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Psychometric Testing of the Malaria Critical Thinking Test

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PSYCHOMETRIC TESTING OF THE MALARIA CRITICAL THINKING TEST

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ABSTRACT

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By

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Background

Accrediting bodies of baccalaureate nursing programs require quantified assessment of critical thinking in students. The current literature indicates two types of critical thinking assessments: (a) standardized, psychometrically sound, and non-nursing specific, and (b) nursing specific, but lacking the established psychometric properties. Therefore, a nursing-specific critical thinking test with established psychometric properties would help nurse educators understand the unique critical thinking ability of baccalaureate nursing students. With information from a quantitative critical thinking ability assessment tool, instructional methods could be revised to target student characteristics that correlate with critical thinking ability. Additionally, nurse educators could use the information from a nursing-specific critical thinking ability assessment to implement program interventions to ensure student success. Ultimately, a nursing-specific critical thinking ability assessment might be used to predict how students perform on other exams, for example, the NCLEX-RN examination.

Tropical and infectious diseases are topics that are often insufficiently covered in most baccalaureate programs, yet these diseases have implications for global health. One specific disease over half of the world's population is at risk for contracting is malaria. Assessing nursing student critical thinking ability about malaria, a topic less prevalent in the United States, may

change the approach to teaching and learning strategies that promote critical thinking in nursing education. Therefore, the purpose of this study is to develop a reliable and valid critical thinking test that can be implemented in baccalaureate curricula to assess students' critical thinking abilities regarding malaria.

Specific Aims

The two specific aims of this study were to (a) test the Malaria Critical Thinking Test's (MCTT) content validity and (b) test the MCTT's construct validity and reliability.

Methods

A cross-sectional survey research design was used to test the MCTT's psychometric properties. Content validity was tested with a critical thinking expert panel review. Construct validity and reliability were tested with a convenience sample of undergraduate baccalaureate nursing students at a Midwest university.

Results

Acceptable content validity for the MCTT was established with three stages of an expert panel's review. Construct validity and internal consistency reliability for the MCTT were tested and deemed not acceptable. An exploratory factor analysis (EFA) indicated that there were four MCTT items with acceptable factor loading values (> 0.32). Results from the EFA indicated that a confirmatory factor analysis of the MCTT is not appropriate at this time.

Conclusions

This study's results provide an initial start to establish the psychometric properties of the MCTT. Future MCTT enhancement should employ multiple strategies for item development to establish acceptable MCTT content validity, reliability, and construct validity through EFA and confirmatory factor analysis.

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DEDICATION

This dissertation is dedicated to my family. First, this dissertation is dedicated to my beautiful daughters, Karys and Kolie. My dissertation was a transformative process in many ways. The most distinct and important transformation was that I became a mother to you both through the dissertation process. Both of you completely light up my life, and I could not imagine this world without you. I love the two of you so much. Second, this dissertation is dedicated to my husband, John. John, you are my constant cheerleader and my never-ending source of support. I cried on your shoulder the most. You never doubted me, and you encouraged me to never doubt myself. Your love and support have meant so much. I love you. Finally, this dissertation is dedicated to my parents. You have been lifelong models of accomplishing goals through hard work. Thank you for your support and encouragement. I would also like to thank my dear friends, Sarah and Dan. You were always supportive of me and encouraged me to celebrate the smallest of milestones along the way. Your friendship means the world to me. Thank you to Shayla, Alex, and Sonja for helping me with the girls when I had deadlines to meet. You were available and happy to help at any and all hours. I will be forever grateful for the loving care you gave to my girls during one of the most intense times of my life. Last, but not least, thank you to my nursing department colleagues at Concordia College: Dr. Polly Kloster, Dr. Jean Bokinskie, Dr. Jack Rydell, Dr. Jennifer DeJong, Jane Indergaard, Dr. Linda Scott, Dr. Connie Peterson, Lu Vitalis, and Kristi Jarolimek. Thank you for your prayers and support, especially during my final semester.

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CHAPTER 1

INTRODUCTION

Background

Vector-borne diseases account for 17% of all infectious diseases worldwide and are responsible for over one million deaths annually (World Health Organization [WHO], 2016). One vector-borne disease that over half of the world's population is at risk for contracting is malaria. Although malaria is a preventable and curable disease, it is responsible for over 200 million diagnoses and 400,000 deaths worldwide each year (WHO, 2016). Failure to recognize early symptoms and the delay of treatment can quickly lead to kidney failure, respiratory complications, anemia or even death (Centers for Disease Control and Prevention [CDC], 2016a; WHO, 2016). Thus, understanding the steps to prevent and control malaria, recognizing the symptoms of malaria, and initiating early treatment are imperative to reducing the number of overall malaria diagnoses and the number of malaria-related deaths.

Approximately 1,500 cases of malaria are diagnosed annually in the United States (CDC, 2016b), a country to which malaria is not endemic, or regularly contracted. Globally, there are other countries where malaria is also not endemic, but see malaria diagnoses rates similar to the United States (WHO, 2016). A reality of modern global travel is the increased risk of tropical and infectious disease exposure. Therefore, it is important that health-care providers are cognizant of and are able to critically think about these less commonly seen, but still serious diseases. Nurses are generally the first contact that a patient has with the health-care system. In addition to recognizing early signs and symptoms for diagnosis and initiating proper treatment of an individual patient, it is also important that nurses think critically about malaria from a standpoint of transmission prevention in order to educate patients and decrease the rate of malaria-transmission exposures worldwide.

Nursing students' fears regarding caring for individuals with non-endemic diseases (e.g., Ebola) is a topic of current relevance that is being specifically explored by professional nursing organizations (National League for Nursing [NLN], 2014b). Nursing-education specific recommendations from the NLN encourage nursing faculty to use teaching approaches that address students' fears about non-endemic and potentially fatal diseases. These recommended teaching approaches specifically focus on teaching students accurate skills to initiate protective measures to ensure patient and personal safety (NLN, 2014c). Unfortunately, due to the relative paucity of U.S. patients diagnosed with malaria, malaria is not often covered in great detail in undergraduate baccalaureate nursing programs.

An example of a potential measure that would help nurse educators identify if students are able to critically think about topics that are insufficiently addressed from a curricular standpoint, yet are important to nursing practice, would be a critical thinking ability tool that assesses critical thinking ability regarding the prevention and risk reduction strategies for malaria. A specific critical thinking tool that focuses on malaria may allow nurse educators to quantitatively evaluate whether students are able to critically think about topics that have relatively limited instruction time. With information from the critical thinking tool, instructional methods could be revised to target student characteristics that correlate with critical thinking ability (GPA, SAT scores). Additionally, a critical thinking tool designed specifically for assessing critical thinking ability of Bachelor of Science in nursing (BSN) students might be useful in identifying weak critical thinking students and implementing interventions during the nursing program to ensure student success. Ultimately, a nursing-specific critical thinking ability assessment might be used to predict how students perform on other exams, for example, the NCLEX-RN examination.

An even greater issue for nursing education is the overall task of measuring critical thinking ability. Nursing programs are required to report students' critical thinking abilities for accreditation (American Association of Colleges of Nursing [AACN], 2008). Although literature regarding the topic of nursing students and critical thinking is plentiful, much of the literature is qualitative; therefore, more measurable data are needed to understand baccalaureate nursing students' critical thinking abilities so that educators can promptly intervene when necessary. Measurable critical thinking data are also important to help educators understand and predict measures related to student success, for example, passing the NCLEX-RN examination on the first attempt. If nurse educators had quantitative measures for predicting both at–risk and excelling students, nurse educators could alter teaching/learning strategies that promote the best student outcomes.

Statement of the Problem

Although critical thinking is a topic of much discussion in nursing education, there is minimal quantitative data within the literature regarding the assessment of the unique critical thinking abilities of baccalaureate nursing students. For example, instruments developed to quantify critical thinking abilities, such as the California Critical Thinking Skills Test (CCTST), the California Critical Thinking Disposition Inventory (CCTDI), and the Watson Glaser Critical Thinking Appraisal® (WGCTA®) are not specific to assessing the critical thinking abilities unique to nursing students. Other instruments that are nursing-specific critical thinking assessments (e.g., Competency Inventory of Nursing Students [CINS], Nursing Process Critical Thinking Examination [NPCTE]) do not have well-established psychometric properties, nor do any nursing-specific critical thinking assessments focus on malaria.

There is, therefore, a need for a nursing-specific critical thinking assessment tool that focuses on malaria. Critical thinking ability assessment tools for malaria and other vector-borne diseases could lead to improvements for in predicting student success. For example, a nursing–specific critical thinking ability assessment for BSN nursing students might be useful in determining the relationship between quantitative critical thinking ability scores and other predictive student success measures such as grade point average (GPA) and Scholastic Aptitude Test (SAT) scores (Kokinda, 1989; Miller, 1992; Stone, Davidson, Evans, & Hansen, 2001; Tiessen, 1987). More reliable and valid tools that isolate the predictive measures for student success would be useful to nurse educators in identifying at-risk students.

While a critical thinking tool that is designed specifically for malaria would likely not greatly advance the field of measuring BSN nursing students' critical thinking ability as a whole, a reliable and valid tool for assessing BSN students' critical thinking ability about malaria might improve future critical thinking ability strategies used in nursing education. A reliable and valid quantitative critical thinking ability assessment could assist nurse educators in understanding the different predictors for student success and allow for early intervention based upon these predictors for success.

Statement of the Study Purpose

The purpose of this study was to test the Malaria Critical Thinking Test's (MCTT) psychometric properties. The study's findings will provide support for further development of the MCTT as a reliable and valid test used to quantify BSN students' critical thinking ability for the topic of malaria.

Specific Aims

The two specific aims of this study were to (a) test the MCTT's content validity and (b) test the MCTT's construct validity and reliability.

CHAPTER 2

LITERATURE REVIEW

A review of the literature was conducted to analyze and evaluate the quantitative literature concerning critical thinking ability in undergraduate nursing students. This review includes a discussion regarding the quantitative literature and a critical review.

Critical Thinking: A Review of the Quantitative Literature

Nursing students' critical thinking ability has been an area of inquiry for nurse educators globally because critical thinking ability is viewed as an essential component of competent patient care (Australian Health Practitioner Regulation Agency, 2016; Sigma Theta Tau International [STTI]), 1999). Critical thinking is hallmark of quality and patient safety in baccalaureate nursing education (AACN, 2006). Critical thinking provokes an inquiry to know, to solve problems based upon evidence, and to anticipate the needs of patients and nurses in order to ensure safe, optimal outcomes (NLN, 2013a).

In the past from 2000 to 2016, five reviews related to nursing students' critical thinking were published in the nursing literature. The oldest review during this period examined articles related to critical thinking and published between January 1989 and 2000 (Simpson & Courtney, 2002). This review focused on distinguishing critical thinking from problem–solving and decision–making, analyzing educational strategies to develop critical thinking for nursing, and analyzing the evaluation of critical thinking skills for the nursing educational setting (Simpson & Courtney, 2002). The next review, in which article inclusion and exclusion criteria were not detailed, explained the relationship between critical thinking and clinical decision-making (Eng & Duke, 2003). The review described five active teaching/learning strategies that have been used to promote the development of critical thinking in nursing students (Eng & Duke, 2003). Yuan,

Williams, and Fan (2008) and Oja (2011) separately published a more targeted review than the previous ones by focusing on evidence specific to problem-based learning and critical thinking outcomes for nursing students. Most recently, Chan (2013) reviewed the qualitative literature in this field. Despite the presence of these reviews, none have collectively examined critical thinking quantitative reports from 1989 to 2016 in a systematic manner to address methodological approaches and findings and to identify new, substantive research questions or methodological approaches. Therefore, this review provides a synthesis of the major methodological components of critical thinking, as well as areas of inquiry related to nursing students' critical thinking abilities, and offers three specific suggestions for future quantitative research.

Literature Search

A review was conducted to establish what is known about the relationship between nursing students and critical thinking ability. After filters were applied to the literature search engine (peer-reviewed journals written in the English language), the relevant references were reviewed for meeting inclusion criteria. Inclusion criteria were that the article (a) had quantitative measures to evaluate critical thinking ability, and (b) BSN students were participants. Studies that consisted of both BSN and associate degree of nursing (ADN) students were also included. A total of 25 articles met the criteria and were analyzed. See Figure 1 for a Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow chart of the literature-search process. The Literature Review Matrix (Appendix A) highlights important methodological elements, including the study design, type of nursing-student participants, tool used to assess critical thinking ability, key results, and reliability and validity of the critical thinking ability tool.

Figure 1. PRISMA Diagram of Critical Thinking and Nursing Student Literature

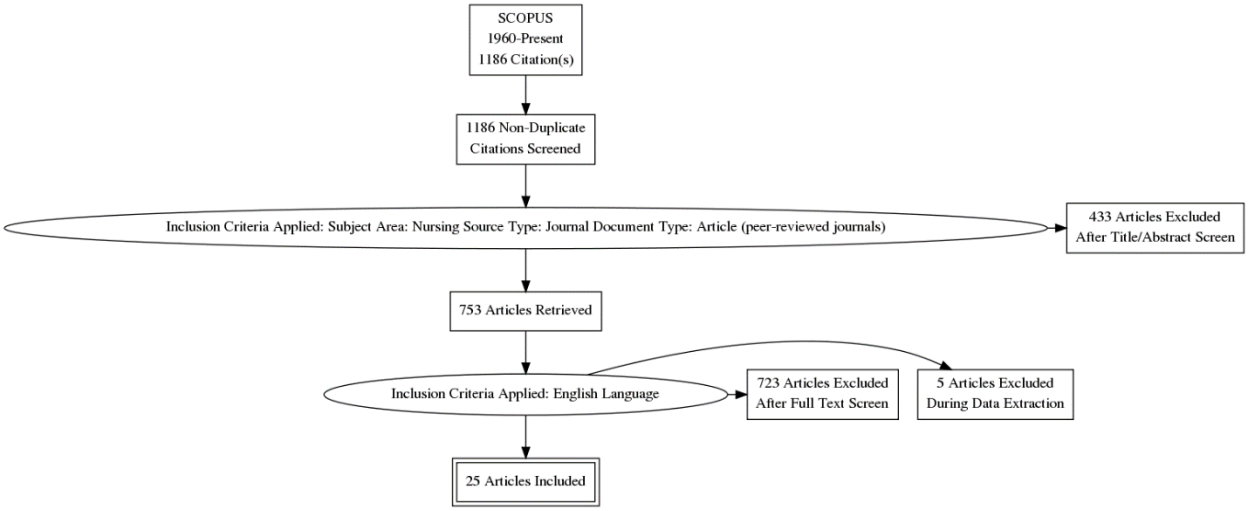


Figure 1. This figure depicts the process for article selection and screening for critical thinking and nursing student literature.

