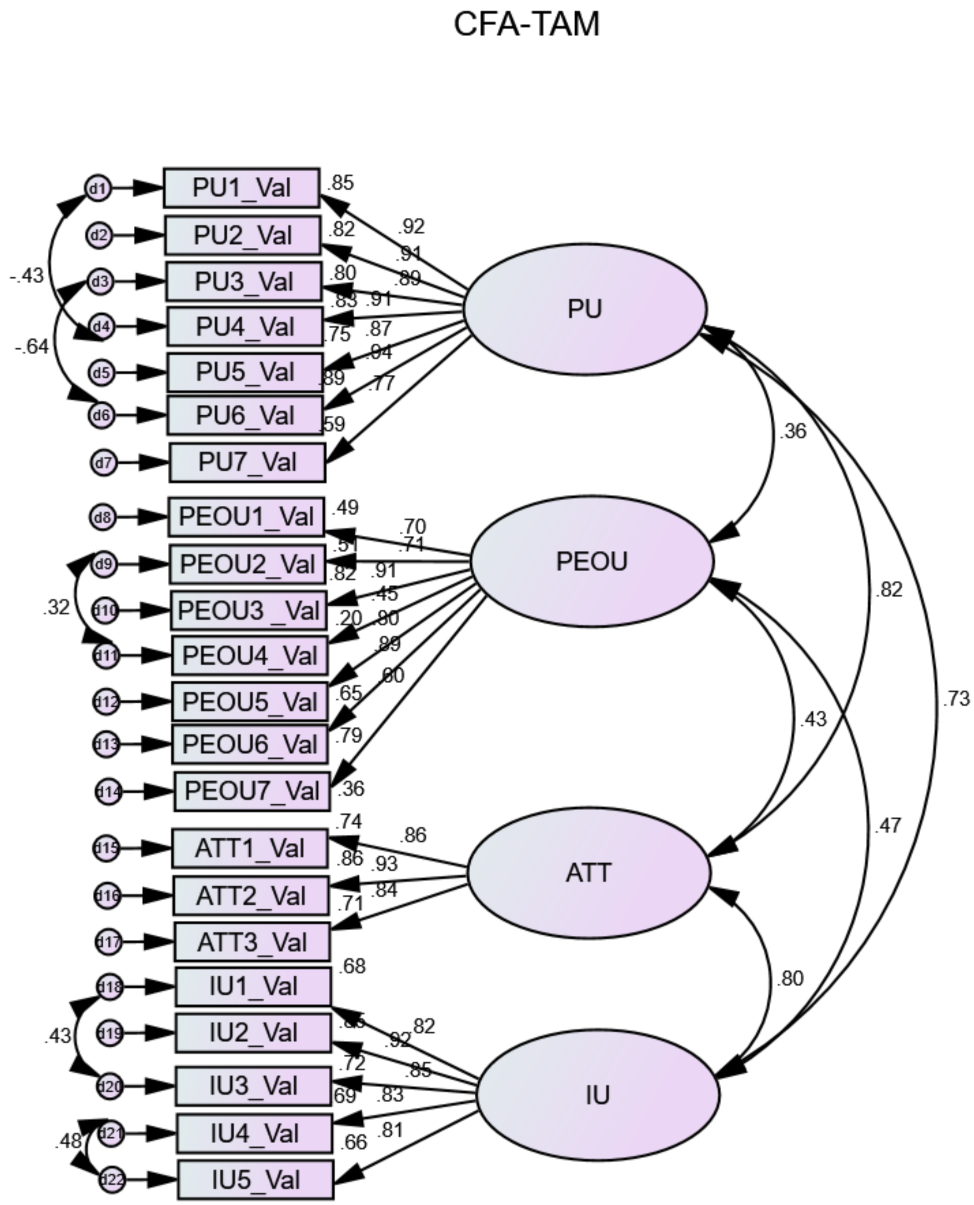


Figure 130: Modified Measurement Model for TAM

HBM-CFA

Table 180: Reliability Statistic for HBM

Reliability Statistics-HBM	
Cronbach's Alpha	N of Items
.782	21

Table 181: Correlations, Variances for the HBM Modified Model

Variables	Covariance Estimate	Correlation Estimate	Standard Errors	Critical Ratio (≥±1.96)	p-value
CA-M	.174	.114	.209	.833	.405
PS-M	.808	.474	.254	3.178	.001
PSV-M	.633	.367	.246	2.573	.010
PT-M	-.150	-.152	.143	-1.047	.295
PB-M	.059	.048	.173	.342	.732
CA-PS	-.079	-.056	.193	-.407	.684
CA-PSV	.145	.103	.194	.747	.455
CA-PT	.016	.020	.115	.142	.887
CA-PB	.387	.384	.165	2.345	.019
PS-PSV	.911	.581	.244	3.742	***
PS-PT	-.127	-.142	.130	-.974	.330
PS-PB	.141	.126	.160	.886	.376
PSV-PT	-.066	-.073	.127	-.522	.601
PSV-PB	.128	.113	.159	.806	.420
PT-PB	.092	.142	.098	.939	.348
d9-d8	-.034	-.058	.135	-.251	.802
d26-d25	-.124	-.168	.141	-.877	.380

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 182: Variances for HBM Modified Measurement Model

Variances	Estimate Modified	Standard Errors	Critical Ratio (≥±1.96)	p-value
PS	1.551	.334	4.641	***
PSV	1.587	.358	4.436	***
PT	.519	.249	2.081	.037
PB	.812	.260	3.122	.002
M	1.877	.393	4.773	***
CA	1.251	.329	3.800	***
d5	1.187	.248	4.784	***
d3	.833	.175	4.749	***
d2	.264	.138	1.920	.055
d10	.226	.185	1.219	.223
d9	.589	.176	3.354	***
d8	.586	.147	3.977	***
d15	.127	.084	1.513	.130
d14	.497	.101	4.921	***
d13	1.374	.260	5.275	***
d16	1.059	.208	5.088	***
d22	3.209	.563	5.699	***
d23	.433	.182	2.377	.017
d24	.270	.179	1.510	.131
d32	.227	.114	1.987	.047
d26	.296	.117	2.530	.011
d27	.628	.155	4.044	***
d28	.502	.113	4.433	***
d25	1.838	.352	5.224	***
d34	.253	.139	1.824	.068
d33	1.030	.189	5.460	***

*** indicated significance smaller than .001
*Statistically significant at <.05

Structural Equation Modeling

TAM Model

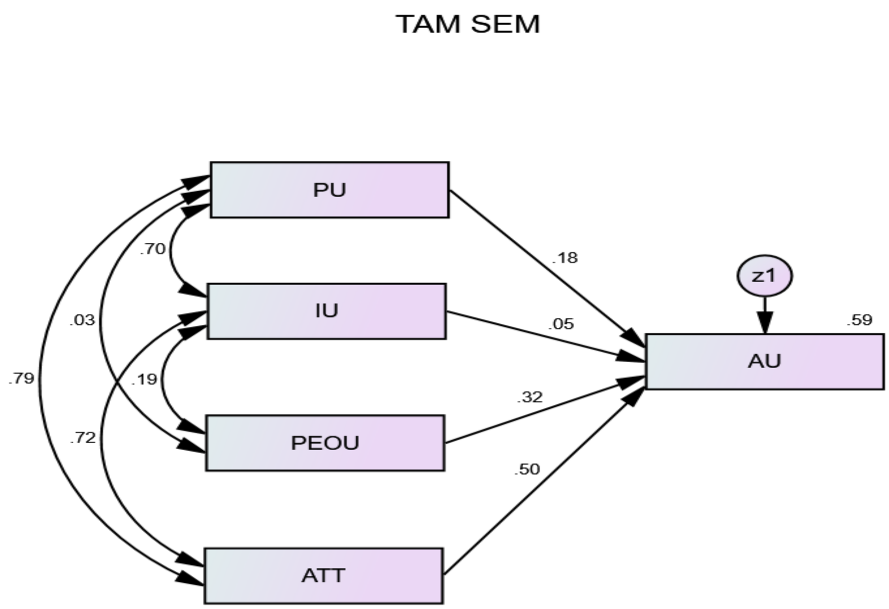


Figure 131: Generic SEM for TAM

Table 183: Regression Weights for Generic TAM SEM

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
PU	.183	.155	.112	1.390	.164
IU	.053	.040	.091	.438	.661
PEOU	.318	.375	.095	3.952	***
ATT	.501	.433	.119	3.630	***

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 184: Correlation and Variances for Generic TAM SEM

Variables	Covariance Estimate	Correlation Estimate	Squared Multiple Correlation Generic	Standard Errors	Critical Ratio (≥±1.96)	p-value
IU-ATT	.907	.723		.185	4.887	***
PU-ATT	.873	.787		.171	5.101	***
PU-IU	.887	.695		.187	4.754	***
IU-PEOU	.172	.188		.080	2.161	.031
PU-PEOU	.024	.029		.061	.393	.694
AU			.594			

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 185: Variances for Generic TAM SEM

Variances	Estimate Generic	Standard Errors	Critical Ratio (≥±1.96)	p-value
PU	1.128	.193	5.834	***
IU	1.443	.243	5.941	***
PEOU	.583	.100	5.831	***
ATT	1.090	.187	5.831	***
Z1	.331	.057	5.831	***

*** indicated significance smaller than .001

*Statistically significant at <.05

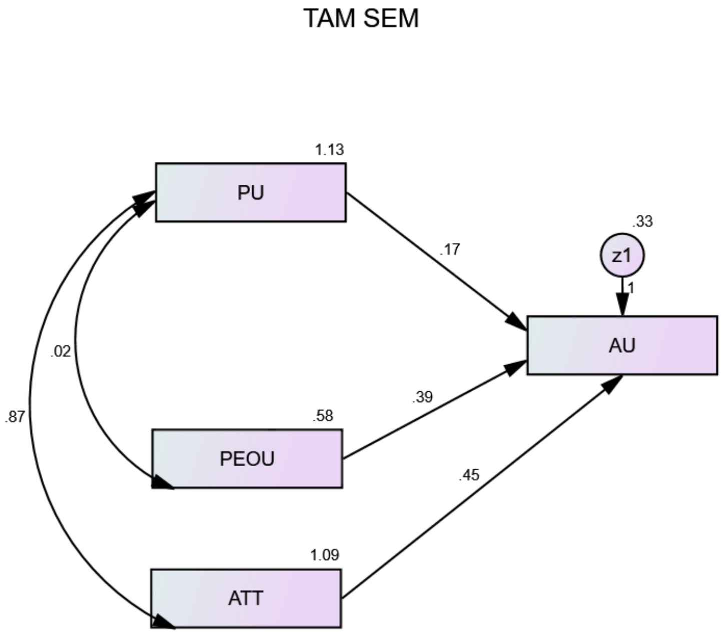


Figure 132: Modified SEM for TAM

Table 186: Regression Weights for Modified TAM SEM

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
PU	.200	.170	.107	1.589	.112
PEOU	.327	.387	.092	4.221	***
ATT	.526	.454	.109	4.187	***

*** indicated significance smaller than .001
*Statistically significant at <.05

Table 187: Correlation and Variances for Modified TAM SEM

Variables	Covariance Estimate	Correlation Estimate	Squared Multiple Correlation Generic	Standard Errors	Critical Ratio (≥±1.96)	p-value
PU-ATT	.873	.787		.171	5.101	***
PU-PEOU	.024	.029		.061	.393	.694
AU			.592			