This review of literature begins by highlighting two major methodological components for the science related to critical thinking ability and nursing students including critical thinking tools and study location. Next, the review examines areas of inquiry including critical thinking ability as a predictor for students' success on the National Council Licensure Examination-Registered Nurse® (NCLEX-RN®) and factors related to critical thinking ability in nursing students. Finally, the implications of these findings for assessing nursing students' critical thinking ability are discussed.

Major Methodological Components

An evaluation of critical thinking ability tools is necessary because it is an important factor for nursing students' success (NLN, 2013b). Because studies published between 1992 and 1997 utilized the Watson-Glaser Critical Thinking Appraisal® (WGCTA®) tool and studies after

1997 utilized the WGCTA® tool and other tools, the studies are divided into two time periods: earlier (1992 to 1997) and current (1998 to 2016) literature for this analysis.

As indicated above, the WGCTA® tool is a commonly used instrument to assess BSN students' critical thinking ability. The WGCTA® was originally developed to assess the critical thinking ability of education students (Pearson Education, 2015). The WGCTA® tool consists of five subtests: inference, assumptions, reduction, interpretation, and evaluation with two equivalent forms (A and B). A total of 80 possible Likert items are available for assessment purposes (Pearson Education, 2015). This tool is not specific to nursing concepts. Rather, the WGCTA® tool is used for a wide variety of professions and disciplines, such as education, business, management, law, manufacturing, publishing/printing, and banking (Pearson Education, 2015).

In contrast to the earlier literature, more current studies (1998 to 2016) involve a variety of assessment tools that are used to measure nursing students' critical thinking ability. Recent studies utilize one of seven different assessment tools. Two of the tools— the California Critical Thinking Disposition Inventory (CCTDI) and the California Critical Thinking Skills Test (CCTST)—are standardized instruments that are similar to the WGCTA®. The other five tools are specific to critical thinking assessments in health sciences including the: (a)Health Sciences Reasoning Test (HSRT), (b) Competency Inventory of Nursing Students (CINS), (c) Nursing Process Critical Thinking Examination (NPCTE), (d) Critical Thinking Disposition Scale (CTDS), and (e) Yoon's Critical Thinking Disposition (CTD) instrument.

The CCTDI and the CCTST tests are similar to the WGCTA® in that these Likert-scale tests assess the critical thinking ability of people in all disciplines and fields (Insight Assessment, 2013). Regarding subtest categories, the CCTST assesses analysis, evaluation, inference,

deduction, induction, and overall reasoning (Insight Assessment, 2013). The CCTDI measures a person's willingness to engage in critical thinking and needs to be used in conjunction with the CCTST for the most accurate assessment of critical thinking ability (Insight Assessment, 2013). However, only one of the 25 studies examined for this review of literature assessed critical thinking ability using both the CCTST and the CCTDI (Stone et al., 2001).

In contrast, the HSRT is a tool designed specifically to assess health-care professionals and health-care students (Insight Assessment, 2013). The HSRT assesses the same categories as the CCTST; however, it is designed to assess the critical thinking ability of health science students and professionals (Insight Assessment, 2013). This tool is a 33-item, multiple-choice test that evaluates five subtests including interpretation, analysis, evaluation, explanation, and inference (Insight Assessment, 2013). One benefit of using the HSRT is that the items use health-care scenarios to evaluate critical thinking ability within a health-care context.

One tool specifically developed for nursing students, the Competency Inventory of Nursing Students (CINS), is a 43-item self-assessment of professional nursing students' development and critical thinking reasoning (Hsieh & Hsu, 2013). This tool is specific for nursing students because it focuses on nursing-student outcomes, such as clinical performance now and in the future as a professional (Hsieh & Hsu, 2013). There are six subscales for the CINS including ethics and accountability, general clinical skills, lifelong learning, clinical biomedical science, caring, and critical thinking and reasoning (Hsieh & Hsu, 2013).

Another tool that is specifically designed to assess nursing students' critical thinking ability is the Nursing Process Critical Thinking Examination (NPCTE) (Kowalski & Louis, 2000). This tool is a 52-item, multiple-choice examination that focuses on objectively measuring critical thinking abilities specific to nursing students (Kowalski & Louis, 2000).

Another tool that is specifically designed to assess the critical thinking ability of nursing students, with a focus on Korean students, is the Critical Thinking Disposition Scale (CTDS) (Kim, Moon, Kim, Kim, & Lee, 2014). This tool consists of a 5-point Likert scale to assess 35 items within eight subcategories: intellectual integrity, creativity, challenge, open-mindedness, prudence, objectivity, truth seeking, and inquisitiveness (Kim et al., 2014).

The final tool identified to assess critical thinking ability, specifically for BSN students, is Yoon's Critical Thinking Disposition (CTD) tool. Similar to the CTDS, the CTD instrument was developed to assess the unique and culturally related critical thinking dispositions of Korean nursing students (Kim et al., 2014). The CTD tool has 27 Likert-scored items. There are seven subscales for the CTD tool including: objectivity, prudence, systematicity, intellectual eagerness/curiosity, intellectual fairness, healthy skepticism, and critical thinking confidence (Shin, Ma, Park, Ji, & Kim, 2015).

In conclusion, nurse researchers have used two major types of tools to study nursing students' critical thinking ability. One type is the standardized instrument that was originally developed to assess college students' critical thinking ability. The main advantage of using this type of tool is its established reliability. However, one shortcoming with using a standardized instrument is its lack of specificity for nursing students. Although nursing students are college students, a standardized tool may not target the critical thinking ability that is required of nursing students when they perform patient care. Therefore, using this type of tool may not be adequate to assess the critical thinking ability of nursing students and to evaluate the educational strategies that promote nursing students' critical thinking ability.

The other type of critical thinking tool used for nursing-student research was developed by health-care professionals. One strength of this type of tool is the specificity to the critical

thinking ability of health-science students (Hsieh & Hsu, 2013; Insight Assessment, 2013). The different forms for this type of assessment tool have only recently been developed and require further psychometric testing. Therefore, their use is currently limited to the assessment of critical thinking ability and not the evaluation of interventions that were developed to promote critical thinking ability. Only reliable and valid tools are suitable to detect these interventions' efficacy.

An analysis of the critical thinking and nursing-student literature also highlighted a distinction related to time and the study location. All the older studies were conducted in the United States. In the contrast, the more recent studies were done in the United States and other countries, such as Canada, Taiwan, China, Korea, and Turkey. Therefore, recent knowledge about nursing students' critical thinking ability has expanded to a global level and new avenues of inquiry that cross languages and cultures have emerged.

Areas of Inquiry

This literature review also highlights two major areas of inquiry involving critical thinking ability and nursing students. One area is critical thinking as a predictor for NCLEX-RN® success. The second area focuses on factors related to nursing students' critical thinking ability.

Waite (1989) and Bauwens and Gerhard (1987) identified critical thinking ability and other variables as predictors for nursing students' NCLEX-RN® success. As indicated in the Literature Review Matrix (Appendix A), the findings from these studies suggest that critical thinking ability is a positive predictor for the success of nursing students on the NCLEX-RN®. However, the nursing student's level of study did not appear to affect this relationship because critical thinking ability was a predictor for both beginning and senior nursing students in two studies using the WGCTA® tool (Bauwens & Gerhard, 1987; Waite, 1989).

Twenty-four of the 25 studies analyzed for this literature review focused on factors related to nursing students' critical thinking ability. Four of these factors were associated with student characteristics including: (a) GPA (Kokinda, 1989; Miller, 1992; Tiessen, 1987); (b) the Scholastic Aptitude Test (SAT; Stone et al., 2001; Tiessen, 1987); (c) student level (Brigham, 1989; Kim et al., 2014; Kokinda, 1989); and, (d) student program (Brooks & Shepherd, 1990, 1992; Gross, Takazawa, & Rose, 1987; Lynch, 1988; Notarianni, 1991). Two other factors were associated with non-student characteristics including: (a) time (Angel, Duffey, & Belyea, 2000; Beckie, Lowry, & Barnett, 2001; Hsieh & Hsu, 2013; Miller, 1992; Notarianni, 1991; Poole, 1989; Sandor, Clark, Campbell, Rains, & Cascio, 1998; Sullivan, 1987); and (b) instructional method (Kowalski & Louis, 2000; Naber & Wyatt, 2014; Ozturk, Muslu, & Dicle, 2008; Shin et al., 2015; Weatherspoon, Phillips, & Wyatt, 2015; Yuan, Kunaviktikul, Klunklin, & Williams, 2008).

In addition to GPA, SAT verbal and quantitative scores were positively correlated with critical thinking ability (Brigham, 1989; Miller, 1992; Stone et al., 2001; Tiessen, 1987). One concern is the lack of specificity to nursing student assessment because these researchers used generic critical thinking tools: WGCTA® (Brigham, 1989; Miller, 1992; Tiessen, 1987), CCTST, and/or CCTDI (Stone et al., 2001). Therefore, this relationship between GPA, SAT verbal and quantitative scores, and critical thinking ability needs to be tested using a tool that is specific for assessing the critical thinking ability of nursing students among all baccalaureate nursing programs.

Another student characteristic is student level. Kim et al. (2014), Kokinda (1989), and Brigham (1989) compared critical thinking ability across different levels of students who were enrolled in the same program (e.g., freshman vs. senior). Kim et al. (2014) used the CTDS to

compare the critical thinking dispositions of Korean nursing students across different student levels for students who were enrolled in the same program. Critical thinking disposition increased from freshman year and was highest during the junior year (Kim et al., 2014). Kim and colleagues (2014) attributed these findings to the current trends for stressors that are specific to senior Korean nursing students (e.g., finding employment and preparing for licensure examinations). Two of the other student-level studies (Brigham, 1989; Kokinda, 1989) both used the WGCTA® tool, and the findings varied. Kokinda (1989) identified that the sophomore students achieved the highest WGCTA® scores (compared to senior, junior, and freshman nursing students). However, Kokinda (1989) attributed this finding to more stringent admission criteria and curriculum revisions that were implemented for the sophomores. Therefore, the possibility exists that critical thinking ability may be similar across levels. In a different study, Brigham (1989) found no significant differences in critical thinking ability across student levels.

A third student characteristic is program. In two studies (Gross et al., 1987; Poole, 1989), the critical thinking ability of both BSN and ADN students were compared. Although Poole (1989) did not detect a difference in critical thinking ability between these two student groups, Gross et al. (1987) found that, at the time of program exit, BSN students had higher critical thinking ability scores than ADN students.

Program was a critical thinking variable considered by Brooks and Shepherd (1990, 1992). In the Brooks and Shepherd (1990) study, a weak, yet significant, correlation was found between critical thinking ability and clinical decision making among four different types of nursing programs (Brooks & Shepherd, 1990). Two years later, Brooks and Shepherd (1992) expanded their research to examine the relationship between critical thinking ability and professionalism among four different program types. Brooks and Shepherd (1992) discussed a

link between the attributes of critical thinking ability and professional behavior. One example was that the ability to successfully navigate uncertain clinical situations is a sign of professionalism (Brooks & Shepherd, 1992).

Two other factors that several studies address are time and instructional method. These factors are distinguished from students' characteristics because the factors are related to program elements.

The first non-student characteristics is time. As a factor, time is the comparison of critical thinking ability scores at program milestones, such as: (a) program entry versus program exit; (b) at program entry, midpoint, and exit; or, (c) at the beginning and end of the semester. Most findings indicate that critical thinking ability improves over time (Angel et al., 2000; Gross et al., 1987; Hsieh & Hsu, 2013; Miller 1992; Poole, 1989; Sandor et al., 1998). A possible reason for the increased critical thinking ability scores could be due to maturation among the program participants. As students are exposed to more experiences in the nursing curriculum through lectures and clinical rotations, their knowledge, including their critical thinking ability, expands. The faculty develops exams and practical experiences with the intent of cultivating improved critical thinking ability. Therefore, the addition of a control group is needed to rule out the maturation effect (Altermatt, 2014).

A second non-student characteristic is instructional method. Six nonrandomized studies compared critical thinking ability scores for four learning/teaching methods: (a) problem-based learning (Ozturk et al., 2008; Yuan et al., 2008), (b) computer technology (Kowalski & Louis, 2000; Weatherspoon et al., 2015), (c) a reflective writing assignment (Naber & Wyatt, 2014), and (d) a repeated high-fidelity simulation (Shin et al., 2015). Critical thinking ability scores were significantly higher for all teaching/learning methods compared to a traditional instruction

group. These findings suggest that a non-traditional approach for teaching methods could positively impact critical thinking ability.

In conclusion, the majority of the state of the science focuses on non-student characteristics that are related to critical thinking ability. Over 50% of the 25 studies reviewed were more than 18 years old and use standardized tools that were developed in the 1920s. Non-student characteristics are important because the faculty could design the curriculum around these characteristics to promote nursing students' critical thinking ability.

These data suggest that time is an important non-student characteristic related to critical thinking ability. However, maturation was not controlled in these studies. The question remains whether critical thinking ability increases over time because the nursing students' critical thinking ability naturally increases over time or because the curricular activities presented later in the program lead to an increased critical thinking ability. Therefore, future research should include a control group to account for maturation.

Recommendations for Future Research

Based on this literature review, three recommendations are offered for future research regarding critical thinking ability and nursing students. The discussion of these recommendations focuses on the approaches used to measure critical thinking ability, critical thinking ability as a predictor for NCLEX-RN® success, and factors related to critical thinking ability.

One recommendation is to conduct research that will test the assessment approaches that focus on the unique critical thinking ability processes required of nursing students. In addition, these approaches need to assess critical thinking ability over time, such as at the beginning and the end of a program, and need to include control groups in order to rule out the maturation

effect. The possibility exists that nursing students' critical thinking ability may naturally increase over time and may not be due to specific curricular activities.

This approach-related recommendation is based on the current complexity of care that is delivered in all health-care settings. Nursing students are encountering more acutely ill patients in the clinical setting (NLN, 2005), and this changing health-care dynamic requires different approaches to assess critical thinking ability than the standardized, multiple-choice instruments that were originally developed in the 1920s to predict post-collegiate job success (Korbin, 2015). For example, educational gaming, innovative prompts, and virtual-reality approaches advance assessment beyond standardization and multiple-choice tests, enabling the assessment of how students react to complex and dynamic patient situations.

A second recommendation is to design more rigorous studies that are focused on critical thinking ability as a predictor of first-time NCLEX-RN® success. Because passing the NCLEX-RN® and other licensing examinations is critical for entry into nursing practice, understanding the predictive relationship between critical thinking ability and NCLEX-RN® success will help nurse educators implement the best methods for promoting student success. Although two studies' findings suggested a positive relationship between critical thinking ability and NCLEX-RN® success, these studies are dated and have a local, homogenous sample (Bauwens & Gerhard, 1987; Waite, 1989).

Finally, future research needs to explore the link between a change in critical thinking ability and nurses' clinical judgment, as well as, patients' outcomes. As indicated in the Literature Review Matrix (Appendix A), a change in critical thinking ability occurs over time and in response to certain interventions. However, the relationship among the change in critical thinking ability, nurses' clinical judgment, and patients' outcomes need to be established.