*** indicated significance smaller than .001
*Statistically significant at <.05

Table 188: Variances for Modified TAM SEM

Variances	Estimate Modified	Standard Errors	Critical Ratio (≥±1.96)	p-value
PU	1.128	.193	5.834	***
PEOU	.583	.100	5.831	***
ATT	1.090	.187	5.831	***
Z1	.332	.057	5.831	***

*** indicated significance smaller than .001

*Statistically significant at <.05

HBM Model

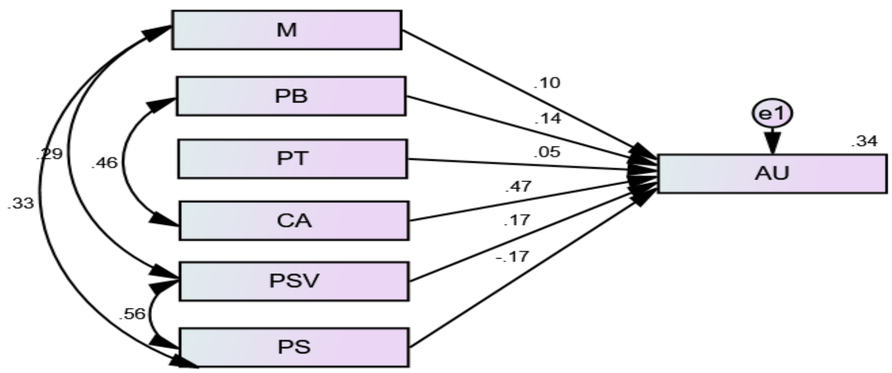


Figure 133: Generic SEM for HBM

Table 189: Regression Weights for Generic HBM SEM

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
M	.101	.083	.087	.958	.338
PB	.137	.127	.103	1.235	.217
PT	.050	.061	.121	.503	.615
CA	.473	.437	.103	4.248	***
PSV	.168	.139	.100	1.396	.163
PS	-.166	-.125	.091	-1.366	.172

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 190: Correlation and Variances for Generic HBM SEM

Variables	Covariance Estimate	Correlation Estimate	Squared Multiple Correlation Generic	Standard Errors	Critical Ratio (≥±1.96)	p-value
PSV-PS	.825	.560		.205	4.027	***
PB-CA	.500	.464		.144	3.473	***
PS-M	.497	.334		.190	2.616	.009
PSV-M	.392	.292		.170	2.308	.021
AU			.339			

*** indicated significance smaller than .001
*Statistically significant at <.05

Table 191: Variances for Generic HBM SEM

Variances	Estimate Generic	Standard Errors	Critical Ratio (≥±1.96)	p-value
PSV	1.332	.229	5.831	***
PS	1.631	.280	5.831	***
PB	1.079	.185	5.831	***
CA	1.073	.184	5.831	***
M	1.355	.232	5.831	***
PT	.613	.105	5.831	***
z1	.605	.104	5.831	***

*** indicated significance smaller than .001
*Statistically significant at <.05

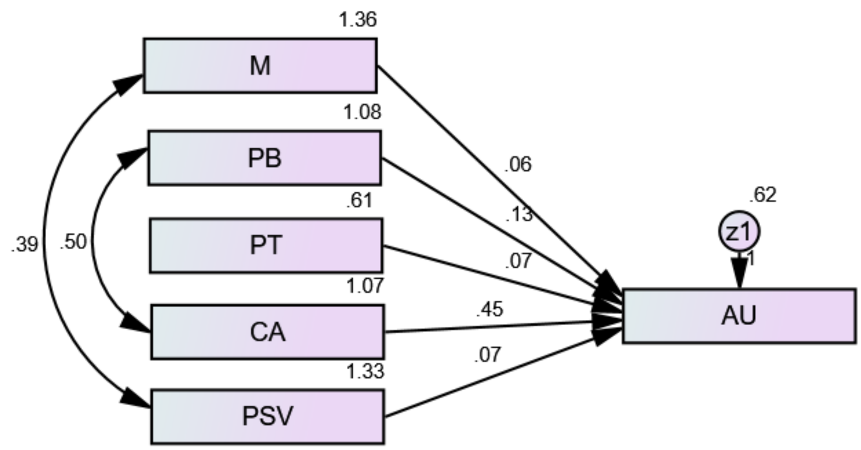


Figure 134: Modified SEM for HBM

Table 192: Regression Weights for Modified HBM SEM

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
M	.069	.057	.086	.666	.505
PB	.138	.128	.104	1.229	.219
PT	.056	.068	.122	.560	.576
CA	.482	.449	.104	4.303	***
PSV	.082	.069	.087	.793	.428

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 193: Correlation and Variances for Modified HBM SEM

Variables	Covariance Estimate	Correlation Estimate	Squared Multiple Correlation Generic	Standard Errors	Critical Ratio (≥±1.96)	p-value
PB-CA	.500	.464		.144	3.473	***
M-PSV	.392	.292		.170	2.308	.021
AU			.331			

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 194: Variances for Modified HBM SEM

Variances	Estimate Modified	Standard Errors	Critical Ratio (≥±1.96)	p-value
PB	1.079	.185	5.831	***
CA	1.073	.184	5.831	***
M	1.355	.232	5.831	***
PSV	1.332	.229	5.831	***
PT	.613	.105	5.831	***
z1	.622	.107	5.831	***

*** indicated significance smaller than .001
*Statistically significant at <.05

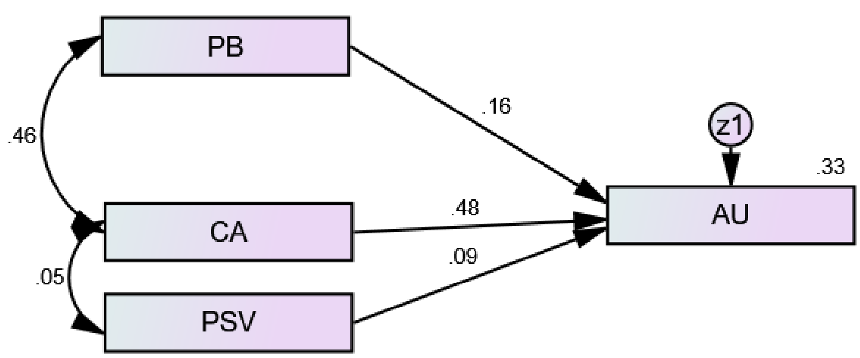


Figure 135: Revised SEM for HBM

Table 195: Regression Weights for Revised HBM SEM

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
PB	.157	.147	.104	1.410	.158
CA	.477	.448	.105	4.270	***
PSV	.095	.080	.083	.957	.338

*** indicated significance smaller than .001
*Statistically significant at <.05

Table 196: Correlation and Variances for Revised HBM SEM

Variables	Covariance Estimate	Correlation Estimate	Squared Multiple Correlation Generic	Standard Errors	Critical Ratio (≥±1.96)	p-value
PB-CA	.494	.460		.143	3.451	***
CA-PSV	.057	.048		.129	.445	.656
AU			.334			

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 197: Variances for Revised HBM SEM

Variances	Estimate Revised	Standard Errors	Critical Ratio (≥±1.96)	p-value
PB	1.079	.185	5.831	***
CA	1.068	.183	5.834	***
PSV	1.332	.229	5.831	***
z1	.627	.108	5.831	***

*** indicated significance smaller than .001

*Statistically significant at <.05

Hypothesized Integrated TAM/HBM Model

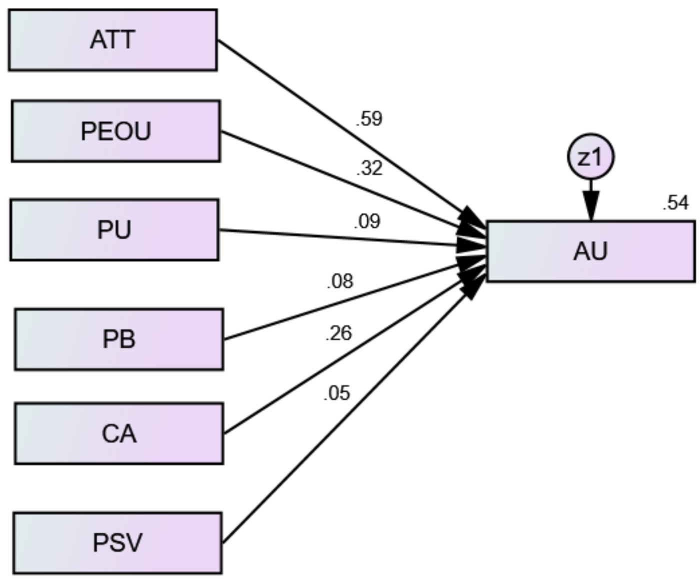


Figure 136: Generic SEM for TAM/HBM (Hypothesized)

Table 198: Regression Weights for Generic TAM/HBM (Hypothesized) SEM

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
ATT	.593	.448	.062	7.210	***
PEOU	.318	.329	.085	3.867	***
PU	.095	.070	.061	1.155	.248
PB	.078	.060	.063	.953	.341
CA	.265	.202	.063	3.223	.001
PSV	.047	.032	.056	.572	.567

*** indicated significance smaller than .001
*Statistically significant at <.05

Table 199: Correlation and Variances for Generic TAM/HBM (Hypothesized) SEM

Variables	Covariance Estimate	Correlation Estimate	Squared Multiple Correlation Generic	Standard Errors	Critical Ratio (≥±1.96)	p-value
AU			.540			

*** indicated significance smaller than .001
*Statistically significant at <.05

Table 200: Variances for Generic TAM/HBM (Hypothesized) SEM

Variances	Estimate Generic	Standard Errors	Critical Ratio (≥±1.96)	p-value
ATT	1.090	.187	5.831	***
PEOU	.583	.100	5.831	***
PU	1.147	.197	5.831	***
PB	1.079	.185	5.831	***
CA	1.073	.184	5.831	***
PSV	1.332	.229	5.831	***
z1	.287	.049	5.831	***

*** indicated significance smaller than .001

*Statistically significant at <.05

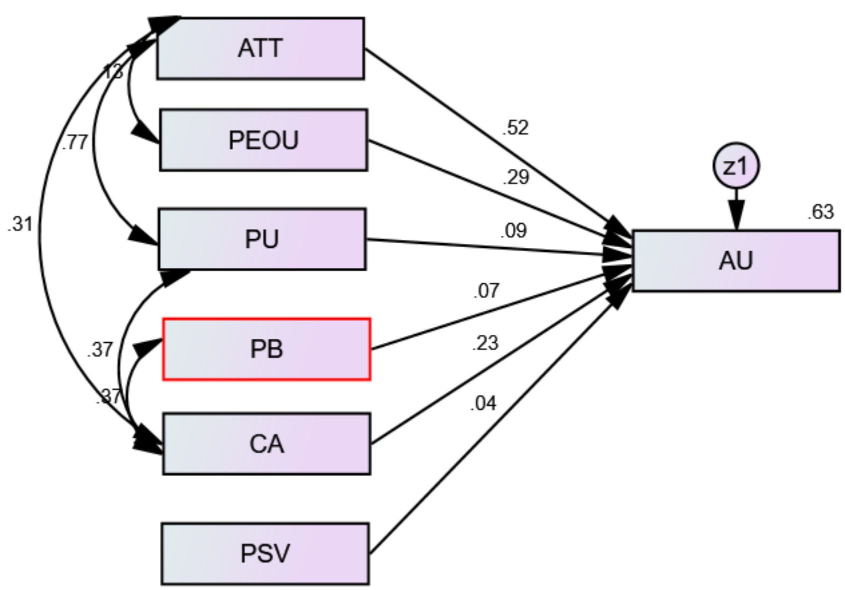


Figure 137: Modified TAM/HBM (Hypothesized) SEM

Table 201: Regression Weights for Modified TAM/HBM (Hypothesized) SEM

Indicators	Standardized Regression Weights	Unstandardized Regression Coefficient	Standard Errors	Critical Ratio (≥±1.96)	p-value
ATT	.518	.448	.104	4.313	***
PEOU	.287	.329	.087	3.780	***
PU	.086	.070	.100	.700	.484
PB	.071	.060	.068	.872	.383
CA	.230	.202	.077	2.628	.009
PSV	.042	.032	.056	.572	.567