Questions arise whether the degree of change in critical thinking ability makes a difference (e.g., 10% versus 50%) for nurses' clinical judgment and patients' outcomes. Examples of research questions that address this relationship are as follows:

1. What is the minimum percentage of change in critical thinking ability that is needed to demonstrate improved nurses' clinical judgment?
2. What is the minimum percentage change in critical thinking ability that is needed to demonstrate improved patient outcomes?

In addition, questions arise regarding the type of educational interventions that impact nurses' clinical judgment and patients' outcomes. For example, does a change in critical thinking ability related to problem-based learning lead to both improved clinical judgment for nurses and improved patient outcomes?

In summary, three recommendations for future research regarding critical thinking ability and nursing students are offered. Overall, future research approaches need to (a) involve a more dynamic assessment, (b) be more rigorous methodologically, and (c) link changes in critical thinking ability with nurses' clinical judgment and patients' outcomes.

Conclusion of the Literature Review

The literature regarding nursing students' critical thinking ability reveals that studies with more dynamic assessment methods; more rigorous methodologies; and more distinct linkages between critical thinking ability, clinical judgment, and outcomes are needed. The impact of a study that implements a dynamic assessment method to measure nursing students' critical thinking ability would provide valuable information about the unique critical thinking ability that is required of nursing students compared to students in other disciplines. This literature review supports the development of a nursing student–specific critical thinking ability assessment that

can be used in conjunction with other student and non-student characteristics to predict student success. Methodologically rigorous studies are appreciated contributions to the body of literature. Finally, a study that demonstrates distinct connections between critical thinking ability and clinical judgement would provide a clear link between critical thinking ability and patient outcomes.

CHAPTER 3

METHODOLOGY

This chapter describes the study's scientific approach. The specific aims, design, sample, ethical considerations, study variables and instrumentation, data collection procedures, and data analysis are explained. The chapter delineates a separate discussion for Specific Aim 1 and Specific Aim 2 because there were two different approaches utilized for each aim.

Specific Aims

The specific aims of this study were as follows:

1. To test the MCTT's content validity.

2. To test the MCTT's construct validity and reliability.

Psychometric Theory

Instrument development allows for tangible measurement of a complex phenomenon (DeVellis, 2003). The instrument measurement process includes two fundamental components, reliability and validity.

The first component of proper instrument measurement is reliability. Reliability refers to a measure's consistency (Waltz et al., 2010). In this study, the MCTT's internal consistency reliability was tested. Internal consistency reliability is important for scale development because it indicates how well (or how consistently) the scale's items fit with one another and the degree to which the items measure the intended phenomenon (DeVellis, 2003). In this study, the Kuder-Richardson Formula 20 (KR-20) was the statistical test that was used to assess the MCTT's internal consistency reliability.

Validity is the second component of instrument development. Validity refers to an instrument's accuracy in measuring the intended attribute or phenomenon (Waltz et al., 2010).

The MCTT's content validity and construct validity were both tested. Content validity relates to how well the instrument's items represent the underlying construct (Waltz et al., 2010). Thus, an instrument's content validity is heavily dependent upon the item development process (Waltz et al., 2010). The MCTT's content validity was tested in three stages using a panel of critical thinking experts. Construct validity relates to how well the items of the instrument effectively measure the phenomenon (Waltz et al., 2010). The MCTT's construct validity was tested with a convenience sample of BSN students. An exploratory factor analysis (EFA) was used to examine the shared variance among the MCTT variables and the common factor.

Specific Aim 1

Design

A cross-sectional survey research design was used. The following sections discuss the methodology for Specific Aim 1.

Population and Sample

The targeted population was adults who are experts in critical thinking assessment for nursing education. A convenience sample of critical thinking experts in nursing education was recruited to review the MCTT. The student investigator emailed experts who had these qualifications to invite them to participate in this part of the study.

The major inclusion criterion for content validity testing was expertise regarding nursing students' critical thinking ability assessment. For this study, an expert (age 18–80) was considered any nursing professional who had clinical experience with the critical thinking assessment of nursing students, had conducted research on the topic of critical thinking in nursing education, had published in a peer-refereed journal on the topic of critical thinking in

nursing education, or had professionally presented on the topic of critical thinking in nursing education.

The sample size for content validity testing was guided by Polit, Beck, and Owen (2007). According to the literature, a pool of three experts is sufficient for establishing item and scale content validity if all three experts are in total agreement on all items (Polit et al., 2007). If this pool of experts is not in agreement, a larger pool (8–12) of experts needs to be recruited. Once the larger panel of experts has submitted feedback for the items, a smaller panel (3–5) evaluates the last MCTT items for the final item content validity index (I-CVI) and the final scale content validity index average (S-CVI/Ave) (Polit et al., 2007). In total, 23 experts were emailed and asked to review the MCTT items. In the third stage of CVIs, eleven experts provided usable feedback. For more details regarding the sampling procedure, see the Procedures section.

Ethical Considerations

Prior to conducting the research, the student investigator completed the Collaborative Institutional Training Initiative (CITI) training module. Ethical considerations regarding this study were addressed through the University of Nevada, Las Vegas (UNLV) Institutional Review Board (IRB) process, and the UNLV IRB Protocol (Appendix B) approval was presented to the participating study university, campus A and campus B.

Consent to participate in the expert review was implied if the expert responded and requested the Content Validity Index (CVI) Rater Packet (Appendix C) from the student investigator. To ensure confidentiality for the data obtained with the content validity testing, expert feedback was reported using numbers, and no direct statements from the experts regarding the specific critical thinking items were disclosed to anyone outside the research team. Electronic

feedback from the experts was secured on a personal laptop with a unique username and password.

Procedures

Content validity was established in three stages as outlined in the IRB Protocol (Appendix B). Stages I and II consisted of expert recruitment and the MCTT item review. To recruit experts, the student investigator first identified experts by searching the internet and the literature. After identifying these experts, the student investigator emailed each expert to inquire if the expert would perform an item review of the MCTT. In the email, the student investigator identified herself, the institution and degree program with which she was affiliated, and the nature of her research. The student investigator then informed the expert that he/she met the qualifications for expert review. If the expert emailed and requested the item-review information, the student investigator emailed the CVI Rater Packet (Appendix C), consisting of the CVI Rater Form, the MCTT blueprint, the cognitive dimensions taxonomy, and the MCTT, to the expert. Experts returned the CVI Rater Packet via email to the student investigator within 4–28 days. During stage III, a final expert MCTT review was conducted after the items were modified, based on the experts' feedback, to compute the final I-CVI and S-CVI/Ave of the MCTT. The final review took 10 days. No experts received compensation for their time.

Study Variables

This section describes the three study variables for Specific Aim 1.

Critical thinking ability. In this study, critical thinking ability is conceptually defined as follows: "All or part of the process of questioning, analysis, synthesis, interpretation, inference, inductive and deductive reasoning, intuition, application, and creativity" (AACN, 1998, p. 9).

Content validity. Content validity is conceptually defined as "the extent to which the content of the measure represents the content domain" (Waltz, Strickland, & Lenz, 2010, p. 165). An expert panel was used to establish content validity.

Malaria Critical Thinking Test. The 12 MCTT items were developed to assess for BSN students' critical thinking ability. These items were developed based on information from Hartjes's (2010) *Life and Death in the Age of Malaria* interactive e-learning game and knowledge test. The format of the 12 MCTT items was multiple-choice with only one correct answer for each item. This format was selected because of the similarity to the NCLEX-RN® examination's assessment items. Each of the 12 MCTT items were written at higher cognitive levels (analysis, application, evaluation, and creation) using Bloom's Revised Taxonomy (Anderson et al., 2001) as a guide to elicit critical thinking ability. Table 1 lists the content for each of the 12 MCTT items.

Table 1. Malaria Critical Thinking Test Variables

Malaria Critical Thinking Test item and content	Cognitive domain	Time point	Measurement
MCTT #1 A community health nursing instructor is teaching a group of student nurses about safe travel practices to a known malaria risk region. Which practice should the students identify as a measure to reduce the risk of malaria transmission?	Application	Upon expert review	Score 1–4 on CVI Rater Form
MCTT #2 A nurse is providing information to a client who has a new prescription for anti-malarial medication prior to travel to a malaria risk region. Which of the following explanations by the nurse describes the purpose of this prescription?	Application	Upon expert review	Score 1–4 on CVI Rater Form
MCTT #3 A nurse is caring for a client who is concerned about contracting malaria and asks the nurse how it is diagnosed. The nurse explains that which of the following tests confirms the diagnosis?	Application	Upon expert review	Score 1–4 on CVI Rater Form
MCTT #4 A nurse is talking with a group of friends about her plan to travel to a malaria risk region. Which statement by the nurse indicates the nurse understands the risk for a malaria infection?	Analysis	Upon expert review	Score 1–4 on CVI Rater Form
MCTT #5 The nurse is teaching students about the course of malaria. Which statement made by a student indicates an understanding of the discussion?	Evaluation	Upon expert review	Score 1–4 on CVI Rater Form
MCTT #6 A nurse educator is traveling with a group of students and conducts a seminar to discuss the consequences of malaria infection. Which statement by the nurse educator explains the consequence of malaria infection?	Application	Upon expert review	Score 1–4 on CVI Rater Form
MCTT #7 A senior nursing student is traveling in a malaria risk region and informs a health professional about symptoms he is experiencing. Which symptom would warrant investigation of malaria infection?	Analysis	Upon expert review	Score 1–4 on CVI Rater Form
MCTT #8 A nurse is taking an antimalarial medication daily while sharing a sleeping space with a person who is not taking antimalarial medication. This person later contracts malaria and receives treatment. Which action should the nurse take to reduce the risk for malaria transmission?	Application	Upon expert review	Score 1–4 on CVI Rater Form
MCTT #9 A nursing student who recently returned from a malaria risk region has developed flu-like symptoms and makes an appointment at student health services. Which of the following is the priority information to be obtained by health services personnel during the student's visit?	Evaluation	Upon expert review	Score 1–4 on CVI Rater Form
MCTT #10 A nurse working in a triage center in Uganda notes an increase in clients presenting with fever, chills, headaches, nausea, vomiting, and body aches. Which of the following is the priority teaching action by the nurse for clients who present with symptoms compatible with malaria infection?	Creation	Upon expert review	Score 1–4 on CVI Rater Form
MCTT #11 The nurse conducts an education seminar for students traveling to Ghana. What information should the nurse include about symptoms that are characteristic of malaria infection?	Analysis	Upon expert review	Score 1–4 on CVI Rater Form
MCTT #12 A nurse is teaching a group of students who will be traveling to a high-risk malaria region. The nurse recognizes that teaching is effective when a student states that transmission of malaria most likely occurs in which situation?	Evaluation	Upon expert review	Score 1–4 on CVI Rater Form

Data Collection and Methods

Content Validity Index (CVI) Rater Form. The purpose of the CVI Rater Form (Appendix C) was to collect quantitative feedback about the MCTT from each content expert to compute the I-CVI and S-CVI/Ave. Each expert was asked to rate each MCTT item using a 1–4 scale: 1 = the item is not representative of critical thinking; 2 = the item needs major revisions to be representative of critical thinking; 3 = the item needs minor revisions to be representative of critical thinking; and 4 = the item is representative of critical thinking. The I-CVI for each item was calculated by adding the number of experts who agreed that the item was representative of critical thinking (by assigning the item a 3 or 4) and dividing that number by the total number of experts who reviewed the item. The S-CVI/Ave values were calculated by adding all 12 of the I-CVI scores and dividing that sum by 12. Polit et al. (2007) suggested the goal for I-CVI be at least 0.78, which denoted that the item has an "excellent" rating. For S-CVI/Ave, a value of 0.90 indicated that some items have complete agreement and that there were only a few items with a modest amount of disagreement (Polit et al., 2007).

Malaria Critical Thinking Test. To construct the MCTT, 12 multiple-choice, critical thinking items were created from a set of 18 previously tested malaria knowledge test (MKT) developed by Hartjes (2010). Because the question complexity increased from the original 18 MKT, the number of MCTT items was reduced. Item stems from Hartjes's (2010) malaria risk-reduction knowledge test were modified, with permission, from a basic knowledge-type questioning format targeted for any undergraduate student to an NCLEX-RN® question format that addressed higher levels of cognition to elicit critical thinking ability in BSN students. The question-modification process was guided, first, by defining the phenomenon of interest, critical thinking ability. Next, a test blueprint was written using the conceptual framework, Bloom's

Revised Taxonomy for higher-level cognitive thinking (Anderson et al., 2001; Appendix C), to guide item construction. Modifying the questions for the original malaria-knowledge instrument was necessary because the MCTT's purpose was to assess BSN students' critical thinking ability for the topic of malaria compared to assessing undergraduate students' (not exclusive to nursing) knowledge gain regarding the topic of malaria by playing a malaria risk-reduction e-learning game (Hartjes, 2010). In addition, MCTT items were modified so that the items were representative of Bloom's Revised Taxonomy's higher levels of cognitive thinking (application, analysis, evaluation, and creation), which parallels the formatting of the NCLEX-RN® (AACN, 2006).

The MCTT items were scored as either correct or incorrect, with a correct answer scoring 1 and an incorrect answer scoring 0. The highest possible MCTT score was 12, and the lowest possible score was 0.

Data Management and Statistical Analysis Plan

This section describes the data management and statistical analysis for the content validity testing. The content validity data were collected and maintained electronically on a computer that was located at the student investigator's home residence. Computerized data storage was secured by utilizing a unique username and password that was only accessible to the student investigator.

Content validity analysis was performed based upon the steps outlined by Polit et al. (2007) and with the assistance of Dr. Du Feng, the UNLV School of Nursing's biostatistician. The S-CVI/Ave score was calculated by adding all of the calculated I-CVI values and dividing the I-CVI sum by 12. After calculating the I-CVI and S-CVI/Ave values, these values were compared with the acceptable ratings described in the Data Collection and Methods section.

Specific Aim 2

The purpose of Specific Aim 2 was to establish the MCTT's reliability and construct validity. The following sections discuss the methodology for Specific Aim 2.

Design

A cross-sectional survey research design was used.

Population and Sample

The targeted population for the reliability and construct validity testing portion of this study was adults who were enrolled in a baccalaureate nursing program as juniors or seniors. A convenience sample of junior and senior BSN students enrolled at one university's two Midwest campuses was recruited.

The inclusion criteria for reliability and construct validity testing were students (age 18–65) enrolled in either junior- or senior-level nursing courses. Exclusion criteria were students who had: (a) a malaria diagnosis; (b)any prior experience working with malaria, either in the field or in the research setting; or, (c) prior experience working with infection control.

A priori determination of sample size for Specific Aim 2 was based upon recommendations for instrument development that were found in the literature. Following the recommendations of scale-development and factor-analytic experts, attempts were made to obtain six to ten participants per item for reliability and construct validity testing (DeVellis, 2003). For reliability testing of the 12-item MCTT and using the KR-20 analysis method, a sample size of 200 was determined to be sufficient (DeVellis, 2003; Faul, Erdfelder, Lang, & Buchner (2007); Streiner, Norman, & Cairney, 2015). For EFA, a sample size as low as 60 is considered sufficient if communality values are greater than 0.6; a sample size of 100–200 is

sufficient with lower (e.g., 0.50) communality values (DeVellis, 2003; Russell, 2002). Table 2 describes the sample-size information. The study's final sample size was 219 participants.

Table 2. Reliability and Construct Validity Testing Sample Size

Campus and Course	Course Enroll-ment	# Packets distributed	# Packets not returned	# Packets returned	# Complete packets with useable data	# Incomplete returned packets	# Excluded
Study University–Campus A	39	38	0	38	34	0	4
N342							
N362	35	21	6	15	15	0	0
N404	29	24	0	24	23	0	1
N450	35	33	2	31	30	0	1
Study University–Campus B							
N342	48	43	0	43	41	1	1
N352	48	40	0	40	36	3	1
N450	47	47	0	47	40	0	7
Total	**281**	**246**	**8**	**238**	**219**	**4**	**15**

Ethical Considerations

For Specific Aim 2, the informed consent (Appendix B) explained the nature of the study to the participants, outlined any risks or benefits of participation, and provided the contact information for the principal investigator and the student investigator. Additionally, contact information for the UNLV Office of Research Integrity was also included on the informed consent form. The consent process occurred in the regularly assigned classroom for the participants' nursing courses at both study university campuses. The student investigator managed each participant's privacy. To ensure confidentiality of the data obtained for the reliability and construct validity testing, no names were requested on the informed consent, the

demographic survey, or the MCTT. Additionally, data were entered electronically and stored on a computer that had a unique username and password. A plan for destroying the electronic and paper data was described in the IRB Protocol (Appendix B).

Procedures

The research procedures for Specific Aim 2 are described in this section.

1. The student investigator obtained study approval from the UNLV IRB. No study university IRB review was necessary because no person affiliated with the study university was directly involved with the research process (Appendix B). Instead, a facility authorization letter to conduct research was obtained from each nursing program director at study university–campus A (Appendix D) and study university–campus B (Appendix E).

2. On the scheduled dates and times arranged with the course coordinators, the student investigator provided a brief introduction about the study to the potential participants using a script (Appendix B). After the student investigator introduced the study, the student investigator distributed the study packet (Appendix B), which consisted of a two-page consent, a nine-item demographic survey, a one-page *The Buzz on Malaria* fact sheet, and the 12-item MCTT, to each potential participant. The total time for providing the introduction, distributing the study packet, and completing the study packet was 15–60 min.

3. The student investigator collected the study packets immediately when they were completed. A $5.00 Starbucks gift card was given to each participant who returned a completed study packet. Funding for the incentive was provided by the UNLV School of Nursing Dissertation Grant.

Variables

For Specific Aim 2, the nine demographic variables from the demographic survey, critical thinking ability, the 12 MCTT items related to critical thinking ability, and the malaria fact sheet were examined.

Demographic variables. Demographic variables (Appendix B) were assessed to more clearly understand the sample population. Demographic variables were operationalized by creating a demographic form.

Critical thinking ability. Critical thinking ability is a construct variable and is defined in this study as follows: "All or part of the process of questioning, analysis, synthesis, interpretation, inference, inductive and deductive reasoning, intuition, application, and creativity" (AACN, 1998, p. 9).

Malaria Critical Thinking Test. Twelve multiple-choice items were constructed to assess BSN students' critical thinking ability for the topic of malaria. Items were written to elicit higher-level thinking at the analysis, application, evaluation, and creation levels of cognition using Bloom's Revised Taxonomy as a conceptual model (Anderson et al., 2001). Items written at these higher cognitive domains are intended to capture all elements inclusive of critical thinking ability. The MCTT consists of 12 different variables, and each variable has a designated question.

Basic malaria knowledge. The *Buzz on Malaria* fact sheet was included in the study packet as a method to operationalize the variable, basic malaria knowledge. The fact sheet provided participants with basic facts about malaria: malaria symptoms, diagnostics, and preventative measures.

Data Collection and Methods

Demographic survey. A nine-item demographic survey (Appendix B), modified from Hartjes (2010), was distributed to participant after their consent. Modifying Hartjes's (2010) demographic survey was necessary to reflect the study's pertinent elements. This demographic information served to screen participants for exclusion criteria and to report on the participants' composite characteristics.

Malaria Critical Thinking Test. The 12-item, multiple-choice MCTT was distributed to each participant upon consenting. These items were developed based on information from Hartjes's (2010) *Life and Death in the Age of Malaria* interactive e-learning game and knowledge test. The MCTT items were scored as either correct or incorrect, with a correct answer scoring 1 and an incorrect answer scoring 0. The highest possible MCTT score was 12, and the lowest possible score was 0. The total mean score and average percentage correct were calculated for the MCTT items.

Data Management and Statistical Analysis Plan

Data Management Plan

A data management plan was important to avoid confusion and to ensure organization for the large data quantities. After each scheduled class visit, paper data were collected, and the data were securely stored in a locked file cabinet at the student investigator's home residence. Once all data were collected, a computerized spreadsheet was constructed for data-variable entry using IBM SPSS Statistics for Windows, version 23 Student Grad Pack (IBM Corp., 2013), software. Additionally, a variable code book was written to identify and to define each variable that was entered in the SPSS for Windows, version 23 Student Grad Pack (IBM Corp., 2013), spreadsheet. Computerized data storage and security were set by using a unique username and

password that was only accessible to the student investigator. The data were double entered to ensure accuracy.

Statistical Analysis Plan

Construct validity and reliability analyses of the MCTT were conducted using SPSS for Windows, version 23 Student Grad Pack (IBM Corp., 2013), and with the assistance of Dr. Du Feng, the UNLV School of Nursing's biostatistician. The data were verified, cleaned by removing surveys that were not completed in total, and transformed prior to running the analysis. Data analysis to establish MCTT construct validity and reliability consisted of descriptive statistics, frequencies table analysis, EFA, and KR–20.

Exploratory Factor Analysis of the MCTT. EFA is a statistical method that is used to identify interrelationships among variables as well as the relationship between the variables and an underlying common factor (or latent variable). The EFA terms are defined in Table 3. In general, the strength of the variables' relationship with the common factor indicates that the variables do, in fact, represent the construct that is being measured, indicating the construct's validity.

In this study, the EFA variables were the MCTT's 12 multiple-choice items. EFA was used to determine the strength of the relationship for the 12 MCTT variables with the common factor, critical thinking ability.

To determine the relationship that may exist between the variables and the common factor, different statistical values within the EFA model were assessed. The major statistical values were communality values, eigenvalues, factor loading values, and the percentage of variance explained.

Table 3. Exploratory Factor Analysis: Terms, Definitions, and Examples

Term	Definition	Example
Exploratory Factor Analysis (EFA)	A statistical analysis in which the goal is to describe the variables based on the shared variance or shared feature with a common factor (Tabachnick & Fidell, 2007).	This EFA examines the relationship between the 10 MCTT items (observed variables) and the common factor (or latent variable), critical thinking ability.
Variable	An item that undergoes a statistical test to determine correlations with other like items to reveal patterns that reflect an underlying process (Tabachnick & Fidell, 2007).	Each item on the MCTT is a variable. Each item is created to assess critical thinking ability.
Common Factor	The underlying construct or dimension that a scale is intended to reflect (DeVellis, 2003; Polit & Beck, 2016). The latent variable that produces scores on the variables (Tabachnick & Fidell, 2007).	The purpose of this EFA is to determine if the 10 MCTT variables captured the unobservable phenomenon that the scale was intended to measure.
Factor Loading Value	The regression coefficient of the variable on the factor (Burns & Grove, 2009). The factor loading value expresses the extent that a single variable is related to the group of variables (Burns & Grove, 2009). The range of factor loading values is from -1 to +1. Items with high factor loading values (≥ 0.50) are the most similar to the common factor (Costello & Osborne, 2005; DeVellis, 2003). A strong factor is considered to have at least five variables with factor loading values 0.50 or better (Costello & Osborne, 2005).	Factor loading values > 0.32 are interpreted because those factor loadings explain at least 10% of the variance (0.32^2 = 10%; Tabachnick & Fidell, 2007). This EFA had four items with factor loading values ≥ 0.32: MCTT 1, MCTT 6, MCTT 8, and MCTT 10. These four items were the most similar to the common factor.
Communality	The communality is the amount of variance in a variable across all factors in the analysis (Burns & Grove, 2009). It is calculated as the sum of squared loadings across all factors (Tabachnick & Fidell, 2007).	This EFA has one common factor, so the communality values will be the squared factor loading values for only one factor.
Extraction Communality	This value is the proportion of the variable's variance that is explained by the retained factor or factors (Kline, 1994). Communality values are considered high if they are 0.8 or greater, and moderate to low values are 0.70−0.40.	For this EFA, the extraction communality values ranged from 0.000−0.153. All values were < 0.40, indicating that the variables were probably not related to one another.
Eigenvalue	The eigenvalue is the sum of the squared loadings for each factor (Burns & Grove, 2009). A factor with an eigenvalue ≥ 1 may be considered for factor analysis (Tabachnick & Fidell, 2007).	The amount of total information that has been captured by the common factor for 11 MCTT item EFA = sum of the squared factor loadings (.758).
Shared or Common Variance	The degree to which variables are similar or related within a factor analysis (DeVellis, 2003).	The explained variance is dependent upon the type of analysis (components for factor). A component analysis examines the total variance; a factor analysis examines the shared variance.
Percent (%) of Variance	The proportion of the variance in the original number of variables that has been compacted into the factor (Tabachnick & Fidell, 2007).	The percent of variance for the 10 MCTT item EFA = sum of the squared factor loadings (.758)/number of MCTT items (10) = 7.583 %.
Factor extraction	The process of condensing variables into a smaller number of common factors with similar underlying dimensions (Polit & Beck, 2016).	In this study, a one factor solution is requested due to the small number of instrument variables.
Factor Loading Matrix	A matrix that lists the correlation values between the variable and the common factor (Tabachnick & Fidell, 2007).	A factor is interpreted based upon the variables that correlate highly (factor loading > 0.32) with it (Tabachnick & Fidell, 2007).
Bartlett's Test of Sphericity	Used to test for the null hypothesis that the correlation matrix is an identity matrix and to verify the assumption of equal variance. It indicates that there is at least some degree of variance among the variables (Tabachnick & Fidell, 2007).	In this study, rejecting the null hypothesis would mean that there are significant relationships between the variables used to assess critical thinking ability.
Kaiser-Meyer Olkin (KMO) Measure of Sampling Adequacy	Statistical test used to determine the adequacy of the sample for correlational analysis. This test indicates that there are relationships among the variables and the factor(s). KMO values are between 0 and 1. High values (0.5-–1) indicate that factor analysis is appropriate (Yong & Pearce, 2013).	The KMO value for the 10 variable analysis was 0.543, indicating relationships among the variables and common factor and the data set was appropriate for EFA.

Reliability. The KR–20 statistical test was selected because this test is appropriate for cognitive measurement. When cognitive measures are of concern, as in this study, tests of internal consistency to estimate reliability are more appropriate than norm-referenced reliabilities (Waltz et al., 2010). Norm-referenced reliability procedures, such as the test-retest procedure, are typically used to assess the reliability of affective measures because affective characteristics are not likely to change rapidly (Waltz et al., 2010). However, cognitive characteristics can and do change rapidly, especially in the educational setting; therefore, it was appropriate to use a measure of internal consistency reliability for the MCTT (Waltz et al., 2010). The KR–20, an internal consistency reliability measure, was an appropriate statistical test to use for establishing the MCTT's reliability because the MCTT is a test of cognitive measurement and the MCTT's data are dichotomously scored (Waltz et al., 2010). A KR–20 reliability value of 0.50 or higher would confirm satisfactory internal consistency reliability of the MCTT because the MCTT is a short (12–item) test with a multiple-choice format (Kehoe, 1995). Additionally, using the KR–20 for internal consistency reliability is an appropriate test for scale reliability because the KR–20 statistic would establish the relationship degree among all items that are aimed to measure a single phenomenon (DeVellis, 2003). Items that are highly correlated with one another most likely indicate that the items measure the same phenomenon. Table 4 lists reliability terms, definitions, and examples.

Table 4. Reliability: Terms, Definitions, and Examples

Term	Definition	Example
Internal Consistency Reliability	The degree to which the items of an instrument consistently measure the same general construct (Waltz et al., 2010). An internal consistency reliability score of 0.70 or greater would indicate acceptable reliability.	Eleven items of the MCTT were measured for internal consistency reliability by administering the test to cohorts of BSN students at one university. The internal consistency reliability for the 10 MCTT variables was 0.346.
Kuder-Richardson Formula 20 (KR–20)	A statistical test of the internal consistency reliability that is specifically used for dichotomous data (Waltz, et al., 2010).	MCTT items were scored as correct or incorrect. The KR–20 was then calculated using statistical software. The KR–20 for the 10 MCTT variables was 0.346.
Corrected Item–Total Correlation	The degree to which each item correlates with other items. Low values (0.2–0.3) indicate that the item is measuring something other than what the overall scale intends to measure. Items with low values do not fit well with the other items on the instrument and should be considered for deletion (Oppenheim, 1992).	All MCTT items had a Corrected Item–Total Correlation of < 0.30, and MCTT 8 had the highest Corrected Item-Total Correlation of 0.242.

CHAPTER 4

RESULTS

This study tested the psychometric properties of the Malaria Critical Thinking Test (MCTT). The two specific aims of this study were to (a) test the MCTT's content validity and (b) test the MCTT's construct validity and reliability. This chapter presents the findings for each of the study's specific aims.

Specific Aim 1

The procedure to establish the MCTT's content validity was guided by Polit et al. (2007). Critical thinking experts were recruited to review the MCTT at three different stages of development. The following paragraphs describe the procedure for the MCTT review and the results of the review for establishing content validity.

In Stage I, two of six (33%) experts declined to review the MCTT because of other commitments. One (17%) expert did not respond to the initial email, and no further follow-up was made. Therefore, only three of the six (50%) experts provided feedback. At the end of this stage, there was usable content validity feedback from the three experts.

Table 5 shows the expert feedback. Seven of the 12 items received an I-CVI score of 1.00, indicating that they were representative of critical thinking ability. Four items had an I-CVI score of 0.67, indicating that those items required moderate revision. One item, MCTT 5, received an I-CVI score of 0.33, indicating that major revision or deletion of that item was necessary. Due to the small number of items, the student investigator chose to revise MCTT 5 before the next stage of item review. The other MCTT items with I-CVI scores of 0.67 were not selected to be revised before the second stage of review because the items could achieve acceptable I-CVI scores with the larger expert panel review. The experts' quantitative and

qualitative feedback was used to guide the MCTT's item revision in order to prepare for a second round of reviews with a larger expert panel.