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 202: Correlation and Variances for Modified TAM/HBM (Hypothesized) SEM

Variables	Covariance Estimate	Correlation Estimate	Squared Multiple Correlation Generic	Standard Errors	Critical Ratio (≥±1.96)	p-value
ATT-PU	.839	.775		.165	5.078	***
ATT-PEOU	.103	.133		.060	1.698	.089
ATT-CA	.313	.311		.119	2.643	.008
PU-CA	.399	.374		.129	3.084	.002
PB-CA	.386	.373		.125	3.078	.002
AU			.626			

*** indicated significance smaller than .001

*Statistically significant at <.05

Table 203: Variances for Modified TAM/HBM (Hypothesized) SEM

Variances	Estimate Modified	Standard Errors	Critical Ratio (≥±1.96)	p-value
ATT	1.022	.173	5.894	***
PEOU	.583	.100	5.831	***
PU	1.147	.197	5.831	***
PB	1.079	.185	5.831	***
CA	.991	.167	5.949	***
PSV	1.332	.229	5.831	***
z1	.287	.049	5.831	***

*** indicated significance smaller than .001

*Statistically significant at <.05

69-Participant Cohort Results

Table 204: Demographic Data for 69 Participant Cohort

	n	Mean Age (yrs.)	Age Range (yrs.)	Gender n (%)		Mean Experience (yrs.)	Experience Range	Experience with Rash Illness n (%)	
				Female	Male			Yes	No
Formal	69	43.7	24-69	52 (75)	17 (25)	15.7	1-45	47 (68)	22 (32)

Table 205: Competency Level for 69 Participant Cohort

Competency Level of using an ITS, managing a patient with rash illness, packing, and shipping clinical specimens for rash illness

n=69	Novice n (%)	Beginner n (%)	Competent n (%)	Proficient n (%)	Expert n (%)
ITS	45 (65.2)	15 (21.7)	6 (8.7)	3 (4.3)	0
Pt Rash	19 (27.5)	9 (13)	19 (27.5)	19 (27.5)	3 (4.3)
Pack/Ship	25 (36.2)	17 (24.6)	19 (27.5)	6 (8.7)	2 (2.9)

Table 206: Comparison Analysis for 69-Participant Cohort

Comparison-Time would have been better spent with Internet search, Knowledgeable Mentor or Class Discussion Group rather than ITS

		Internet Search n (%)	**Mentor n (%)**	**Class Discussion n (%)**
Study	**Yes**	11(15.9)	25 (36.2)	18 (26.1)
n=69	**No**	58 (84.1)	44 (63.8)	51 (73.9)

Table 207: Learner Attributes for 69 Participant Cohort

Learner Attributes							
N=69	Extremely Unconfident n (%)	Unconfident n (%)	Slightly unconfident n (%)	Neither n (%)	Slightly Confident n (%)	Confident n (%)	Extremely Confident n (%)
LA8 (Prior Knowledge, Grit): Knowledge about content	9 (13)	10 (14.5)	5 (7.2)	5 (7.2)	15 (21.7)	22 (33.3)	2 (2.9)
LA9 (Prior Knowledge, Grit): Patient walked into facility could order the correct labs based on clinically and epidemiological evidence	11 (15.9)	10 (14.5)	6 (8.7)	5 (7.2)	17 (24.6)	18 (26.1)	2 (2.9)
LA10 (Grit, Motivation): Willingness to learn about content on an ITS platform	2 (2.9)	2 (2.9)	2 (2.9)	4 (5.8)	7 (10.1)	35 (50.7)	17 (24.6)
LA11 (Grit, Motivation): Complete the entire course on the ITS format.	0	1 (1.4)	2 (2.9)	6 (8.7)	10 (14.5)	31 (44.9)	19 (27.5)
LA12 (Motivation): Return to this learning platform for a refresher course if you find it useful	1 (1.4)	1 (1.4)	2 (2.9)	15 (21.7)	15 (21.7)	24 (34.8)	11 (15.9)

Table 208: Assessment Statistics for the 69-Participant Cohort

Assessment Statistics

	Pre-Test	Post Test
n	69	69
Mean	6.88	8.74
Std. Deviation	2.004	1.686
Std. Error of Mean	0.241	0.203
Minimum	2	2
Maximum	10	10
25th Percentiles	6	8
50th Percentiles	7	9
75th Percentiles	8	10

Paired Samples Correlation	
Correlation	0.518
Sig.	0

Paired Samples Test	
Mean	-1.855
Std. Deviation	1.833
Std. Error of Mean	0.221
95% CI Lower	-2.295
95% CI Upper	-1.415
t	-8.8405
df	68
Sig. (2-tailed)	0

Wilcoxon Signed Ranks Test		**N**	**Mean Ranks**	**Sum of Ranks**
Negative Ranks (Post < Pre)		6	11.67	70
Positive Ranks (Post > Pre)		51	31.04	1583
Ties (Post =Pre)		12		
Z test statistic	-6.054			
Sig. (2-tailed)	0			

Table 209: Scoring Assessments for 69-Participant Cohort

Scoring of Assessments					
Points	**Pre-Test n (%)**	**Post Test n (%)**	**Change in Points n (%)**	**% Change from Pre to Post**	**Scenario n (%)**
-2	N/A	N/A	1 (1)		
-1	N/A	N/A	5 (7)		
0	0	0	12 (17)	0	17 (25)
1	0	0	12 (17)	0	52 (75)
2	1 (1)	0	14 (20)	-100%	
3	2 (3)	2 (3)	13 (19)	0%	
4	9 13)	2 (3)	7 (10)	-78%	
5	4 (6)	0	3 (4)	-100%	
6	10 (14)	1 (1)	1 (1)	-90%	
7	15 (22)	6 (9)	1 (1)	-60%	
8	14 (20)	12 (17)	0	-14%	
9	6 (9)	15 (22)	0	150%	
10	8 (12)	31 (45)	0	288%	

Table 210: TAM Survey Responses for Perceived Usefulness for Cohort

PU							
	PU1	**PU2**	**PU3**	**PU4**	**PU5**	**PU6**	**PU7**
Extremely Disagree	1	0	1	0	0	0	1
Disagree	2	1	1	2	2	2	5
Slightly Disagree	3	2	8	0	2	4	3
Neither disagree or agree	11	12	11	13	17	5	19
Slightly Agree	20	18	16	18	11	20	15
Agree	27	29	27	29	30	29	21
Extremely Agree	5	7	5	7	7	9	5
No Response							

Table 211: TAM Survey Responses for Perceived Ease of Use for Cohort

PEOU							
	PEOU1	PEOU2	PEOU3	PEOU4	PEOU5	PEOU6	PEOU7
Extremely Disagree	0	1	0	1	0	0	0
Disagree	0	0	1	2	0	0	1
Slightly Disagree	0	1	0	5	0	1	1
Neither disagree or agree	3	8	2	7	6	2	12
Slightly Agree	1	6	6	8	6	3	6
Agree	32	26	31	30	33	32	28
Extremely Agree	33	26	29	15	24	30	21
No Response		1		1		1	

Table 212: TAM Survey Responses for Intention to Use for Cohort

Intention to Use					
	IU1	IU2	IU3	IU4	IU5
Extremely Disagree	1	0	0	3	4
Disagree	2	5	4	7	9
Slightly Disagree	2	5	5	8	10
Neither disagree or agree	18	23	11	27	25
Slightly Agree	14	12	16	6	6
Agree	24	17	23	13	11
Extremely Agree	7	7	10	5	4
No Response	1				

Table 213: TAM Survey Responses for Attitude for Cohort

Attitude			
	ATT1	ATT2	ATT3
Extremely Disagree	0	0	0
Disagree	1	2	4
Slightly Disagree	0	2	1
Neither disagree or agree	5	6	7
Slightly Agree	10	8	11
Agree	32	34	34
Extremely Agree	21	17	12
No Reponses			

Table 214: HBM Survey Responses for Perceived Susceptibility for Cohort

Perceived Susceptibility					
	PS1	PS2	PS3	PS4	PS5
Extremely Unlikely	22	1	1	22	3
Unlikely	26	0	0	29	5
Slightly Unlikely	6	8	10	5	5
Neither	4	3	14	7	3
Slightly Likely	8	16	12	4	18
Likely	3	24	21	2	22
Extremely Likely	0	17	11	0	13
No Response					

Table 215: HBM Survey Responses for Perceived Severity for Cohort

Perceived Severity					
	PSV1	PSV2	PSV3	PSV4	PSV5
Extremely Unlikely	7	10	1	3	1
Unlikely	22	29	3	14	13
Slightly Unlikely	10	10	13	14	14
Neither	9	7	13	16	14
Slightly Likely	11	8	27	18	19
Likely	6	4	10	2	8
Extremely Likely	4	1	1	1	
No Response			1	1	

Table 216: HBM Survey Responses for Perceived Threat for Cohort

Perceived Threats								
	PT1	PT2	PT3	PT4	PT5	PT6	PT7	PT8
Extremely Disagree	39	26	26	24	35	24	23	1
Disagree	18	17	20	30	25	25	24	11
Slightly Disagree	5	5	11	6	3	9	9	6
Neither disagree or agree	2	5	3	6	3	2	4	4
Slightly Agree	0	5	3	0	0	4	5	17
Agree	2	3	2	0	0	2	1	17
Extremely Agree	0	5	1	0	0	0	0	10
No Response	3	3	3	3	3	3	3	3

Table 217: HBM Survey Responses for Perceived Benefits for Cohort

Perceived Benefits						
	PB1	PB2	PB3	PB4	PB5	PB6
Extremely Disagree	0	0	1	6	1	1
Disagree	0	0	11	14	0	0
Slightly Disagree	0	0	3	1	1	0
Neither disagree or agree	0	1	9	18	7	6
Slightly Agree	0	0	9	5	8	7
Agree	12	10	22	13	31	31
Extremely Agree	54	55	11	9	18	21
No Reponses	3	3	3	3	3	3

Table 218: HBM Survey Responses for Cues to Action for Cohort

Cue to Action				
	CA1	CA2	CA3	CA4
Extremely Disagree	3	1	1	1
Disagree	3	1	3	1
Slightly Disagree	0	0	1	1
Neither disagree or agree	6	10	7	7
Slightly Agree	9	17	12	14
Agree	26	23	26	33
Extremely Agree	19	14	16	9
No Response	3	3	3	3

Table 219: HBM Survey Responses for Motivations for Cohort

Motivations						
	M1	M2	M3	M4	M5	M6
Extremely Disagree	2	0	1	1	0	1
Disagree	12	1	0	2	4	5
Slightly Disagree	4	5	0	2	1	1
Neither disagree or agree	8	3	4	7	6	5
Slightly Agree	10	7	9	9	7	6
Agree	18	29	36	32	34	36
Extremely Agree	12	20	16	13	14	12
No Reponses	3	4	3	3	3	3