Table 5. Content Validity Expert Feedback Stage I

	I#1[a]	I#2	I#3	I#4	I#5	I#6	I#7	I#8	I#9	I#10	I#11	I#12
E1[b]	✓[c]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
E2	✓	✓	–[d]	✓	–	✓	–	✓	✓	✓	–	–
E3	✓	✓	✓	✓	–	✓	✓	✓	✓	✓	✓	✓
#Agree[e]	3	3	2	3	1	3	2	3	3	3	2	2
I-CVI[f]	1.00	1.00	0.67	1.00	0.33	1.00	0.67	1.00	1.00	1.00	0.67	0.67
S-CVI/Ave[g] = 0.83 (Average of the I-CVIs for all items on the MCTT)												

Note. [a] Indicates MCTT item number. [b] Indicates expert reviewer. [c] A ✓ represents an expert score of 3 or 4 assigned to the item on the CVI Rater Form. [d] A – represents an expert score of 1 or 2 assigned to the item on the CVI Rater Form. [e] The number of experts who agree that the item is representative of critical thinking. [f] The Item Content Validity Index (I-CVI) score for each MCTT item (I-CVI acceptable values ≥ .78). [g] S-CVI/Ave is the overall computed scale content validity average (S-CVI/Ave acceptable values 0.80–1.00).

In Stage II, an additional 13 experts were emailed for recruitment. Again, the student investigator conducted an Internet and literature search to identify experts who had qualifications for MCTT review. Seven of the thirteen (54%) experts agreed to provide content validity feedback; six (46%) experts declined review or did not reply. Of the seven experts who returned feedback, the feedback from six (46%) experts was usable. Feedback from one expert was omitted due to expressed bias. Therefore, by the end of Stage II, there was usable content validity feedback from nine experts.

Table 6 shows the expert feedback from Stage II. Five items had an I-CVI of 1.00; three items had an I-CVI of 0.89; three items had an I-CVI of 0.78; and one item had an I-CVI of 0.67 (Table 6). Stage II feedback indicated that only one item (MCTT 3) required further revision based upon the I-CVI values. Once MCTT 3 was revised, a third and final review was required to establish the MCTT's final content validity (Polit et al., 2007).

Table 6. Content Validity Expert Feedback Stage II

	I#1[a]	I#2	I#3	I#4	I#5	I#6	I#7	I#8	I#9	I#10	I#11	I#12
E1[b]	✓[c]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
E2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
E3	✓	✓	–[d]	✓	✓	✓	–	✓	✓	✓	–	–
E4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
E5	✓	✓	✓	✓	–	✓	✓	✓	✓	✓	✓	✓
E6	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
E7	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
E8	✓	✓	–	✓	✓	✓	✓	✓	–	–	✓	✓
E9	✓	✓	–	✓	✓	✓	–	✓	✓	✓	–	–
#Agree[e]	9	9	6	9	8	9	7	9	8	8	7	7
I-CVI[f]	1.00	1.00	0.67	1.00	0.89	1.00	0.78	1.00	0.89	0.89	0.78	0.78
S-CVI/Ave[g] = 0.89 (Average of the I-CVIs for all items on the MCTT)												

Note. [a] Indicates MCTT item number. [b] Indicates expert reviewer. [c] A ✓ represents an expert score of 3 or 4 assigned to the item on the CVI Rater Form. [d] A – represents an expert score of 1 or 2 assigned to the item on the CVI Rater Form. [e] The number of experts who agree that the item is representative of critical thinking. [f] The Item Content Validity Index (I-CVI) score for each MCTT item (I-CVI acceptable values ≥ .78). [g] S-CVI/Ave is the overall computed scale content validity average (S-CVI/Ave acceptable values 0.80–1.00).

In Stage III, a final review panel of five experts was selected to complete the MCTT's content validity testing. A final review was necessary because feedback from the Stage II review indicated that revisions were required for MCTT 3. Of these five experts, three (60%) people provided content validity feedback; one expert provided content validity feedback for both Stages II and III; and two (40%) experts did not reply, and no further follow-up was made. By the end of Stage III, there was usable content validity feedback from a total of 11 experts.

For the final stage of instrument development, all three experts agreed that each item on the MCTT was representative of critical thinking because all MCTT items received an I-CVI of 1.00. The mean I-CVI for all 12 items on the MCTT yielded an S-CVI/Ave of 1.00 (Table 7), meaning that, in the final stage of development, all items on the MCTT were considered to be representative of critical thinking.

Table 7. Content Validity Expert Feedback Stage III

	I#1[a]	I#2	I#3	I#4	I#5	I#6	I#7	I#8	I#9	I#10	I#11	I#12
E1[b]	✓[c]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
E2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
E3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
#Agree[e]	3	3	3	3	3	3	3	3	3	3	3	3
I-CVI[f]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
S-CVI/Ave[g] =1.00 (Average of the I-CVIs for all items on the MCTT)												

Note. [a] Indicates MCTT item number. [b] Indicates expert reviewer. [c] A ✓ represents an expert score of 3 or 4 assigned to the item on the CVI Rater Form. [d] A – represents an expert score of 1 or 2 assigned to the item on the CVI Rater Form. [e] The number of experts who agree that the item is representative of critical thinking. [f] The Item Content Validity Index (I-CVI) score for each MCTT item (I-CVI acceptable values ≥ .78). [g] S-CVI/Ave is the overall computed scale content validity average (S-CVI/Ave acceptable values 0.80–1.00).

Specific Aim 2

Sample and Demographics

The purpose of Specific Aim 2 was to test the MCTT's reliability and construct validity. Surveys were collected from 238 participants. Fifteen (6%) of the participants indicated they had a prior malaria diagnosis, prior experience working with malaria either in the field or in the research setting, or prior professional experience working in infection control and were excluded from the study. Four (2%) participants chose not to participate and turned in blank study packets. Once the data were cleaned and verified, there were usable data from 219 (92%) participants to test the MCTT's reliability and construct validity.

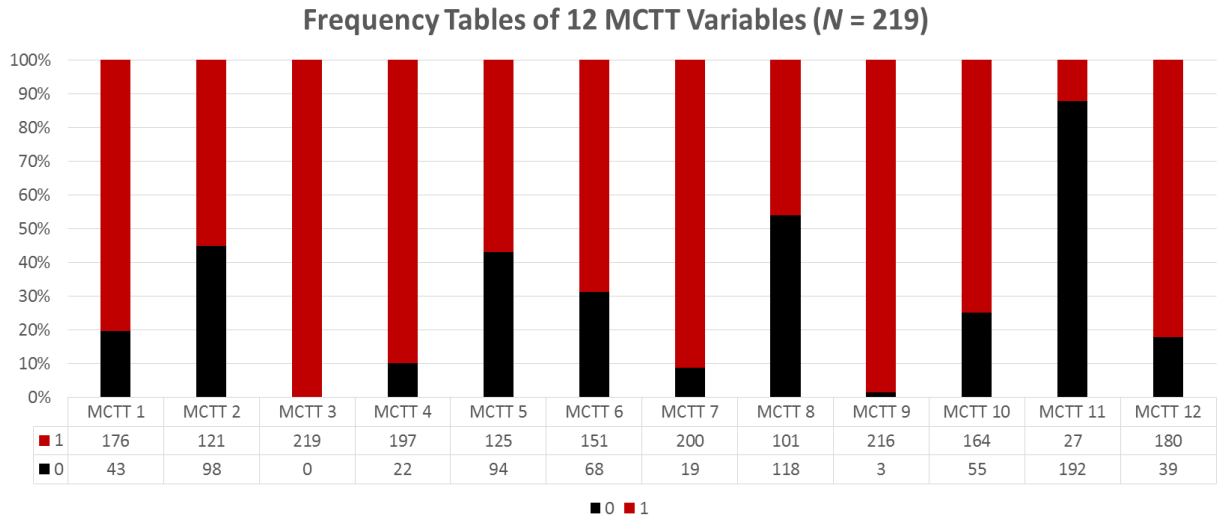
Demographic information was collected to describe the sample. The participants' age range, in years, was 19-53. Almost 81% of the participants (n = 177) were between the ages of 19 and 23. Females made up 89% of the participants (n = 194). Fifty-eight percent (n = 127) of the participants were juniors, and 41% (n = 90) were seniors. Two participants did not specify their program year. Campus affiliation was almost evenly divided with 103 (47%) of the participants enrolled at the study university–campus A campus and 107 (49%) of the participants enrolled at the study university–campus B. Nine (4%) participants did not indicate any campus

affiliation. Ninety-four percent (n = 206) of the participants were Caucasian; 2% (n = 4) were African American; and 4% (n = 9) were Asian, Native American, Pacific Islander, or Other.

Frequency Table Analysis

A frequency table analysis of the 12 MCTT variables was used to identify any variables that emerged as constants. All participants (N = 219) answered MCTT 3 correctly, indicating that this item was a constant and was removed from further statistical analysis. Table 8 lists the frequencies of the 12 MCTT variables.

Table 8. Frequency Tables of 12 Malaria Critical Thinking Test Variables



	MCTT 1	MCTT 2	MCTT 3	MCTT 4	MCTT 5	MCTT 6	MCTT 7	MCTT 8	MCTT 9	MCTT 10	MCTT 11	MCTT 12
1	176	121	219	197	125	151	200	101	216	164	27	180
0	43	98	0	22	94	68	19	118	3	55	192	39

Note. The MCTT score is correct (1) or incorrect (0).

Construct Validity Testing of the Malaria Critical Thinking Test

After the one constant (MCTT 3) was removed, the remaining 11 MCTT variables were subject to an exploratory factor analysis using the principal axis factoring (PAF) extraction method. The PAF extraction method was selected because only common variance was analyzed (Tabachnick & Fidell, 2007). No rotation was used because only one factor was requested for

extraction. First, the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity were conducted to confirm that the remaining 11 MCTT variables were suitable for exploratory factor analysis. Both tests indicated that the remaining 11 MCTT variables were suitable for factorability (KMO = 0.548; Bartlett's Test of Sphericity $p = 0.002$). A one factor extraction solution was requested for the analysis due to the small number of variables. Extracted communality values ranged from 0.000 – 0.168. The common factor had an eigenvalue of 1.666 prior to extraction and explained 15% of the total variance for all 11 MCTT variables. After extraction, the common factor only explained 7% of the total variance for all 11 MCTT variables. Next, factor loading values were examined from the factor matrix. Factor loading values of each of the 11 MCTT variables ranged from -0.174–0.410 (Table 9). MCTT 11 had a factor loading value of -0.174 indicating that this variable was a weak indicator of the common factor. A decision was made to remove MCTT 11 from further analysis.

Table 9. Factor Loading Matrix of 11 Malaria Critical Thinking Test Variables

Variable	Factor 1
MCTT 10[a]	0.410
MCTT 8	0.398
MCTT 6	0.387
MCTT 1	0.352
MCTT 9	0.261
MCTT 4	0.184
MCTT 5	0.178
MCTT 11	-0.174
MCTT 7	0.150
MCTT 12	0.031
MCTT 2	-0.020

Note. [a] The MCTT score is correct (1) or incorrect (0).

A second exploratory f actor analysis using the principal axis factor extraction method was conducted for the remaining 10 MCTT variables. The KMO and Bartlett's Test of Sphericity

indicated that the remaining 10 variables were suitable for factorability (KMO = 0.543; Bartlett's Test of Sphericity $p = 0.001$). A one factor extraction solution was requested for analysis. Communality values ranged from 0.000–0.153. The common factor had an eigenvalue of 1.635 prior to extraction and explained 16% of the total variance for all 10 MCTT variables. After extraction, the common factor explained 7.5% of the total variance for all 10 MCTT variables. Next, factor loading values were examined from the factor matrix. Factor loading values of each of the 10 MCTT variables ranged from -0.017–0.391 (Table 10). A decision was made to test the MCTT internal consistency reliability with the remaining 10 MCTT variables.

Table 10. Factor Loading Matrix of 10 Malaria Critical Thinking Test Variables

Variable	Factor 1
MCTT 8[a]	0.391
MCTT 6	0.381
MCTT 10	0.380
MCTT 1	0.373
MCTT 9	0.294
MCTT 5	0.203
MCTT 4	0.189
MCTT 7	0.115
MCTT 2	-0.017
MCTT 12	0.013

Note. [a] The MCTT score is correct (1) or incorrect (0).

Reliability Testing of the Malaria Critical Thinking Test

The KR-20 was used to measure the internal consistency reliability because the MCTT variables were scored dichotomously (correct, scored as 1, or incorrect, scored as 0). Table 11 lists the means and standard deviations of the 10 MCTT variables. The mean MCTT score was 7.45 ($SD = 1.542$), indicating that the mean correct score was 74.5%. The KR-20 of the 10 MCTT variables was 0.346. An alpha value of (a) 0.90 or above equals excellent reliability, (b) 0.80–0.90 is very good for classroom tests, (c) 0.70–0.80 is good, (d) 0.60–0.70 is low, (e) 0.50–

0.60 indicates a need for test revision (unless the test has 10 or fewer items), and (f) 0.50 or below indicates questionable reliability (DeVellis, 2003).

Table 11. Malaria Critical Thinking Test: Variable Means and Standard Deviations

Variable	Content	M	SD	N
MCTT 1[a]	A community health nursing instructor is teaching a group of student nurses about safe travel practices to a known malaria risk region. Which practice should the students identify as a measure to reduce the risk of malaria transmission?	0.80	0.398	219
MCTT 2	A nurse is providing information to a client who has a new prescription for anti-malarial medication prior to travel to a malaria risk region. Which of the following explanations by the nurse describes the purpose of this prescription?	0.55	0.498	219
MCTT 4	A nurse is talking with a group of friends about her plan to travel to a malaria risk region. Which statement by the nurse indicates the nurse understands the risk for a malaria infection?	0.90	0.301	219
MCTT 5	The nurse is teaching students about the course of malaria. Which statement made by a student indicates an understanding of the discussion?	0.57	0.496	219
MCTT 6	A nurse educator is traveling with a group of students and conducts a seminar to discuss the consequences of malaria infection. Which statement by the nurse educator explains the consequence of malaria infection?	0.69	0.464	219
MCTT 7	A senior nursing student is traveling in a malaria risk region and informs a health professional about symptoms he is experiencing. Which symptom would warrant investigation of malaria infection?	0.91	0.282	219
MCTT 8	A nurse is taking an antimalarial medication daily while sharing a sleeping space with a person who is not taking antimalarial medication. This person later contracts malaria and receives treatment. Which action should the nurse take to reduce the risk for malaria transmission?	0.46	0.500	219
MCTT 9	A nursing student who recently returned from a malaria risk region has developed flu-like symptoms and makes an appointment at student health services. Which of the following is the priority information to be obtained by health services personnel during the student's visit?	0.99	0.117	219
MCTT 10	A nurse working in a triage center in Uganda notes an increase in clients presenting with fever, chills, headaches, nausea, vomiting, and body aches. Which of the following is the priority teaching action by the nurse for clients who present with symptoms compatible with malaria infection?	0.75	0.435	219
MCTT 12	A nurse is teaching a group of students who will be traveling to a high-risk malaria region. The nurse recognizes that teaching is effective when a student states that transmission of malaria most likely occurs in which situation?	0.82	0.383	219

Note. [a] The MCTT score is either correct or incorrect.

Item-total statistics of the 10 variables (MCTT items) are presented in Table 12. The corrected item-total correlation can be interpreted as how well the item fits with the scale's other items. Corrected item-total correlation values that are close to zero indicate that those variables do not measure what the rest of the scale's items are measuring (Polit & Beck, 2016). All variables have corrected item-total correlation values that are less than 0.30, indicating that no variables are reliable measures of the scale.

Table 12. Item–Total Statistics of 10 Malaria Critical Thinking Test Variables

Variable[a]	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
MCTT 1	0.202	0.290
MCTT 2	0.017	0.382
MCTT 4	0.146	0.318
MCTT 5	0.122	0.327
MCTT 6	0.205	0.283
MCTT 7	0.056	0.346
MCTT 8	0.242	0.259
MCTT 9	0.113	0.338
MCTT 10	0.192	0.291
MCTT 12	0.019	0.365

Note. [a] Variables are scored as "correct" or "incorrect."

CHAPTER 5

DISCUSSION

The final chapter includes the study's major findings, limitations, and implications. Next, the lessons learned and recommendations for future research are discussed. Finally, study conclusions are presented.

Discussion of Major Findings

The major findings of this research were acceptable content validity and low reliability and construct validity for the MCTT. A discussion of the MCTT's psychometric testing is presented.

Content Validity of the Malaria Critical Thinking Test

The three-stage, expert review process resulted in acceptable MCTT content validity. All MCTT items had an I-CVI of 1.00 ("excellent") and the S-CVI/Ave was 1.00. A total of 366 studies cite the Polit et al. (2007) process. In the nursing student literature, Polit et al. (2007) have been cited 51 times. Further inspection of these studies indicate that over 60% of the articles use the Polit et al. (2007) process for developing Likert scale self-report instruments, not cognitive assessment instruments. None of the articles citing Polit et al. (2007) focused on critical thinking ability assessment. It is possible that the Polit et al. (2007) process was not appropriate for cognitive instrument development.

The first reason that this expert review process may not have been the best technique for establishing the content validity of the MCTT relates to the reporting process for establishing I-CVI and S-CVI/Ave. The lack of a standardized method for computing scale-level statistics limits the ability to draw conclusions regarding the overall validity of an instrument. Polit and Beck (2006) indicated that although the CVI is the most commonly reported content validity

measure for instrument development in the nursing literature, the processes for achieving CVI and S-CVI values are under described (Polit & Beck, 2006). In a further literature review, Polit and Beck (2006) found three issues concerning the practice of obtaining, calculating, and reporting scale-level statistics. The first issue relates to the reporting process for establishing I-CVI and S-CVI statistics. The lack of clear explanation of the processes involved for establishing instrument I-CVI and S-CVI is problematic because it forces the reader to make inferences about the calculation methods. Polit et al. (2007) discussed three different ways of calculating S-CVI statistics, and the results of the three methods lead to varying validity instrument results using the same data set. For example, in this study, S-CVI was calculating using I-CVI average, and the S-CVI value was acceptable. However, this calculation method could lead to an overestimation of scale content validity. Calculating the S-CVI/UA of an instrument using the same data could result in an S-CVI that is unacceptable, but also may be too stringent.

An accepted and standardized computation and reporting process would enhance the overall understanding about the content validity properties of the instrument. Polit et al. (2007) explained the discrepancy for calculating S-CVI statistics. The wide range among three calculation techniques presents issues pertaining to the instrument's overall content validity. Polit and Beck (2006) discussed two methods for computing content validity, S-CVI/Ave and scale-content validity index universal agreement (S-CVI/UA). The S-CVI/Ave is the average of all I-CVI scores. The S-CVI/UA is a proportion of items on an instrument that received a score of 3 ("the item needs minor revisions to be representative of the phenomenon") or 4 ("the item is representative of the phenomenon") by all expert reviewers. Thus, depending on the calculation method, a scale could be considered acceptable or unacceptable using the same data. Calculations that are too liberal (S-CVI/Ave) may lead to an instrument that does not prove to

have adequate validity; therefore, the items on the scale will not adequately measure the underlying phenomenon. The method used for establishing the S-CVI in this study most likely overestimated the MCTT content validity. More research regarding the best practice for calculating an instrument's S-CVI is warranted.

The third issue concerning the process of establishing the MCTT's content validity relates to the discrepancy about the number of experts recommended for the I-CVI and S-CVI calculation processes (Polit & Beck, 2006; Polit et al., 2007). The number of experts ultimately depends on agreement. For example, if three experts are recruited for the I-CVI and S-CVI review and all experts agree about all items, then no further review is necessary. However, an approach with too few experts could result in an underrepresentation of the measured construct. Conversely, an expert panel that is too large (i.e., 16 or more experts) would increase the chance for overall disagreement, leading to a more cumbersome instrument-development process. Polit and Beck (2006) suggest that instrument developers using 3 to 5 experts would need to achieve I-CVI of 1.0 for all items to consider the instrument "excellent" and a minimum I-CVI of 0.78 if using an expert panel of 6 to 10 experts to consider the instrument "excellent." Additionally, an "excellent" instrument would achieve a 0.90 S-CVI. In the current study, the experts in the first round of item review were not in universal agreement about all MCTT items, so a second stage of item review was required. The lack of clear recommendations for expert review creates challenges for the researcher. An expert panel should be large enough to provide a comprehensive review of the measured construct, yet not too large where consensus about items cannot be achieved.

Construct Validity of the Malaria Critical Thinking Test

The 12 MCTT variables did not establish the MCTT's construct validity. The communality values for all MCTT variables that were obtained during the EFA were low (< 0.50), indicating that the major proportion of each variable's variance cannot be explained by a common factor.

One explanation for these low communality values could be that each variable might have been assessing a different kind of cognitive attribute that is similar to critical thinking ability, but not entirely representative of critical thinking ability. For example, certain MCTT items could have assessed reflexive comparison instead of critical thinking ability. Reflexive comparison is a technique that students use to make judgements and decisions about a situation after comparing against known standards (Banning, 2008). An example of reflexive comparison is if a participant used prior clinical experiences to make an educated guess on the MCTT. Although a definition for critical thinking ability was included on the CVI Rater Packet, perhaps including specific examples of what critical thinking ability is and is not would have been beneficial for the experts during the review process.

Developing and testing more items that specifically represent the different attributes of critical thinking ability would also improve the MCTT's reliability and validity. The MCTT was originally developed to assess the four higher-level cognitive domain with three critical thinking ability questions per domain. The results from the EFA and reliability testing indicate that the MCTT has an insufficient number of items. Testing construct validity of an instrument with too few items is problematic. An instrument with too few items may not capture the construct and associated dimensions that the instrument is intended to measure (Waltz et al., 2007). Increasing the number of MCTT items from 12 items total to at least 20 items per each of the higher-level

cognitive domains (application, analysis, evaluation, and creation) may positively impact both the reliability and construct validity of the MCTT. Therefore, future MCTT testing would involve developing and testing a minimum of 80 higher–level cognitive items.

Factor analysis for scale development considers the number of items in the initial item pool instead of the number of items that are actually retained for the final scale (Costello & Osborne, 2005). Thus, the subject-to-item ratio for factor analysis ranges from 2:1 to greater than 100:1. However, a 20:1 subject-to-item ratio is recommended to ensure the best possibility for the correct factor structure (Costello & Osborne, 2005). For future MCTT development, a subject-to-item ratio of at least 20:1 would be ideal instead of the current MCTT's final subject-to-item ratio of 4:1. A larger subject-to-item ratio ensures that there are sufficient items accurately associated with the common factor and reduces the chance of error (Costello & Osborne, 2005).

Reliability of the Malaria Critical Thinking Test

It was unexpected for the MCTT to demonstrate low reliability because experts deemed acceptable MCTT content validity. This low reliability was likely due to the high ($\geq$ 75%) mean scores for 6 of the 10 MCTT items analyzed for internal consistency reliability. There are four possible explanations for these high mean scores.

One explanation might be attributed to the level of the nursing students who were tested. Junior- and senior-level BSN students may have already developed critical thinking ability through the completion of prerequisite and current nursing courses, and were able to apply these skills—analysis, application, evaluation, and creation (Anderson et al., 2001)—to higher-level cognitive tests, explaining the items' overall high mean scores. Findings from previous studies indicated that critical thinking ability improves over time as the student progresses through the

nursing program (Angel et al., 2000; Gross et al., 1987; Hsieh & Hsu, 2013; Miller 1992; Poole, 1989; Sandor et al., 1998). Therefore, the MCTT may not have been written at a level to discriminate among those junior and senior nursing students who were able to critically think at a higher level than their peers.

A second possible explanation for the high MCTT item mean scores could be related to the students' overall scholastic aptitude. For example, students' scholastic aptitude characteristics, GPA as well as SAT verbal and quantitative scores, are positive correlates of BSN students' critical thinking ability (Brigham, 1989; Kokinda, 1989; Miller, 1992; Stone et al., 2001; Tiessen, 1987). However, GPA or the SAT verbal and quantitative scores were not requested from the participants of this study. Therefore, no inferences about critical thinking ability and this sample's GPA and SAT verbal and quantitative scores can be made.

Issues related to the expert review process may also explain the high MCTT-item mean scores. Experts were recruited based on their critical thinking knowledge and were asked to evaluate each MCTT item for critical thinking representativeness. It is unknown if any of the reviewers had expertise with malaria or infectious diseases because no demographic data were collected from the expert panel. Furthermore, without demographic data, it is difficult to determine if the expert panel was appropriate for evaluating the MCTT variables. An indication that the expert panel may not have been appropriate for evaluating the MCTT variables could be the high mean scores of the MCTT. The high mean scores indicated that the MCTT items were too easy and did not actually assess for critical thinking ability. Therefore, the inability to describe the suitability of the content validity expert panel jeopardizes the MCTT reliability and construct validity.

Finally, another reason for high MCTT item mean scores related to the expert-review process may be that the malaria fact sheet was not included with the CVI Rater Packet that was reviewed. The malaria fact sheet included with the study packet was used to provide factual knowledge about the disease to prompt critical thinking about the topic. However, this fact sheet was not included in the expert CVI Rater Packet and contained verbatim answers for two MCTT items. If this fact sheet had been reviewed along with the MCTT, then the experts would have probably advised revisions for the MCTT items or the fact sheet. With these revisions, the items would have been more discriminatory and, perhaps, led to higher reliability and construct validity scores. Therefore, one lesson learned about establishing content validity is to ensure that the experts review all materials that participants will receive, even if an additional review is required. Although the content validity process had begun before the decision was made to use a fact sheet, there were subsequent stages during which the student investigator could have provided the experts with the fact sheet.

Study Limitations

Limitations

The study's limitations include demographic, procedural, and statistical limitations. Further details about each type of limitation are discussed.

Demographic limitation. The study's demographic limitation was the homogeneity of the sample for reliability and construct validity testing. For example, only 2% (n = 4) of the respondents were African American compared to the national average of 12.8% of the BSN students being African American (NLN, 2014a). Additionally, 4% (n = 9) of the total respondents indicated Asian, Native American, Pacific Islander, or Other as their race-ethnicity. Nationally, Asian students account for 5.8% of the BSN enrollment; Hispanic students account

for 7.3% of the BSN enrollment; Pacific or Hawaiian Islander students account for 0.5% of the BSN enrollment; American Indian or Alaskan Native students account for 0.7% of the BSN enrollment; and Other accounts for 5.9% of the BSN student enrollment (NLN, 2014a). A lack of race-ethnic diversity with the study sample limits the generalizability of the findings.

Procedural limitations. Three procedural limitations of this study are discussed. The first one relates to the expert pool. Expert selection was done using an online search for nursing professionals with expertise in critical thinking assessment. The criteria for expertise with critical thinking included publishing on the topic of critical thinking, professional presentations about critical thinking, and/or conducting research about critical thinking. One limitation to this selection process was that no information was collected regarding the recency of their critical thinking expertise. Additionally, in contrast to Lavoie et al. (2016), no information was requested from this study's experts regarding age, educational preparation, race/ethnicity, professional certifications, current practice areas, or experience/knowledge regarding malaria or tropical diseases. Lack of expert panel demographic information limits the ability to determine of the expert panel was suitable for evaluating the MCTT content validity. Collecting the experts' demographic information would have been helpful to describe characteristics of the overall expert panel related to (a) critical thinking ability assessment and/or (b) malaria or infectious-disease prevention. The lack of expert demographic information about the experts limits the ability to judge whether the expert panel was appropriate.

A potential threat to internal validity was related to the procedure for testing the reliability of students at different points in their education. Critical thinking ability may mature over time as a natural process, so it is important to control for the maturation effect. The addition of a control group when testing a cognitive instrument would be helpful to determine the true

critical thinking ability rather than assessing different student levels (juniors and seniors) at various points in their education.

The final procedural limitation relates to participant sampling for the reliability and construct validity testing. Participants from only one Midwest university were sampled. Multi-site sampling with more students would enhance the MCTT's psychometric properties because of the likelihood of a more representative sample of all U.S. BSN students. A more representative sample of BSN students would enhance the generalizability of the MCTT.

Statistical limitation. Reliability and construct validity of the MCTT were not established in this study. As a result, confirmatory factor analysis (CFA) was not appropriate. CFA is appropriate if an acceptable KR–20 is achieved and if the EFA indicates a strong relationship among the MCTT variables and the common factor. Conducting a CFA is important for validating the relationship between the MCTT variables and critical thinking ability. CFA would confirm that participants' MCTT scores are caused by their critical thinking ability. Therefore, the major statistical limitation of this study is that CFA was not performed.

Implications for the Study Findings

One important implication of this study's findings is that the development of a malaria critical thinking ability tool has begun. The development of the MCTT offers nursing education a unique tool that assesses specifically for critical thinking ability in BSN students. If acceptable psychometric properties are established, then additional studies could be conducted to determine if there is a link between the MCTT score and other NCLEX-RN predictive factors (e.g., GPA and SAT scores).

Lessons Learned and Recommendations for Future Research

Lessons Learned

This research brought to light three lessons. First, a procedural lesson was to implement a different participant-exclusion-criteria screening process for the reliability and construct validity testing. The student investigator was the only person collecting data; therefore, screening participant packets for the exclusion criteria was difficult, and participants who indicated exclusion criteria but still turned in a packet were given a gift card for study completion. In the future, a research assistant would be helpful to screen packets for exclusion criteria, ensuring that only those participants who met the inclusion criteria and completed the packet in full were awarded a gift card for participation.