Table 220: HBM Survey Responses for Actual Use for Cohort

Actual Use				
	AU1	**AU2**	**AU3**	**AU4**
Extremely Disagree	0	0	0	2
Disagree	4	3	1	5
Slightly Disagree	0	1	1	4
Neither disagree or agree	6	5	6	24
Slightly Agree	14	13	12	16
Agree	32	34	35	11
Extremely Agree	10	10	11	4
No Response	3	3	3	3

Table 221: Technology Acceptance Model Response Scale

1	2	3	4	5	6	7
Extremely Disagree	Disagree	Slightly Disagree	Neither disagree or agree	Slightly Agree	Agree	Extremely Agree

Table 222: Health Belief Model Response Scale

1	2	3	4	5	6	7
Extremely Unlikely	Unlikely	Slightly Unlikely	Neither	Slightly Likely	Likely	Extremely Likely

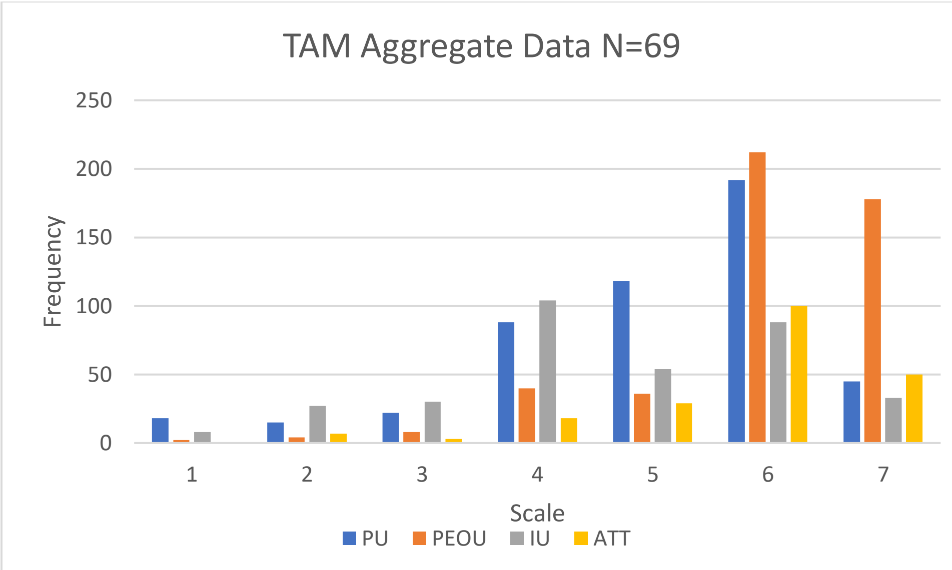


Figure 138: TAM Aggregate Data for 69-Participant Cohort

Table 223: Aggregate Data for Cohort-TAM Concepts

Scale	PU	PEOU	IU	ATT	AU
1	18	2	8	0	2
2	15	4	27	7	13
3	22	8	30	3	6
4	88	40	104	18	41
5	118	36	54	29	55
6	192	212	88	100	112
7	45	178	33	50	35
No response		3	1		12

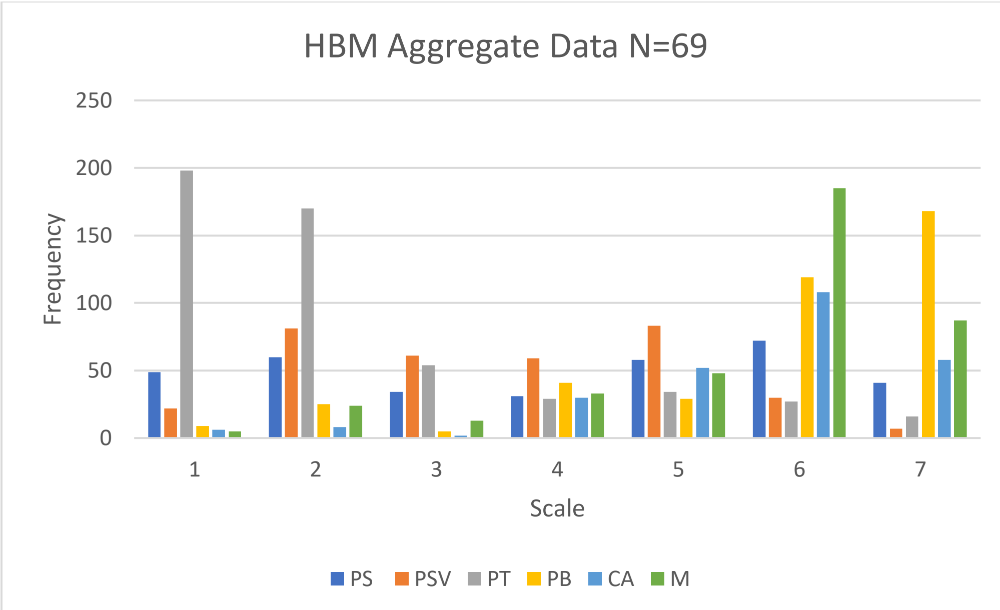


Figure 139: HBM Aggregate Data 69 Participant Cohort

Table 224: Aggregate Data for Cohort HBM Concepts

Scale	PS	PSV	PT	PB	CA	M	AU
1	49	22	198	9	6	5	2
2	60	81	170	25	8	24	13
3	34	61	54	5	2	13	6
4	31	59	29	41	30	33	41
5	58	83	34	29	52	48	55
6	72	30	27	119	108	185	112
7	41	7	16	168	58	87	35
No response		2	24	18	12	19	12

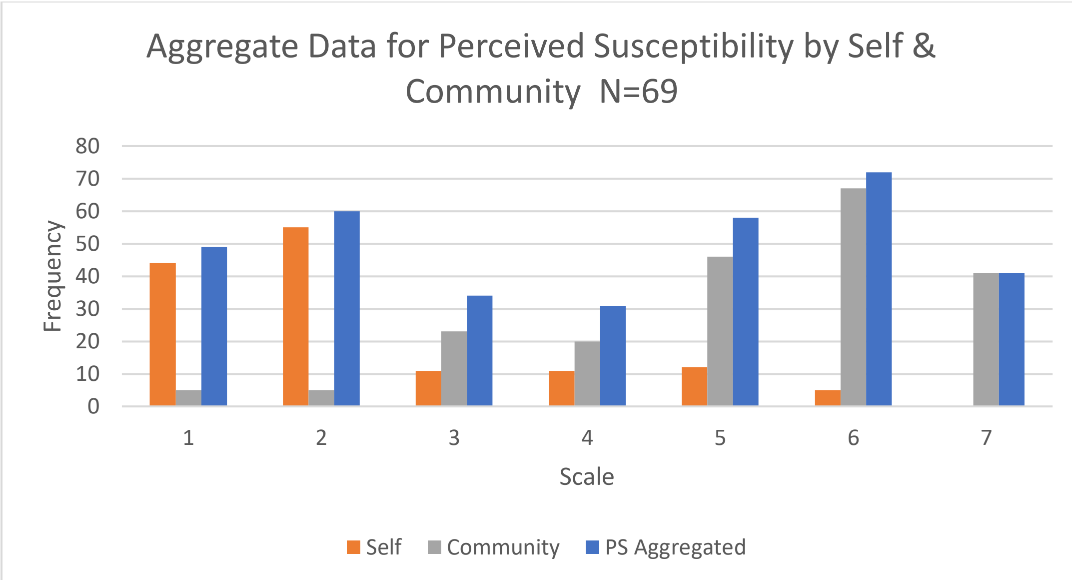


Figure 140: Aggregate Data for Perceived Susceptibility Self & Community

Table 225: Aggregate Data for PS Self & Community

Scale	PS Aggregated	Self	Community
1	49	44	5
2	60	55	5
3	34	11	23
4	31	11	20
5	58	12	46
6	72	5	67
7	41	0	41

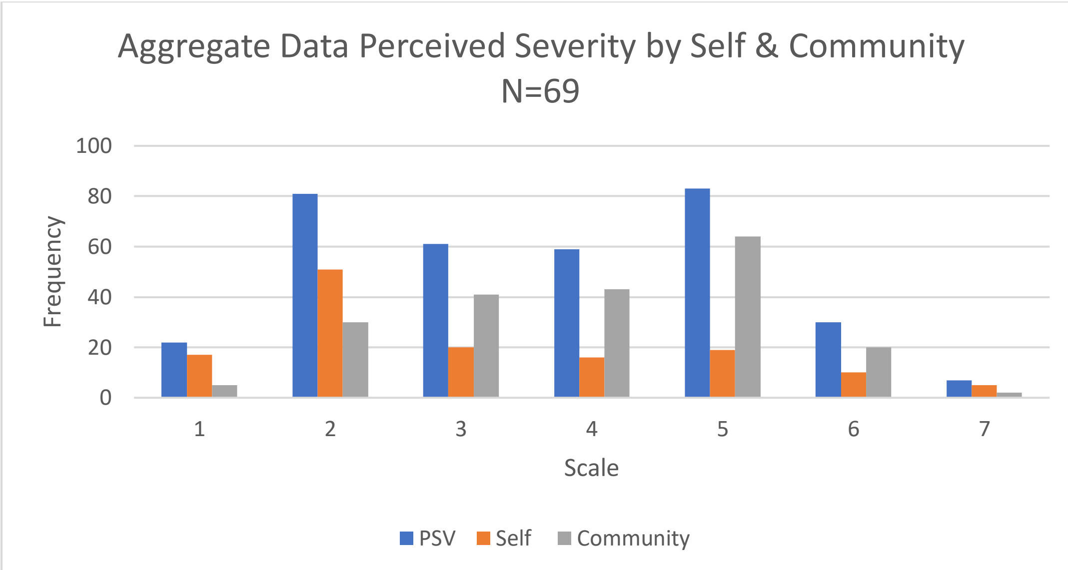


Figure 141: Aggregate Data for Perceived Severity Self & Community

Table 226: Aggregate Data for Perceived Severity Self & Community

Scale	PSV	Self	Community
1	22	17	5
2	81	51	30
3	61	20	41
4	59	16	43
5	83	19	64
6	30	10	20
7	7	5	2
No Response	2	0	2

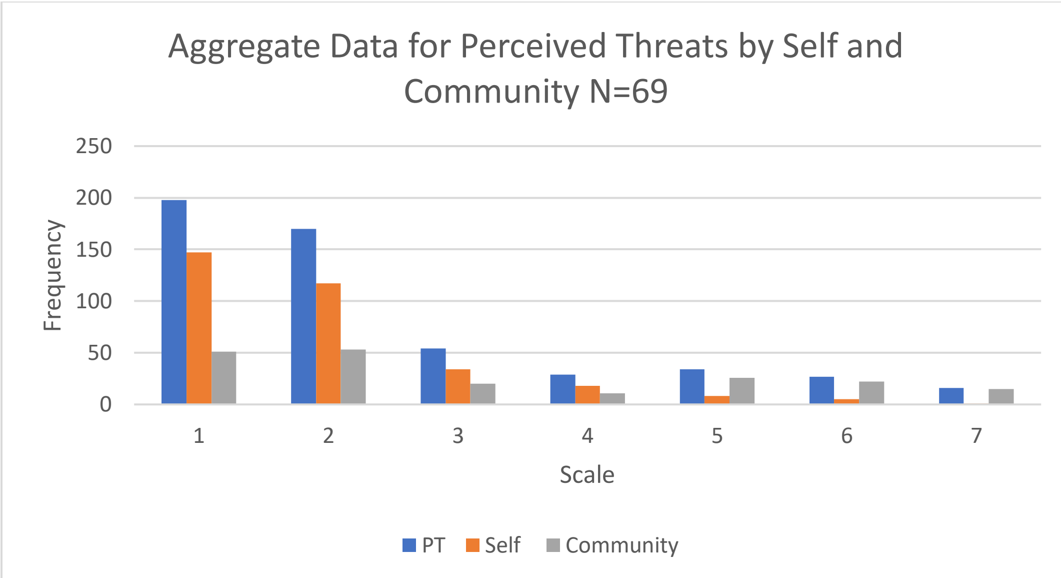


Figure 142: Aggregate Data for Perceived Threats Self & Community

Table 227: Aggregate Data for Perceived Threats Self & Community

Scale	PT	Self	Community
1	198	147	51
2	170	117	53
3	54	34	20
4	29	18	11
5	34	8	26
6	27	5	22
7	16	1	15
No Response	24	15	9