The second lesson related to scheduling the classroom visits. It was time consuming to contact course instructors, individually, via email and to follow-up when scheduling classroom visits. The scheduling inefficiency led to a classroom visit for one group of participants on their last day of classes. The last scheduled visit for data collection was challenging because the study competed with the end-of-semester wrap-up events. For planning purposes, it may have been more efficient to request time during a faculty meeting early in the semester to introduce the study, to answer the faculty's questions, and to schedule all the classroom visits with the lead instructors.

Finally, the third lesson related to the malaria fact sheet. The fact sheet was constructed after the MCTT items were written. More careful attention between information on the fact sheet and MCTT items would have eliminated obvious MCTT item answers found verbatim on the fact sheet. More close attention to the information on both the MCTT and the fact sheet could have had in impact on the overall mean score of the MCTT. Additionally, the fact sheet was not

included in the CVI Rater Packet for expert review. Including the fact sheet in the CVI Rater Packet could have also caught the verbatim information on the fact sheet and the MCTT items.

Recommendations for Future Research

Based upon the discussion of the major findings, five recommendations for future development and psychometric testing of the MCTT are proposed.

The first recommendation for future studies relates to the demographic information about the expert panel who did the reviews for content validity testing. Demographic information should be collected from the expert panel's members. Demographic information about the experts is needed to describe the expert panel in order to make determinations regarding the expert reviewers' appropriate qualifications. Experts selected for the content validity review portion of the psychometric testing need to demonstrate expertise that qualifies them for the review. As previously mentioned, these criteria may include special training in the content area, research conducted on the content topic, national presentation on the content topic, publication about the topic in a peer-reviewed journal, or clinical expertise on the content topic. In addition, for experts to be considered for the item review process, each expert should provide a short discussion regarding their most current work in the content area.

The second recommendation relates to nursing students' education level. Testing students at different education levels (e.g., junior in the first semester or senior in the last semester) does not control for the maturation effect, creating a threat to internal validity. Rather than testing any junior- or senior- level nursing student for his/her current critical thinking ability, testing a specific group of students at different points as they progress through the program may help control for the maturation effect.

Next, studies should include a diverse student sample for reliability and construct validity testing. An ethnically diverse sample of students that is more representative of the NLN demographics will enhance the generalizability of the MCTT's reliability and construct validity testing of the MCTT. Furthermore, employing the MCTT for psychometric testing at multiple colleges and universities across the country would diversify the sample's student characteristics and academic demographics. The MCTT is intended to be a standardized critical thinking ability test for assessing baccalaureate nursing students, so generalizability to the NLN-reported BSN students' demographic is important.

The fourth recommendation relates to using prompts to encourage meaningful learning. For example, instead of offering a fact sheet about malaria, a prompt in the form of a small memory game or different mnemonics about malaria may be more useful to foster meaningful learning. Mnemonics are strategies that have been used in education to help promote long-term memory, improve the application of knowledge to practice, and jog or aid memory recall for complex concepts (Gibson, 2009; Stephens & Dwyer, 1997). Specific to nursing education, mnemonics have been useful for assessing practice competency and student confidence in a variety of educational settings and with a variety of learning activities (El Hussein & Jakubec, 2015; Linnard-Palmer, Phillips, Fink, Catolico, & Sweeny, 2013; Schumacher, 2005). One type of mnemonic that is utilized in education is called an acrostic mnemonic (Gibson, 2009). Specific examples of malaria-focused, acrostic mnemonic prompts from the literature (Yousaf & Chaudhry, 2006) describe the early symptoms of malaria, *Heard a mosquito* (headache, anorexia, and myalgia/malaise), and the later symptoms of malaria, *Feel rather cold* (fever that peaks every 3rd day, rigors, chills). The accompanying mnemonic prompts would be included with the CVI Rater Packet for experts' review and feedback. Participants during the reliability and

construct validity testing of the MCTT would have access to the paper mnemonics as they completed the MCTT.

Finally, future studies should include additional MCTT item development with the goal of obtaining acceptable content validity, reliability, and construct validity via EFA and CFA. The first step for future MCTT item development should begin with a clear understanding of the underlying construct, critical thinking ability, and the associated dimensions of the underlying construct: analysis, application, evaluation, and creation. An in-depth knowledge about the current literature describing the construct will help clarify what critical thinking ability is and help differentiate critical thinking ability from what it is not. Additionally, it is important to conceptually understand the population for which the scale is intended (Polit & Beck, 2016). The MCTT is specific for BSN students, not general undergraduate students, so a clear understanding regarding the implications for each MCTT item needs to be explored in the context of BSN students.

In the next step for future item development, a conceptual model or framework that supports the underlying construct and associated dimensions should be used to guide the development of a test blueprint. The blueprint's purpose is to outline the aspects for the phenomenon of interest (Waltz et al., 2010). Specifically, the blueprint includes the topics, questions, and associated behaviors of the phenomenon that are important to help guide the item development and construction (Waltz et al., 2010). The blueprint is also a helpful guide for experts' reference during the content review process.

Items included on the MCTT should represent all dimensions of the concept. Therefore, generating an adequate number of items is necessary to fully represent each dimension. For future MCTT development, item generation of at least 20 items per dimension (analysis,

application, evaluation, and creation) should be included for testing (Waltz et al., 2010). If four dimensions of critical thinking ability are outlined on the blueprint, then the MCTT should include a minimum of 80 initial items for the MCTT's content validity review.

Once the items have been generated by using the guidelines listed above, the next step is an internal review of the items by expert scale developers (Polit & Beck, 2016). The purpose of an internal review is to critically appraise the items for readability and concept comprehension.

To add further item clarity, a focus group of BSN students could be conducted prior to the test deployment. A small (10–20) focus group of people from the target population (BSN students) would provide vital information about the preliminary instrument properties and highlight any patterns or potential issues that might warrant further investigation before full psychometric testing deployment (Polit & Beck, 2016). For example, a focus group might be helpful in identifying any items that lack variability (e.g., if all participants answered the item correctly) and should be revised or removed from the instrument (Polit & Beck, 2016).

The next step, an external review by current critical thinking experts, further enhances the instrument's content validity. Recruiting experts for future MCTT development should focus on gathering an expert panel that is knowledgeable about all facets of the instrument: the construct (critical thinking ability), the topic (malaria), and the population of interest (BSN students). Both qualitative and quantitative data would be collected from the MCTT expert review. These data would ensure that the tool sufficiently and accurately represented the phenomenon and associated dimensions. Item revision and review should continue until acceptable I-CVI and S-CVI/Ave and S-CVI/UA statistics are achieved. Then, once acceptable content validity statistics are achieved, the next step would be to test the revised MCTT's reliability and construct validity

with a sample size of at least 200 participants if anticipated communality values are at least 0.50 (DeVellis, 2003; Russell, 2002).

Conclusion

Because of the limitations discussed above, the MCTT did not achieve acceptable reliability or construct validity and, therefore, cannot accurately assess BSN students' critical thinking ability for the topic of malaria. However, some useful information emerged from the study. Four MCTT items achieved acceptable minimum factor loading values, indicating the potential for these items to assess BSN students' critical thinking ability for the topic of malaria. It is important to continue MCTT development because of the valuable information that the instrument could potentially have for the future of nursing education and student success. Future studies should focus on utilizing an accepted procedure for testing the content validity specifically for cognitive items. Then, EFA and reliability statistics should be retested and interpreted for satisfactory psychometrics. Finally, CFA would confirm the MCTT reliability and EFA results, indicating that the MCTT is appropriate to use for assessing BSN critical thinking ability.

APPENDIX A. LITERATURE REVIEW MATRIX

Critical Thinking and Baccalaureate Nursing Students Literature Matrix

Study	Design	Students	Tool	Psychometric Properties	Results[a]
Bauwens & Gerhard (1987)	One-group descriptive	BSN (*N* = 177) (U.S.)	WGCTA® Form not noted	Not reported	22% of NCLEX-RN® score explained by AA and CT scores at program entry. E = G.
Gross et al. (1987)	2-group correlational Pretest-posttest	BSN (*n* = 34) & ADN (*n* = 37) (U.S.)	WGCTA® Form A (entry) & Form B (exit)	SHRC 0.69-0.85; Stability measure over time coefficient 0.73; Alternate form reliability *r* = 0.75	t2 > t1 (both BSN & ADN); BSN ↑ 27%; ADN ↑ 23.6%
Sullivan (1987)	One-group correlational	BSN (*N* = 51) (U.S.)	WGCTA® Form A (entry) & B (exit)	Not reported	E = G
Tiessen (1987)	One-group correlational	BSN (*N* = 150) (U.S.)	WGCTA® Form Zm	Not reported	+ CT & GPA + CT & SATv + CT & SATq None CT & age
Lynch (1988)	2-group comparative descriptive	BSN (*n* = 74) & ADN (*n* = 87) (U.S.)	WGCTA®, Form A	Not reported	BSN CT > ADN, 11.5% Ed level (indep. of SAT score) predicts ↑ CTA
Brigham (1989)	4-group exploratory	BSN (*N* = 114) (U.S.)	WGCTA® Form not noted	Not reported	Seniors > juniors, 2.3%; seniors > sophomores, 2.2%; Seniors > freshmen, 10.9%. SAT v (*r* = 0.55) SAT q (*r* = 0.30) GPA (*r* = 0.41)

Kokinda (1989)	4-group descriptive	BSN (*N* = 49) (U.S.)	WGCTA® Form B	Not reported	Sophomores > seniors, 12.3%; sophomores > juniors, 15.2%; sophomores > freshmen, 17.9%; sophomores received new curriculum; sophomores. GPA vs CT *r* = 0.71, correlation GPA and WGCTA scores (all levels) *r* = 0.35
Poole (1989)	2-group descriptive	BSN (*n* = 228) & ADN (*n* = 201) (U.S.)	WGCTA® Form A	h^2 >0.61 for all categories on WGCTA	BSN and ADN ↑ CT (high cog); BSN and ADN E = G (low cog)
Waite (1989)	One-group descriptive correlational	BSN (*N* = 299) (U.S.)	WGCTA® Form A	SS = 0.73; Scores on alternate forms: *r* = 0.75	GPA > CT scores in predicting NCLEX-RN® success
Brooks & Shepherd (1990)	4-group descriptive	BSN (*n* = 50), ADN (*n* = 50), diploma (*n* = 50), RN-BSN (*n* = 50) (U.S.)	WGCTA® Form not noted	RC = 0.72 (nursing students)	Generic > RN-BSN, ADN, & diploma. Pearson *r* CT & CDM = 0.249 among all prog.
Notarianni (1991)	4-group pretest-posttest	BSN (*n* = 188) & ADN (*n* = 133) (U.S.)	WGCTA® Form A (beginning of year); Form B (end of year)	Pre-test α = 0.80 (total); 0.48-0.78 (subtests); Post-test α = 0.80 (total); 0.46-0.68 (subtests)	Diff in pretest-posttest scores for 2nd yr BSN and 2nd yr ADN (opp direction than predict)
Brooks & Shepherd (1992)	4-group descriptive	BSN (*n* = 50), ADN (*n* = 50),	WGCTA® Form not noted	IC = 0.72 (nursing students)	Generic & upper > diploma & associate; (0.3%; generic > ADN,

		diploma (*n* = 50), RN-BSN (*n* = 50) (U.S.)			22.6%; generic > diploma, 19.5%)
Miller (1992)	4-group comparison Pretest-posttest	BSN (*N* = 137) (U.S.)	WGCTA® Form YM	IC = 0.85-0.87; IC (subtests) 0.41-0.74.	CT ↑ 3.6% on post-test Relat between NUR GPA & posttest scores
Sandor et al. (1998)	4-group pretest-posttest	BSN & ADN JC (*n* = 32), SU (*n* = 6), MU (*n* = 7), LU (*n* = 8) (U.S.)	WGCTA® Form A (1st class session); Form B (end of course)	Not reported	LU > MU > SU > JC (*p* = 0.004)
Angel et al. (2000)	2-group comparison pretest-posttest	BSN (*N* = 142) (U.S.)	Case Study Questionnaire	Not reported	t2 > t1 for both; structured group ↑ 63.1%; unstructured group ↑ 55.3%
Kowalski & Louis (2000)	2-group comparison	BSN (*N* = 79) (U.S.)	NPCTE	α = 0.53; IC = 0.53; CV conducted by 4 experts.	Exp group 3% > than control group
Beckie et al. (2001)	3-group pretest-posttest; nonequivalent	BSN c1 (*n* = 55), c2 (*n* = 55), c3 (*n* = 73) (U.S.)	CCTST	α = 0.55-0.83 (cohort ranges)	Total score: c1: t2 < t1 < t3 c2: t1 < t2 < t3 c3: t3 < t2 < t1
Stone et al. (2001)	One-group correlational	BSN (*N* = 226—CCTDI); (*N* = 184—CCTST) (U.S.)	CCTST & CCTDI	CCTST: α = 0.61 (total); 0.20-0.43 (subscale). CCTDI: α = 0.89 (total); 0.54-0.76 (subscale)	Traits measured on the CCTDI do not correlate with CT skills.

Ozturk et al. (2008)	2-group comparison	BSN (*N* = 147) (Turkey)	CCTDI (Turkish version, translated)	α = 0.85 (total); 0.56-0.79 (subscale range)	PBL > trad. & overall CCTDI and in "open-mindedness" and "truth-seeking"
Yuan et al. (2008)	2-group comparison	BSN (*N* = 46) (China)	CCTST Form A Chinese-Taiwan Version	Reliability = 0.80 (total); 0.60-0.78 (subscale range)	PBL > trad., 10% analysis, induction, overall
Hsieh & Hsu (2013)	One-group comparison	BSN (*N* = 591) (Taiwan)	CINS	S-CVI = 0.99; I-CVI = 0.83-1.00; α = 0.91-0.98	t2 > t1 ↑10%
Kim et al. (2014)	4-group comparison	BSN (*N* = 1074) (Korea)	CTDS	RC = 0.877; internal reliability = 0.573-0.822.	CTD ↑ → jr then ↓ sr.
Naber & Wyatt (2014)	2-group comparison Pretest-posttest	BSN (*N* = 70) (U.S.)	CCTST & CCTDI	Not reported	Reflective writing > trad in truth-seeking
Shin et al. (2015)	3-group comparison Pretest-posttest	BSN (*N* = 237) (Korea)	YCTD	α = 0.844	↑in CT gains after 3 simulation exposures
Weatherspoon et al. (2015)	2-group comparison Pretest-posttest	BSN (*N* = 117) (U.S.)	CCTDI	Not reported	EIS > TPCSS in truth-seeking, open mindedness, confidence in reasoning, and overall.