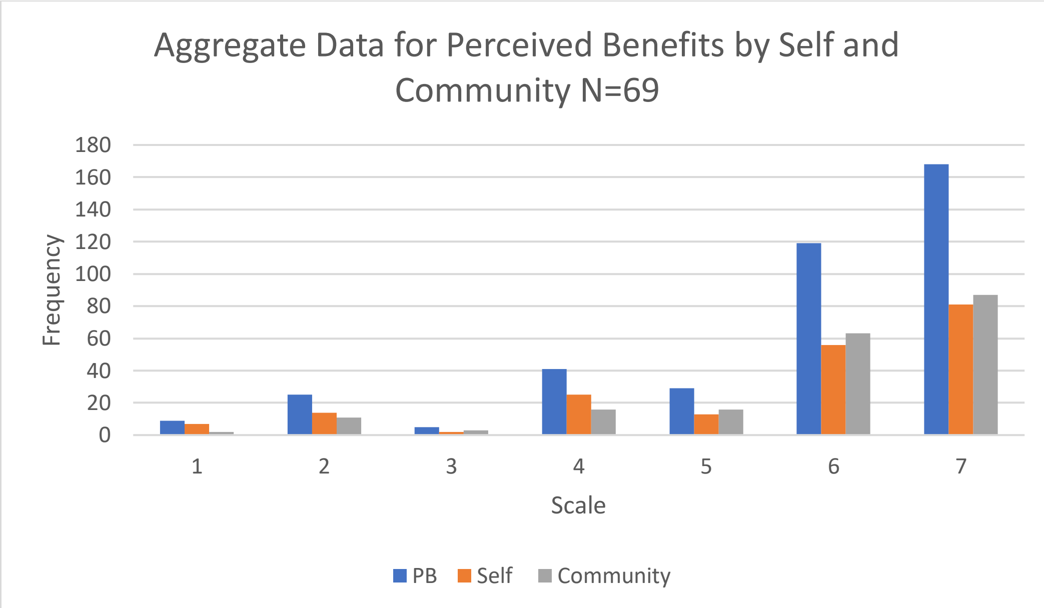


Figure 143: Aggregate Data for Perceived Benefits Self & Community

Table 228: Aggregate Data for Perceived Benefits Self & Community

Scale	PB	Self	Community
1	9	7	2
2	25	14	11
3	5	2	3
4	41	25	16
5	29	13	16
6	119	56	63
7	168	81	87
No Response	18	9	9

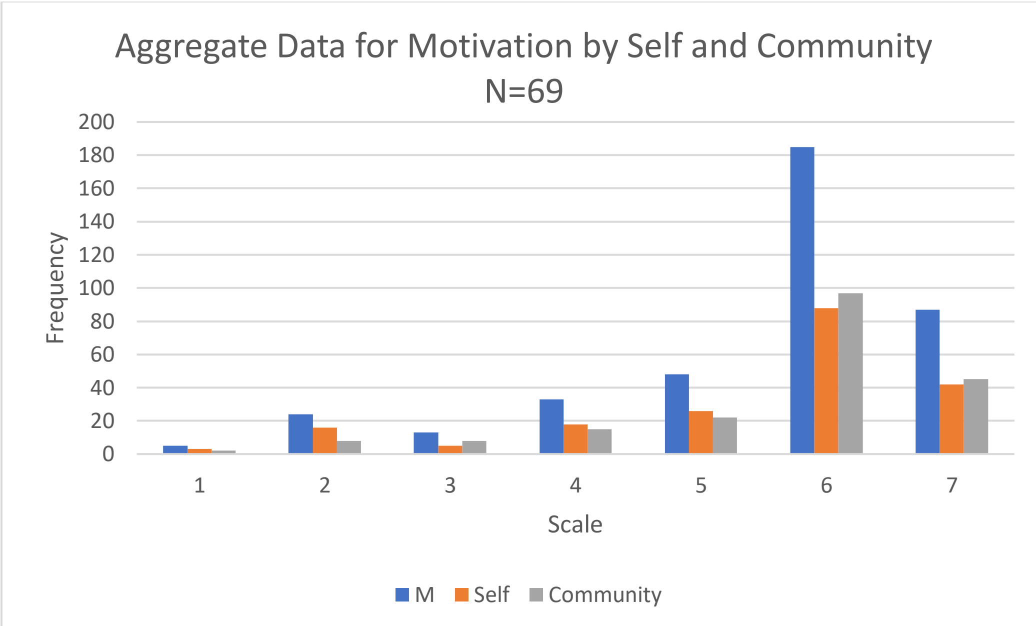


Figure 144: Aggregate Data for Motivations Self & Community

Table 229: Aggregate Data for Motivations Self & Community

Scale	M	Self	Community
1	5	3	2
2	24	16	8
3	13	5	8
4	33	18	15
5	48	26	22
6	185	88	97
7	87	42	45
No Response	19	9	10

Table 230: One-Sample Wilcoxon Signed Rank Test TAM Concepts N=69

Model Concepts	Indicators	Label	α=0.05	Null H	β=0.4	Null H
Attitude						
	Good idea to Use	Att1	p<0.01	Reject	p<0.01	Reject
	I like the idea to Use	Att2	p<0.01	Reject	p<0.01	Reject
	Using it is a pleasant experience.	Att3	p<0.01	Reject	p<0.01	Reject
Perceived Ease of Use						
	Easy to Operate	PEOU1	p<0.01	Reject	p<0.01	Reject
	Easy to do what I want it to do.	PEOU2	p<0.01	Reject	p<0.01	Reject
	Interaction was clear and understandable	PEOU3	p<0.01	Reject	p<0.01	Reject
	Flexible to interact with.	PEOU4	p<0.01	Reject	p<0.01	Reject
	Easy to become skillful at using	PEOU5	p<0.01	Reject	p<0.01	Reject
	Overall, easy to use	PEOU6	p<0.01	Reject	p<0.01	Reject
	Over the last 12 months, easy to use.	PEOU7	p<0.01	Reject	p<0.01	Reject
Perceived Usefulness						
	Enable to accomplish tasks more quickly.	PU1	p<0.01	Reject	p<0.01	Reject
	Improve my job performance	PU2	p<0.01	Reject	p<0.01	Reject
	Increase productivity.	PU3	p<0.01	Reject	p<0.01	Reject
	Enhances effectiveness on the job	PU4	p<0.01	Reject	p<0.01	Reject
	Easier to do my job.	PU5	p<0.01	Reject	p<0.01	Reject
	Overall, useful in my job.	PU6	p<0.01	Reject	p<0.01	Reject
	Over the last 12 months, useful in job.	PU7	p<0.01	Reject	p<0.01	Reject
Intention for Use						
	Intend to use it for training.	IU1	p<0.01	Reject	p<0.01	Reject
	Predict will use it for training.	IU2	p<0.01	Reject	p<0.01	Reject
	Expect to use it.	IU3	p<0.01	Reject	p<0.01	Reject
	Over the next 3 months, expect to use	IU4	p=0.183	Retain	p=0.183	Reject
	Over the next 3 months, intend to use	IU5	p=0.91	Retain	p=0.91	Retain

Table 231: One-Sample Wilcoxon Signed Rank Test HBM Concepts N=69

Model Concepts	Indicators	Label	α=0.05	Null H	β=0.4	Null H
Perceived Susceptibility	Chances of getting a febrile rash illness	PS1	p<0.01	Reject	p<0.01	Reject
	Chance of community febrile rash illness outbreak in the future	PS2	p<0.01	Reject	p<0.01	Reject
	Likelihood community exposure to an outbreak	PS3	p<0.01	Reject	p<0.01	Reject
	Over last 12 months, myself susceptible to a febrile rash-like illness.	PS4	p<0.01	Reject	p<0.01	Reject
	Over last 12 months, community susceptible to rash illness outbreak	PS5	p<0.01	Reject	p<0.01	Reject
Perceived Severity	Over the last 12 months, severity of infection	PSV1	p=0.007	Reject	p=0.007	Reject
	Over the last 12 months, experience long term problems from infection	PSV2	p<0.01	Reject	p<0.01	Reject
	Severity of the illness on community	PSV3	p=0.007	Reject	p=0.007	Reject
	Community experience long term problems from that outbreak	PSV4	p=0.014	Reject	p=0.14	Reject
	Over the last 12 months, community severity of outbreak	PSV5	p=0.41	Retain	p=0.41	Retain
Perceived Threat	Over the last 12 months, afraid for myself to have the lab testing done	PT1	p<0.01	Reject	p<0.01	Reject
	Over the last 12 months, be afraid to perform lab testing for community	PT2	p<0.01	Reject	p<0.01	Reject
	I do not know the accurate lab tests required for febrile rash illness.	PT3	p<0.01	Reject	p<0.01	Reject
	The laboratory tests required for febrile rash illnesses are not reliable.	PT4	p<0.01	Reject	p<0.01	Reject
	Preventing rash illness is next to impossible for myself	PT5	p<0.01	Reject	p<0.01	Reject
	Preventing rash illness is next to impossible for the community	PT6	p<0.01	Reject	p<0.01	Reject
	Over the last 12 months, threat to myself to be infected	PT7	p<0.01	Reject	p<0.01	Reject
	Over the last 12 months, threat to my community to be infected	PT8	p=0.002	Reject	p=0.002	Reject
Perceived Benefits	Important to know how to stay healthy.	PB1	p<0.01	Reject	p<0.01	Reject
	Important that my community knows how to stay healthy	PB2	p<0.01	Reject	p<0.01	Reject
	Understanding content decreases chances of exposure for community	PB3	p<0.01	Reject	p<0.01	Reject
	Understanding content decreases chances of exposure for myself	PB4	p=0.538	Retain	p=0.538	Retain
	Over the last 12 months, training myself will be a benefit to me	PB5	p<0.01	Reject	p<0.01	Reject
	Over the last 12 months, training myself benefits my community	PB6	p<0.01	Reject	p<0.01	Reject
Cue to Action	Gaining more knowledge on a topic would improve confidence	CA1	p<0.01	Reject	p<0.01	Reject
	Learning about technology from others influences my use of it.	CA2	p<0.01	Reject	p<0.01	Reject
	Learning in a self-paced environment influences my use of technology.	CA3	p<0.01	Reject	p<0.01	Reject
	Communication from colleagues about technology influences my use.	CA4	p<0.01	Reject	p<0.01	Reject
	General concern about my health.	M1	p=0.004	Reject	p=0.004	Reject
Motivations	General concern for health of community	M2	p<0.01	Reject	p<0.01	Reject
	Frequently do things to improve health	M3	p<0.01	Reject	p<0.01	Reject
	Frequently do things to improve health of community	M4	p<0.01	Reject	p<0.01	Reject
	Search for new information related to health	M5	p<0.01	Reject	p<0.01	Reject
	Search for new information related to keeping community healthy	M6	p<0.01	Reject	p<0.01	Reject

Free Text Responses

Responses to Free Text Question at the end of the TAM Survey

What changes would have to be made for this technology (intelligent tutor) to be useful for the type of work that you do? 154593

- simply a change in the subject matter
- It would be nice to know the date at which the information presented on the slide was relevant. What will happen if/when new diagnostic tests are introduced?
- Showing correct responses for those missed on the post test.
- Any of the modules/learning sessions may need to be created and/or changed according to the reason for the public health event.
- This is not what I do for a living, but it was an interesting experience
- Made the charts of laboratory test information into PDFs that can be downloaded and saved as references
- I'm not sure how this is different than watching a YouTube video. Is it the questions that make it ITS? If yes, it would have been helpful to know the correct answers for the questions I got wrong.
- Felt just like watching YouTube videos and answering questions. In these events, better to have suggested materials or ways to ensure providers have what they need. We are working to make toolkits and 1-pagers available for providers and response staff. These types of materials are more helpful than 20+ minute trainings.
- A more engaging speaker. This speaker was very bland and boring.
- More comprehensive and up-to-date information regarding measles laboratory testing. Nothing was mentioned at all about PCR testing for measles, which is the primary method we have been using for a while for measles case confirmation. I did appreciate, however, how the results of the quizzes and answers were given right afterwards.
- Clearly it has platform issues that are not worth the time. I wound up doing it at night at home on my windows computer and I need to get to sleep!
- change in topic. This would be great for training on opioid or drug overdose
- Rash pictures in questions or with interactive figures
- I already knew pretty much all the material covered here, so hard to say that the tutor was useful in this case. Some critique:1. "enanthema," "maculopapular," "vesicular" were mispronounced.2. Measles testing should mention PCR; see wwwn.cdc.gov/nndss/conditions/measles/case-definition/20133. One slide had "affects on the CNS"; should be "effects."4. "Virus isolation can be done with 3 types of lab tests: DFA, PCR, or tissue culture." These are certainly all methods of virus DETECTION, but of the 3, only tissue culture accomplishes virus ISOLATION.
- Some questions had multiple correct or multiple incorrect answers. (Maybe this varies by state guidance?)
- The ability to view the slide material without the video.
- back button at the beginning

- this method would be very helpful in general education projects
- Access to a glossary of terms and definitions.
- The videos were fairly lengthy for a remedial review and could use some editing to just cover topics that were identified after the pretest.
- I found your course content at times to be confusing - for e.g. in the varicella video on slide at about 6:35 (2nd "paragraph") you are talking about testing for varicella with IgG assays - all good. but then in the same paragraph you mention IgM ("may be performed on unimmunized people or persons with questionable immunity" This is confusing to mention IgM assays when discussing immune status determination as IgM would not be appropriate for determining immunity.
- Having a printout of results, especially information on stuff you got incorrect.
- More case scenarios
- Measles section was misleading and ignored PCR and importance of collecting swabs, not just serum. That was such a frustrating omission that it soured the whole experience.
- The only concern would be having to go through the entire tutorial to find an answer if I were just looking for one piece of information. A lot was contained in the videos, which were great, but they could be difficult to browse through.
- I thought it was pretty good. My only suggestion would have been to identify the amount of time needed to take the class.... somewhere in the lesson, as it kinda got buried in the email. I would have broken them out into "modules" so you could have the option of just taking the measles one or the chickenpox one or both.
- Need to be able to stop in the middle of the class and resume at a later time.
- Length of time for ITS system training may be prohibitive in real-life scenario.
- The video portion needs to be condensed, the speaker needs to be faster, and slides need to be more concise
- The info on the slides was very relevant for the epi work I do
- Recommend ensuring system is interoperable across platforms (e.g. mobile devices)
- I think this type of training is most useful for refresher training, but not necessarily the most efficient way to train during a surge event. Something shorter and quicker would be more practical.

Responses to Free Text Question at the end of the Comparison Survey

Free Text: Optional: Provide any comments or clarification for the answers you provided above. 154594

- clarification on 9 and 11: I forgot to press the play button on the varicella video/PPT, and I recognized that when I went forward- and saw that it was the post-test- I was not able to go back to watch the presentation. (no back button in the training that I saw and using the browser back button (Chrome) would not take me to the preceding screen. I know that one of the instructions in the very beginning was to watch the video, but for dummies like me, perhaps another mention when the measles section was introduced? Or, set the training up so that the learner could not proceed to the post test screen? clarification on # 18 and # 19 - just recently retired (10 months) so I don't think I will have the opportunity to use this system in the next 3 months.

- I do not know if I will use this type of system in the future as this is the first exposure, I have had to it.
- The first series of questions left me thinking that actual technicians or nurses would be using this while (or right before) doing an assessment. That struck me as odd and hence the slightly agree responses. If intended as training, then you have my apology.
- I think a dropdown menu would prove useful
- The Control of Communicable Disease Manual was always kept with me (initially the book, later the app on my smartphone and is a much better resource. Knowing how to get the information when needed is much better. Granted this would be great during an actual outbreak of varicella or chicken pox but it could easily be a YouTube that is not computer specific (unless it was confidential which in an outbreak it would not be. ALSO, and very very important you did not discuss ISOLATION and PERSONAL PROTECTION. Everyone evaluating rashes MUST be vaccinated for all of the known pathogens AND negative pressure rooms, masks etc. may still be necessary since immunity can wane or this could be a mutation. Thanks.
- I have several training platforms available to me that I am more likely to use, but this one is nice.
- Might be useful for topics with which I was less familiar.
- Good tool, too many questions made it slightly confusing. Tool may be for useful as separate Varicella and Measles courses.
- Again I found your course content somewhat confusing and at times at odds with established expert sources such as CDC VPD surveillance manual, varicella chapter (https://www.cdc.gov/vaccines/pubs/surv-manual/chpt17-varicella.html#laboratory) and CDC national VZV laboratory information (https://www.cdc.gov/chickenpox/lab-testing/cdc-vzv-lab.html) With respect to measles, you seem to emphasize IgM serology for confirmation but have less emphasis on the equal (if not greater) importance of obtaining a throat (or other respiratory swab) for measles PCR
- Easy to use and understand. Like the summary at the end. Would like a checklist or quick tips which I can print and use as a job aid.
- This system might be useful for diseases I don't know much about yet.
- Most of them were in the middle to slight. Not that the class was great and easy to use, it’s just depending on the job and the time I have available, what comes up in public health, whether there is a class for that problem, etc. I would use it if it was available and timely.
- I thought the content, though valuable was geared more towards recognizing individual cases, so it was a good refresher to those working in a clinical setting but it wasn't as helpful for surge capacity purposes (e.g. what is my role in reporting, how to properly package and ship samples for testing) during a massive outbreak.
- I'm retired, which is why I wouldn't use an IT in the future.
- I dislike video as a means of education. Reading a few slides with bullet points is faster.

- My current work does not involve diagnosis or investigation of infectious diseases. Therefore, I don't anticipate using this in the next 3 months but may use it later on.
- Here in Washington State, serum is NOT the preferred diagnostic specimen for measles. We prefer nasopharyngeal swabs for PCR, which has several major advantages over IgM. I consistently discourage IgM testing almost universally. Additionally, we do not approve of EIA demonstrating a fourfold rise in IgG titer as it is not a quantitative test. That can only be done by a quantitative test like plaque reduction neutralization testing at CDC.

Responses to Free Text Question at the end of the HBM Survey

Provide any comments or clarification for the answers you provided above. 154605

- 25 and 28:   recently (10 months) retired from health department
- #15 I do not order the tests, but knowing more about the tests will increase my understanding of the results
- It is difficult to answer they would I recommend questions without knowing the cost of such systems. It may be the greatest platform but if it is unaffordable, it is a moot question.
- Some of the evaluation questions and/or their scales didn't make sense
- I enjoyed learning via ITS. It increased my knowledge and confidence rapidly and accurate.
- In addition to missing information on isolation and personal protection, this training missing how to send specimens so that they do not break and infect the mail man. It also misses the MANY other febrile rash illness from the minor (hand foot and mouth) to the bioterrorism (smallpox.)
- 30 minutes are up
- I think your training would benefit from a review and possible re-phrasing of your survey questions and statements.
- A lot of the questions on the previous page (re: confidence) and this one, to a lesser extent, were worded very confusingly.
- When you mention "perform laboratory testing" I'm assuming you mean ordering it, not performing the actual test myself.
- Again, I am not a lab person, so I would not do any testing, so that is why I disagreed with that answer.
- I would pair the use of ITS with a real-life scenario/training exercise to gauge student retention of and ability to demonstrate the knowledge they've acquired through ITS
- I'm retired, which is why I won't be using ITS technology in the next 3 months.
- I would use ITS if it were more readily available.
- Again, I think the content of this training was actually incorrect. Nasopharyngeal swabs are the preferred diagnostic specimen for measles testing through RT-PCR. This has several advantages over IgM. IgM is dramatically less useful than PCR.

Communications via email during Study

- A 30-45-minute course and survey is way too long. I do not have time in my day to complete this. If it were 10-15 minutes, I could complete the task.
- I tried twice to complete the trainings and surveys, but the one time the whole system shut down before I got to the videos and then the second time the training videos wouldn't play (so totally invalidating the pre- and post-test responses I submitted) and then as I was about to make it through the final survey the system shut down again.
- I have no involvement in this issue so please delete me from your email list
- Not interested and don't have time. Sorry
- I tried to do the course both on my Mac and on my Smart Phone - using Chrome and neither worked. I could not even get the survey to work.
- I work mainly in environmental health and have no experience with events with rash-like illnesses. The CSTE disaster epi group tends to be more on the environmental side, however there are folks who work in infectious disease response, so I hope they can answer your questions.
- Great training methodology.
- only complaint is not having the ability to save in between, spouse interrupted me about a billing question, and I had to start all over
- I took the class yesterday but kept getting an error on the last part. Do I need to redo it?
- I watched the presentation on varicella and when I went to complete the assessment it said that it couldn't find the link or complete the request.
- I missed answering one of the questions, so I got one wrong! Throat (or NP) and urine are now the preferred specimens for measles PCR testing, which is the preferred test for measles. Measles PCR testing can currently only be performed at a public health laboratory.
- Although these tests meet the CSTE definition for confirmatory tests for measles, in California, we almost never confirm measles by IgM testing, and truly never confirm measles by a rise in IgG or by isolation of measles virus from a clinical specimen. See: https://www.cdph.ca.gov/Programs/CID/DCDC/CDPH%20Document%20Library/Measles-Testing-InformationVRDL.pdf
- Tried but it didn't let me complete the process
- No error messages. Just couldn't continue when pushed the continue button.

LIST OF REFERENCES

Aegerter, P., Auvert, B., Gilbos, V., Andrianiriana, F., Bertrand, W. E., Emmanuelli, X., . . . Bos, D. (1992). An intelligent computer-assisted instruction system designed for rural health workers in developing countries. *Methods Of Information In Medicine, 31*(3), 193-203. Retrieved from https://login.ezproxy.net.ucf.edu/login?auth=shibb&url=https://search.ebscohost.com/login.aspx?direct=true&db=cmedm&AN=1406333&site=eds-live&scope=site

AERD. (2018). Wilcoxon Signed-Rank Test using SPSS Statistics. Retrieved from https://statistics.laerd.com/spss-tutorials/wilcoxon-signed-rank-test-using-spss-statistics.php

Ahadzadeh, A. S., Sharif, S. P., Ong, F. S., & Khong, K. W. (2015). Integrating health belief model and technology acceptance model: An investigation of health-related Internet use. *Journal of Medical Internet Research, 17*(2). doi:10.2196/jmir.3564

Albright, J. (2006). Confirmatory Factor Analysis using Amos, LISREL and MPlus. Retrieved from http://www.iu.edu/~statmath/stat/all/cfa/cfa2008.pdf

Analytics, I. (2018). IBM SPSS Software. Retrieved from https://www.ibm.com/analytics/data-science/predictive-analytics/spss-statistical-software

Association, A. P. H. (2011). *The Affordable Care Act's Public Health Workforce Provisions: Opportunities and Challenges*. Washington, DC: American Public Health Association Retrieved from https://www.apha.org/~/media/files/pdf/topics/aca/apha_workforce.ashx

Association, A. P. H. (2018). What is Public Health? Retrieved from https://www.apha.org/what-is-public-health

ASTHO. (2013). Public Health Workforce Position Statement. *Policy and Position Statements.* Retrieved from http://www.astho.org/Policy-and-Position-Statements/Workforce-Development/

Beck, A. J., & Boulton, M. L. (2012). Building an Effective Workforce A Systematic Review of Public Health Workforce Literature. *American Journal of Preventive Medicine, 42*(5, Suppl. 1), S6-S16. Retrieved from https://login.ezproxy.net.ucf.edu/login?auth=shibb&url=https://search.ebscohost.com/login.aspx?direct=true&db=lsdbip&AN=PREV201200350505&site=eds-live&scope=site http://www.ajpm-online.net/ajbeck@umich.edu

Beck, A. J., Boulton, M. L., & Coronado, F. (2014). Enumeration of the Governmental Public Health Workforce, 2014. *American Journal of Preventive Medicine, 47*(5, Suppl. 3), S306-S313. Retrieved from https://login.ezproxy.net.ucf.edu/login?auth=shibb&url=https://search.ebscohost.com/login.aspx?direct=true&db=lsdbip&AN=PREV201400797209&site=eds-live&scope=site http://www.ajpm-online.net/ajbeck@umich.edu

Becker, M. H., Radius, S. M., Rosenstock, I. M., Drachman, R. H., Schuberth, K. C., & Teets, K. C. (1978). Compliance with a medical regimen for asthma: a test of the health belief model. *Public health reports, 93*(3), 268.

Benta, D., Bologa, G., Dzitac, S., & Dzitac, I. (2015). University level learning and teaching via e-learning platforms. *Procedia Computer Science, 55*, 1366-1373.

Bujang, M. A., & Baharum, N. (2016). Sample size guideline for correlation analysis. *World, 3*(1).

Byrne, B. (2016). Chapter 3-Application 1: Testing the factorial validity of theoretical construct. In *Structural Equation Modeling with Amos* (pp. 69-148). New York: Routledge.

Byrne, B. M. (2016). *Structural equation modeling with Amos : basic concepts, applications, and programming*: New York, N.Y. : Routledge, 2016.Third edition.

CDC. (2019). Nationally Notifiable Diseases. Retrieved from https://www.cdc.gov/healthywater/statistics/surveillance/notifiable.html

Champion, V. L., & Champion, V. L. (1984). Health Belief Model Scales. *Instrument development for Health Belief Model constructs, 6*(4), 73-85. Retrieved from https://login.ezproxy.net.ucf.edu/login?auth=shibb&url=https://search.ebscohost.com/login.aspx?direct=true&db=hpi&AN=HaPI-1347&site=eds-live&scope=site

Chi, M. T., Adams, J., Bogusch, E. B., Bruchok, C., Kang, S., Lancaster, M., . . . Stump, G. S. (2018). Translating the ICAP theory of cognitive engagement into practice. *Cognitive science, 42*(6), 1777-1832.

Cohen, J. (1992). Quantitative methods in psychology: A power primer. *Psychol. Bull., 112*, 1155-1159.

Crowley, R., & Gryzbicki, D. (2006). Guest editorial: Intelligent medical training systems. *Artificial Intelligence in Medicine, 38*(1), 1-4.

Cunningham, J. B., & McCrum-Gardner, E. (2007). Power, effect and sample size using GPower: practical issues for researchers and members of research ethics committees. *Evidence-Based Midwifery, 5*(4), 132-137.

Czibula, G., Guran, A.-M., Czibula, I. G., & Cojocar, G. S. (2009). *IPA-An intelligent personal assistant agent for task performance support.* Paper presented at the Intelligent Computer Communication and Processing, 2009. ICCP 2009. IEEE 5th International Conference on.

Davidovic, A., Warren, J., & Trichina, E. (2003). Learning benefits of structural example-based adaptive tutoring systems. *IEEE Transactions on Education, 46*(2), 241-251.

Davis, F. (1989). Perceived usefulness, perceived ease of use and user accepatance of information technology. *MIS Quarterly*, 319-340.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS quarterly*, 319-340.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: a comparison of two theoretical models. *Management science, 35*(8), 982-1003.

Dishaw, M. T., & Strong, D. M. (1999). Extending the technology acceptance model with task-technology fit constructs*(1),* 9. Retrieved from https://login.ezproxy.net.ucf.edu/login?auth=shibb&url=https://search.ebscohost.com/login.aspx?direct=true&db=edsggr&AN=edsgcl.54995291&site=eds-live&scope=site

Dziuban, C., Moskal, P., Parker, L., Campbell, M., Howlin, C., & Johnson, C. (2018). Adaptive Learning: A Stabilizing Influence across Disciplines and Universities. *Online Learning, 22*(3), 7-39. Retrieved from https://login.ezproxy.net.ucf.edu/login?auth=shibb&url=https://search.ebscohost.com/login.aspx?direct=true&db=eric&AN=EJ1191489&site=eds-live&scope=site

Education, U. S. D. o. (2018). Use of Technology in Teaching and Learning. Retrieved from https://www.ed.gov/oii-news/use-technology-teaching-and-learning

Educator, M. (Writer). (2011). Clean Catch Urine. In. UTube.

Epidemiology, F. B. o. (2009). *Epidemiology and Rash Illness Outbreak Tactics (EPI-RIOT): Combining epidemiologic practice with field operation*. Florida: Florida Department of Health

Evashwick, C. J., Begun, J. W., & Finnegan Jr, J. R. (2013). Public health as a distinct profession: has it arrived? *Journal of Public Health Management and Practice, 19*(5), 412-419.

Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using G* Power 3.1: Tests for correlation and regression analyses. *Behavior research methods, 41*(4), 1149-1160.

Fischetti, E., & Gisolfi, A. (1990). From computer-aided instruction to intelligent tutoring systems. *Educational Technology, 30*(8), 7-17.
Folsom-Kovarik, J. T., Schatz, S., & Nicholson, D. (2010). *Plan ahead: Pricing ITS learner models.* Paper presented at the Proceedings of the 19th Behavior Representation in Modeling & Simulation (BRIMS) Conference.
Foundation, P. H. (2014). *About the Core Competencies for Public Health Practice*. Retrieved from Washington, DC: http://www.phf.org/resourcestools/Documents/Core_Competencies_for_Public_Health_Professionals_2014June.pdf
Foundation, P. H. (2018). TRAIN National Retrieved from https://www.train.org/DesktopShell.aspx
Gefen, D., Straub, D., & Boudreau, M.-C. (2000). Structural equation modeling and regression: Guidelines for research practice. *Communications of the association for information systems, 4*(1), 7.
Gefen, D., Straub, D. W., & Boudreau, M. (2000). Structural equation modeling and regression: Guidelines for research practice. *Communications of the Association for Information Systems, 4*(7), 1-77.
Gonzalez, C., Burguillo, J. C., & Llamas, M. (2007). *Integrating intelligent tutoring systems and health information systems.* Paper presented at the Database and Expert Systems Applications, 2007. DEXA'07. 18th International Workshop on.
Gurunath, R., Ravi, S., & Srivatsa, S. (2012). Effective professional training through adaptive e-learning and decision making systems. *International Journal of Scientific & Engineering Research, 3*(11).
Hackett, M., & Proctor, M. (2016). Three-Dimensional Display Technologies for Anatomical Education: A Literature Review. *Journal of Science Education and Technology, 25*(4), 641-654. Retrieved from https://login.ezproxy.net.ucf.edu/login?auth=shibb&url=https://search.ebscohost.com/login.aspx?direct=true&db=eric&AN=EJ1106633&site=eds-live&scope=site http://dx.doi.org/10.1007/s10956-016-9619-3

Hair, J. F., Ringle, C. M., & Sarstedt, M. (2013). Partial least squares structural equation modeling: Rigorous applications, better results and higher acceptance. *Long range planning, 46*(1-2), 1-12.
Harrington, D. (2008). Confirmatory factor analysis: Oxford university press. In: USA.
Health, C. o. E. f. P. (2017). Accredited Schools and Programs. Retrieved from https://ceph.org/accredited/
Hendricks, D. (2014). These six companies are leading the way in EdTech. *Forbes*. Retrieved from https://www.forbes.com/sites/drewhendricks/2014/06/20/these-six-companies-are-leading-the-way-in-tech-education/#41c87e5d79c7
Hilliard, T. M., & Boulton, M. L. (2012). Public health workforce research in review: a 25-year retrospective. *American Journal of Preventive Medicine, 42*(5), S17-S28.
Holden, R. J., & Karsh, B.-T. (2010). The technology acceptance model: its past and its future in health care. *Journal of biomedical informatics, 43*(1), 159-172.
IBM. (2018). IBM SPSS Amos. Retrieved from https://www.ibm.com/us-en/marketplace/structural-equation-modeling-sem
IBM SPSS Software. (2018). *IBM*. Retrieved from https://www.ibm.com/analytics/data-science/predictive-analytics/spss-statistical-software
InfluentialPoints. Wilcoxon matched-pairs signed ranks test. Retrieved from https://influentialpoints.com/Training/wilcoxon_matched_pairs_signed_rank_test-principles-properties-assumptions.htm

Janz, N., Champion, V., & Strecher, V. (2008). Health behavior and health education: Theory, research, and practice. The health belief model (pp. 45–66). In: San Francisco, CA: Jossey-Bass.
Jones, J. A., Banks, L., Plotkin, I., Chanthavongsa, S., & Walker, N. (2015). Profile of the public health workforce: registered TRAIN learners in the United States. *American journal of public health, 105*(S2), e30-e36.
Kabanza, F., Bisson, G., Charneau, A., & Jang, T.-S. (2006). Implementing tutoring strategies into a patient simulator for clinical reasoning learning. *Artificial Intelligence in Medicine, 38*(1), 79-96.
Kak, N., Burkhalter, B., & Cooper, M.-A. (2001). Measuring the competence of healthcare providers. *Operations Research Issue Paper, 2*(1), 1-28.
Laboratory, M. (2018). Introduction of Intelligent Agents. Retrieved from http://slideplayer.com/slide/8822061/
Learning, C. f. D. L. D. o. D. (n.d.). We are the center for distributed learning. Retrieved from https://cdl.ucf.edu/
Lederberg, J. (2000). *Summary and Assessment-Public Health Systems and Emerging Infectionss: Assessing the Capabilities of the Public and Private Sectors-Workshop Summary*. Retrieved from https://www.ncbi.nlm.nih.gov/books/NBK100244/
Legris, P., Ingham, J., & Collerette, P. (2003). Why do people use information technology? A critical review of the technology acceptance model. *Information & management, 40*(3), 191-204.
Leider, J. P., Coronado, F., Beck, A. J., & Harper, E. (2018). Reconciling supply and demand for state and local public health staff in an era of retiring baby boomers. *American Journal of Preventive Medicine, 54*(3), 334-340.
Ma, W., Adesope, O. O., Nesbit, J. C., & Liu, Q. (2014). Intelligent tutoring systems and learning outcomes: A meta-analysis. *Journal of Educational Psychology, 106*(4), 901.
Matell, M. S., & Jacoby, J. (1972). Is there an optimal number of alternatives for Likert-scale items? Effects of testing time and scale properties. *Journal of Applied Psychology, 56*(6), 506.
Mcquiggan, S. W., Mott, B. W., & Lester, J. C. (2008). Modeling self-efficacy in intelligent tutoring systems: An inductive approach. *User modeling and user-adapted interaction, 18*(1-2), 81-123.
MedCram (Writer). (2015). Measles (rubeola) explained clearly by MedCram.com. In. UTube: MedCram.
Medicine, I. o. (1988). *The Future of Public Health*. In I. C. f. t. S. o. t. F. o. P. Health (Ed.). Retrieved from https://www.ncbi.nlm.nih.gov/books/NBK218212/
Medicine, I. o. (2002). *The future of the public's health in the 21st centry*. In IOM (Ed.). Retrieved from http://www.nationalacademies.org/hmd/~/media/Files/Report%20Files/2002/The-Future-of-the-Publics-Health-in-the-21st-Century/Future%20of%20Publics%20Health%202002%20Report%20Brief.pdf
Medicine, N. E. J. o. (Writer). (2009). NEJM Procedure: Collection of Nasopharyngeal Specimens with the Swab Technique. In.
Menold, N., & Zuell, C. (2010). Reasons for refusals, their collection in surveys and interviewer impact.
Microsoft. (2015). Introduction to Cortana Intelligence Suite. Retrieved from https://social.technet.microsoft.com/wiki/contents/articles/36688.introduction-to-cortana-intelligence-suite.aspx
Nguyen, L., & Do, P. (2008). Learner model in adaptive learning. *World Academy of Science, Engineering and Technology, 45*(70), 395-400.
Nunkoo, R., Ramkissoon, H., & Gursoy, D. (2013). Use of structural equation modeling in tourism research: Past, present, and future. *Journal of Travel Research, 52*(6), 759-771.
Organization, W. H. (2018). Public Health Services. Retrieved from http://www.euro.who.int/en/health-topics/Health-systems/public-health-services

Oxman, S., & Wong, W. (2014). White paper: Adaptive learning systems. *Integrated Education Solutions*.
Pai, F.-Y., & Huang, K.-I. (2011). Applying the technology acceptance model to the introduction of healthcare information systems. *Technological Forecasting and Social Change, 78*(4), 650-660.
Partners, T. (2016). *Learning to adapt 2.0: The evolution of adaptive learning in higher education*. Retrieved from Boston: http://tytonpartners.com/tyton-wp/wp-content/uploads/2016/04/yton-Partners-Learning-to-Adapt-2.0-FINAL.pdf
Prevention, C. f. D. C. a. (2010). *Varicella (Chickenpox) and Herpes Zoster (Shingles): Overview of VZV Disease and Vaccination for Healthcare Professionals*. Atlanta, GA: CDC Retrieved from https://www.cdc.gov/vaccines/vpd-vac/shingles/downloads/VZV_clinical_slideset_Jul2010.pdf
Prevention, C. f. D. C. a. (2012). An Introduction to Applied Epidemiology and Biostatistics. *Principles of Epidemiology in Public Health Practice.* Third Edition. Retrieved from https://www.cdc.gov/ophss/csels/dsepd/ss1978/lesson6/section1.html
Prevention, C. f. D. C. a. (2016a). *Measles-It isn't just a little rash: An introduction to Measles*. Atlanta, GA: CDC Retrieved from https://www.cdc.gov/measles/downloads/IntroToMeaslesSlideSet.pdf
Prevention, C. f. D. C. a. (2016b). *Varicella and Breakthough Varicella: To test or not to test.* . Atlanta, GA Retrieved from https://www.cdc.gov/chickenpox/downloads/varicella-and-breakthrough-varicella.pdf
Prevention, C. f. D. C. a. (2017a). Measles. Retrieved from https://www.cdc.gov/measles/lab-tools/rt-pcr.html
Prevention, C. f. D. C. a. (2017b). The Public Health System & the 10 Essential Public Health Services. *State, Tribal, Local & Territorial Public Health Professional Gateway.* Retrieved from https://www.cdc.gov/stltpublichealth/publichealthservices/essentialhealthservices.html
Prevention, C. f. D. C. a. (2018). Global Health Protection and Secruity. *Field Epidemiology Training Program.* Retrieved from https://www.cdc.gov/globalhealth/healthprotection/fetp/about.html
Proctor, M., & Creech, G. (2001). Object-oriented modeling of patients in a medical federation. *IEEE Transactions on Information Technology in Biomedicine, 5*(3), 244. doi:10.1109/4233.945295
Proctor, M. D., & Campbell-Wynn, L. (2014). Effectiveness, Usability, and Acceptability of Haptic-Enabled Virtual Reality and Mannequin Modality Simulators for Surgical Cricothyroidotomy. *Military Medicine, 179*(3), 260-264. doi:10.7205/MILMED-D-13-00365
Raykov, T., & Marcoulides, G. A. (2012). *A first course in structural equation modeling*: Routledge.
Ritter, L. A., & Sue, V. M. (2007). *The Use of Online Surveys in Evaluation: New Directions for Evaluation, Number 115* (Vol. 84): Jossey-Bass.
Romero, C., Ventura, S., Gibaja, E. L., Hervás, C., & Romero, F. (2006). Web-based adaptive training simulator system for cardiac life support. *Artificial Intelligence in Medicine, 38*(1), 67-78.
Rosenstock, I. M. (1974a). The health belief model and preventive health behavior. *Health education monographs, 2*(4), 354-386.
Rosenstock, I. M. (1974b). Historical origins of the health belief model. *Health education monographs, 2*(4), 328-335.
Rosenstock, I. M., Strecher, V. J., & Becker, M. H. (1988). Social learning theory and the health belief model. *Health education quarterly, 15*(2), 175-183.
Ruiz, J. G., Mintzer, M. J., & Leipzig, R. M. (2006). The impact of e-learning in medical education. *Academic medicine, 81*(3), 207-212.
Solutions, S. (2013). Confirmatory Factor Analysis. Retrieved from http://www.statisticssolutions.com/confirmatory-factor-analysis/
Sottilare, R., Graesser, A., Hu, X., & Goldberg, B. (2014). *Design Recommendations for Intelligent Tutoring SystemsVolume 2-Instructional Management* (Vol. 2).

Sottilare, R., Graesser, A., Hu, X., & Holden, H. (2013). *Design Recommendations for intelligent tutoring systemsVol 1. Learner Modeling* (Vol. 1).

Sottilare, R. A. (2018). A Comprehensive Review of Design Goals and Emerging Solutions for Adaptive Instructional Systems. *Technology, Instruction, Cognition & Learning, 11*(1).

Sottilare, R. A., Burke, C. S., Salas, E., Sinatra, A. M., Johnston, J. H., & Gilbert, S. B. (2018). Designing adaptive instruction for teams: A meta-analysis. *International Journal of Artificial Intelligence in Education, 28*(2), 225-264.

Suebnukarn, S., & Haddawy, P. (2007). COMET: A collaborative tutoring system for medical problem-based learning. *IEEE Intelligent Systems, 22*(4).

Tao, D., Evashwick, C. J., Grivna, M., & Harrison, R. (2018). Educating the Public health Workforce: a scoping review. *Frontiers in public health, 6*, 27.

Tarhini, A., Hone, K., & Liu, X. (2014). Measuring the moderating effect of gender and age on e-learning acceptance in England: A structural equation modeling approach for an extended technology acceptance model. *Journal of Educational Computing Research, 51*(2), 163-184.

Techopedia. (2018). Text Processing. Retrieved from https://www.techopedia.com/definition/22541/text-processing

Today, P. A. (2018). Top 22 Intelligent personal assistants or automated personal assistants. Retrieved from https://www.predictiveanalyticstoday.com/top-intelligent-personal-assistants-automated-personal-assistants/

Turner, M., Kitchenham, B., Brereton, P., Charters, S., & Budgen, D. (2010). Does the technology acceptance model predict actual use? A systematic literature review. *Information and Software Technology, 52*(5), 463-479.

Twente, U. o. (February 27, 2017). Communication Studies Theories: Health Belief Model. Retrieved from https://www.utwente.nl/en/bms/communication-theories/sorted-by-cluster/Health%20Communication/Health_Belief_Model/

USAID. (2019). One Health Workforce (OHW) Next Generation Agency for International Development. Retrieved from https://www.grants.gov/web/grants/search-grants.html?keywords=Enter%20Keyword...One%20Health%20Workforce

USHHS. (2019). CDC's Collaboration with Academia to Strengthen Public Health Workforce Capacity. Retrieved from https://www.grants.gov/web/grants/view-opportunity.html?oppId=301012

Van Lent, M. (2019). *Defining Artificial Intelligence.* Paper presented at the Soar Technology Tech Talk at the 2019 Interservice/Industry Training Simulation and Education Conference (IITSEC), Orlando, Florida.

VanLehn, K. (2011). The relative effectiveness of human tutoring, intelligent tutoring systems, and other tutoring systems. *Educational Psychologist, 46*(4), 197-221.

Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management science, 46*(2), 186-204.

Wahyuni, R., & Nurbojatmiko. (2017). Explaining acceptance of e-health services: An extension of TAM and health belief model approach. In (pp. 1): IEEE.

Wan, T. T. H. (2002). *Evidence-based health care management : multivariate modeling approaches*: Boston : Kluwer Academic Publishers, c2002.

Westland, J. C. (2010). Lower bounds on sample size in structural equation modeling. *Electronic commerce research and applications, 9*(6), 476-487.

Wolfe, C. R., Reyna, V. F., Widmer, C. L., Cedillos, E. M., Fisher, C. R., Brust-Renck, P. G., & Weil, A. M. (2015). Efficacy of a web-based intelligent tutoring system for communicating genetic risk of breast cancer: A fuzzy-trace theory approach. *Medical Decision Making, 35*(1), 46-59.

Woo, C. W., Evens, M. W., Freedman, R., Glass, M., Shim, L. S., Zhang, Y., . . . Michael, J. (2006). An intelligent tutoring system that generates a natural language dialogue using dynamic multi-level planning. *Artificial Intelligence in Medicine, 38*(1), 25-46.

Woolf, B. P. (2010). *Building intelligent interactive tutors: Student-centered strategies for revolutionizing e-learning*: Morgan Kaufmann.

Workforce, P. i. I. A. f. P. H. (2018, May 2018). Workforce Development. *Education and Training.* Retrieved from https://phpartners.org/educ.html

Wynne, W. C., Robert, A. P., & Steven, P. B. (2008). Structural Equation Modeling in Marketing: Some Practical Reminders. *Journal of Marketing Theory and Practice, 16*(4), 287. doi:10.2753/MTP1069-6679160402

Yeager, A. (2018). Cuts to Prevention and Public Health Fund Puts CDC Programs at Risk. *The Scientist*. Retrieved from https://www.the-scientist.com/daily-news/cuts-to-prevention-and-public-health-fund-puts-cdc-programs-at-risk-30298