Note. AA= academic achievement, α = Cronbach's α, c = cohort, CCTDI = California Critical Thinking Disposition Inventory, CCTST = California Critical Thinking Skills Test, CDM = Clinical decision-making, CINS = Competency inventory of nursing students, CT = critical thinking, cta = critical thinking ability, CTD = Critical thinking disposition, CTDS = Critical Thinking Disposition Scale, CV = content validity, E = G = Program entry to graduation score, HSRT = Health Sciences Reasoning Test, IC = Internal consistency reliability, I-CVI = Item-content validity index, JC = junior college, LU = large university, MU = medium university, NCLEX-RN® = National Council Licensure Examination-Registered Nurse, NPCTE = Nursing Process Critical Thinking Examination, RC = reliability coefficient, S-CVI = scale-content validity index, SR = Stability reliability, SHRC = split-half reliability coefficient, SS = stability of scores, SU = small university, t = time, U. S. = United States; WGCTA® = Watson-Glaser Critical Thinking Appraisal®, YCTD = Yoon's Critical Thinking Disposition instrument.

[a] Numerical values represent the percentage change and are significant at p = or < 0.05.

APPENDIX B. IRB PROTOCOL

UNLV

Research Protocol Proposal Form
For Research Involving Human Subjects

Instructions:
1. CITI certification (www.citiprogram.org) must be current at the time of protocol submission.
2. Complete all sections. Do not reference other sections as a response (e.g., "see section…" or "see attached…")
3. Projects with funding/proposed funding must include copy of the application or proposal.
4. You must proofread your document for spelling and grammar before submitting to assure timely IRB review.

Note:
1. Research may not begin until you have received notification of IRB approval.
2. For your records, it is important that you keep a copy of this completed form.

1. Research Protocol Title (Research Protocol Title must match the funding/proposed funding application or proposal):

Psychometric Testing of the Malaria Critical Thinking Test

2. Investigator(s) Contact Information

(The PI must be UNLV faculty in all cases involving studies carried out by students or fellows.)

A. Principal Investigator (*Name and Credentials*): Barbara St. Pierre Schneider, PhD, RN, CNE

☐ Faculty ☒ Faculty Advisor

Department: Nursing Mail Stop: 3018 Phone Number: 702-895-1216

E-Mail Address: barbara.stpierreschneider@unlv.edu

B. Student/Fellow Investigator (*Name and Credentials*): Tally Tinjum, MSN, RN

☐ Undergraduate ☐ Master's Student ☒ Doctorate Student ☐ Fellow

Department: Nursing Mail Stop: 2314 38th St S, Moorhead, MN 56560 Phone Number: 218-731-9073

E-Mail Address: tinjumt@unlv.nevada.edu

C. Please complete (if applicable).

Protocol Coordinator (*Name and Credentials*):

Phone Number:

E-Mail Address:

Co-Principal Investigator (*Name and Credentials*):

☐ Faculty

Department: Mail Stop: Phone Number:

E-Mail Address:

3. Research Team Members: *List all research team members (including PI) who will have contact with subjects, have contact with subjects' data or biological samples, or use subjects' personal information. If additional members will be included, submit Appendix "Additional Research Team Members."*

NAME and DEPARTMENT	ROLE IN PROTOCOL	SPECIFIC EXPERIENCE WITH ROLE IN PROTOCOL	ROLE IN CONSENT PROCESS
EXAMPLE: Dr. Chris Researcher, Research Department	**EXAMPLE:** Developed protocol, collecting data, analyzing	**EXAMPLE:** Has had 7 years of conducting and publishing human subjects	**EXAMPLE:** Recruiting subjects, writing the consent form, consenting subjects,

	data, writing report	research at a university	answering questions
Barbara St. Pierre Schneider	Principal Investigator & Faculty Advisor	Principal investigator and faculty advisor to doctoral student. Has 22 years of experience conducting and publishing research.	
Tally Tinjum	Student Investigator	Doctoral student	Responsible for recruiting subjects, consenting subjects
Du Feng	Biostatistician	Experience in research methodology and multivariate data analysis. Teaches courses in research methods and statistics.	

Hit tab in last available cell to add additional rows.

4. Duration of Study

Anticipated Start Date: 04/8/2016 Anticipated Termination Date: 07/15/2016

5. Research Subjects

5.1 Describe the sampling strategy used to select subjects.

There are two parts to this study: content validity testing and reliability and construct validity testing of an instrument called the Malaria Critical Thinking Test (MCTT). The student investigator's original plan was to complete the two parts prior to dissertation work. However, these two parts have now become the focus of the student's dissertation.

Content Validity Testing

The student investigator contacted experts in the field via email before content validity testing of the MCTT became the focus of the student investigator's dissertation. This testing required three stages and consisted of recruiting experts who met certain qualifications. To recruit these experts, the student investigator first identified experts by searching the internet and the literature. After identifying these experts, the student investigator emailed each individual expert to inquire if the expert would perform an item review of the MCTT. In the email, the student investigator identified herself, the institution and degree program she was affiliated with, and the nature of her research. The student investigator then informed the expert that he/she met the qualifications for expert review. If the expert emailed and requested the item review information, then the student investigator emailed the expert the Content Validity Index (CVI) rater form, the MCTT blueprint, and the MCTT. The student investigator requested that the expert return the CVI rater form via email within one week upon receipt. The procedures to reach acceptable item content validity indices (I-CVI) and an acceptable scale content validity index average (S-CVI/Ave) of the MCTT were guided by Grant and Davis (1997) and Polit, Beck, and Owen (2007). Three stages were required for content validity testing in order to achieve a final MCTT with acceptable I-CVI and S-CVI/Ave statistics. Stages I and II were needed to create an expert pool, and stage III was needed for a final expert review of the MCTT. The anticipated time for review of the MCTT is a minimum of one hour.

The following steps outline the purposive sampling strategy used for content validity testing of the MCTT in three stages.

Stage I
1. Six experts were emailed.
2. Three out of the six experts provided feedback. Two experts declined review of the MCTT due to other commitments. One expert did not respond to the initial email, and no further follow-up was made.
3. Feedback from the three experts was compiled into a table for I-CVI analysis and S-CVI/Ave analysis, and it was determined that more experts were needed to achieve acceptable statistics for content validity. At the end of this stage, there was usable content validity feedback from three experts.

Stage II
4. An additional 13 experts were emailed for recruitment. Again, the student investigator conducted an internet search and literature search to identify experts who had qualifications for MCTT review.
5. Seven of the 13 experts agreed to provide the student investigator with content validity feedback on the MCTT; six

experts declined review or did not reply.
6. Of the seven experts who returned feedback, feedback from six experts was usable. Feedback from one expert was omitted due to expressed bias. Therefore, by the end of stage II, there was usable content validity feedback from nine experts.

Stage III
7. To complete content validity testing of the MCTT, a final review panel of five experts was selected. Three experts provided sufficient content validity feedback (one expert provided content validity feedback in both stage II and stage III); two did not reply and no further follow-up was made. By the end of stage III, there was usable content validity feedback from a total of 11 experts.

Reliability and Construct Validity Testing Sampling Strategy
This part of the dissertation has not begun. A convenience sampling strategy at the research sites will be used to select subjects for the reliability testing and construct validity testing of the MCTT.

5.2 Maximum number of subjects:
Content Validity Testing: 23

Reliability and Construct Validity Testing: 250

5.3 Describe the targeted population (e.g. healthy adults age 18-45), including age range. Delineate between the various subject groups:

Content Validity Testing
The targeted population is adults (age 18–80) who are experts in the area of critical thinking assessment in nursing education.

Reliability and Construct Validity Testing
The targeted population is adults (age 18–65) who are juniors or seniors enrolled in a baccalaureate program of nursing.

5.4 Summarize the inclusion criteria for each subject group that must be met in order for the subject to participate in the study.

Content Validity Testing
The inclusion criteria are as follows: adults (age 18–80) who have expertise in critical thinking assessment of nursing students. For this study, an expert is considered any nursing professional who has clinical experience in critical thinking assessment of nursing students, has conducted research on the topic of critical thinking in nursing education, has published in a peer-refereed journal on the topic of critical thinking in nursing education, or has professionally presented on the topic of critical thinking in nursing education.

Reliability and Construct Validity Testing
The inclusion criteria are students (age 18–65) who are enrolled in either junior or senior level nursing courses, have not had a diagnosis of malaria, have not had any prior experience working with malaria (either in the field or in the research setting), and/or have not had any prior professional experience working in infection control.

5.5 Are there any enrollment restrictions based on gender, pregnancy, race or ethnic origins? ☐ Yes ☒ No
If yes, specify and explain the nature of the restriction(s) and provide justification for each population.

5.6 Will you be recruiting any of these specific populations?

☐ Children 17 and under	☐ Prisoners, Parolees and/or Probationers
☒ College Students	☐ Pregnant Women, Fetuses and Neonates
☐ Wards of the State	☐ I will be using biological specimens
☐ CCSD Employees and/or students	

5.7 Would your population be considered decisional/cognitively impaired? ☐ Yes ☒ No
5.7.1 Will the subjects be able to provide consent/assent on their own? ☒ Yes ☐ No

6. Recruitment Procedures

6.1 Describe the methods of recruitment including use of letters and/or advertising. Include when, how and by whom the subjects will be recruited.

Content Validity Testing

The student investigator contacted experts in the field via email before content validity testing of the MCTT became the focus of the student investigator's dissertation. This testing required three stages and consisted of recruiting experts who met certain qualifications. To recruit these experts, the student investigator first identified experts by searching the internet and the literature. After identifying these experts, the student investigator emailed each individual expert to inquire if the expert would perform an item review of the MCTT. In the email, the student investigator identified herself, the institution and degree program she was affiliated with, and the nature of her research. The student investigator then informed the expert that he/she met the qualifications for expert review. If the expert emailed and requested the item review information, then the student investigator emailed the expert the Content Validity Index (CVI) rater form, the MCTT blueprint, and the MCTT. The student investigator requested that the expert return the CVI rater form via email within one week upon receipt. The procedures to reach acceptable item content validity indices (I-CVI) and an acceptable scale content validity index average (S-CVI/Ave) of the MCTT were guided by Grant and Davis (1997) and Polit, Beck, and Owen (2007). Three stages were required for content validity testing in order to achieve a final MCTT with acceptable I-CVI and S-CVI/Ave statistics. Stages I and II were needed to create an expert pool, and stage III was needed for a final expert review of the MCTT. The anticipated time for review of the MCTT is a minimum of one hour.

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7. To complete content validity testing of the MCTT, a final review panel of five experts was selected. Three experts provided sufficient content validity feedback (one expert provided content validity feedback in both stage II and stage III); two did not reply and no further follow-up was made. By the end of stage III, there was usable content validity feedback from a total of 11 experts.

Reliability and Construct Validity Testing Recruitment Procedure

After securing permission from the nursing department chairs and course coordinators at North Dakota State University (NDSU)-Fargo and NDSU-Bismarck, the student investigator may attend a regular session of the 341, 342, 352, 360, 362, 402, 403, 404, 406, 410, 450, and 460 nursing courses on both campuses and distribute a study packet to each subject. The study packet will consist of four documents: the study consent, a nine-item demographic survey, a one-page "The Buzz on Malaria" fact sheet, and the 12-item MCTT (Appendix A). The student investigator will inform the subjects about the study over 3–15 minutes with a script (Appendix C).

6.2 Indicate the types of recruitment materials to be used below (check all that apply). Attach copies of all recruitment materials to this application.

☒ Internet/Email ☐ Television/Radio/Newspaper ☐ Flyers/Posters/Brochures

☐ Letter of Contact ☐ Subject Pool Description ☐ Telephone Script

☐ Word of Mouth ☐ Social Media ☒ Other (Describe): Short Classroom Presentation (Appendix C)

☐ This research study will not be using any recruitment materials.

7. Purpose and Procedures

7.1 State the purpose of the study:

The purpose of this study is to test the psychometric properties of the MCTT.

7.2 Lay language summary (Please use non-technical language to summarize your research study):

To determine if the MCTT consistently and accurately measures the concept of critical thinking on the topic of malaria in junior and senior students enrolled in a baccalaureate program of nursing.

7.3 Describe all research procedures (sequentially). Include required screening procedures performed before enrollment and while on study. Describe the types, frequency and duration of tests, observations, interviews, questionnaires, etc. Please provide a list or outline format/flow chart for ease of review.

There are two parts to this study: content validity testing and reliability and construct validity testing of an instrument called the MCTT. The student investigator's original plan was to complete the two parts prior to dissertation work. However, these two parts have now become the focus of the student's dissertation.

Content Validity Testing Research Procedure

The student investigator contacted experts in the field via email before content validity testing of the MCTT became the focus of the student investigator's dissertation. This testing required three stages and consisted of recruiting experts who met certain qualifications. To recruit these experts, the student investigator first identified experts by searching the internet and the literature. After identifying these experts, the student investigator emailed each individual expert to inquire if the expert would perform an item review of the MCTT. In the email, the student investigator identified herself, the institution and degree program she was affiliated with, and the nature of her research. The student investigator then informed the expert that he/she met the qualifications for expert review. If the expert emailed and requested the item review information, then the student investigator emailed the expert the Content Validity Index (CVI) rater form, the MCTT blueprint, and the MCTT. The student investigator requested that the expert return the CVI rater form via email within one week upon receipt. The procedures to reach acceptable item content validity indices (I-CVI) and an acceptable scale content validity index average (S-CVI/Ave) of the MCTT were guided by Grant and Davis (1997) and Polit, Beck, and Owen (2007). Three stages were required for content validity testing in order to achieve a final MCTT with acceptable I-CVI and S-CVI/Ave statistics. Stages I and II were needed to create an expert pool, and stage III was needed for a final expert review of the MCTT. The anticipated time for review of the MCTT is a minimum of one hour.

The following steps outline the research procedure for content validity testing of the MCTT in three stages.

Stage I
1. Six experts were emailed.
2. Three out of the six experts provided feedback. Two experts declined review of the MCTT due to other commitments. One expert did not respond to the initial email, and no further follow-up was made.
3. Feedback from the three experts was compiled into a table for I-CVI analysis and S-CVI/Ave analysis, and it was determined that more experts were needed to achieve acceptable statistics for content validity. At the end of this stage, there was usable content validity feedback from three experts.

Stage II
4. An additional 13 experts were emailed for recruitment. Again, the student investigator conducted an internet search and literature search to identify experts who had qualifications for MCTT review.
5. Seven of the 13 experts agreed to provide the student investigator with content validity feedback on the MCTT; six experts declined review or did not reply.
6. Of the seven experts who returned feedback, feedback from six experts was usable. Feedback from one expert was omitted due to expressed bias. Therefore, by the end of stage II, there was usable content validity feedback from nine experts.

Stage III
7. To complete content validity testing of the MCTT, a final review panel of five experts was selected. Three experts provided sufficient content validity feedback (one expert provided content validity feedback in both stage II and stage III);

two did not reply and no further follow-up was made. By the end of stage III, there was usable content validity feedback from a total of 11 experts.

Reliability and Construct Validity Testing Research Procedure

1. The student investigator will submit the UNLV IRB approval letter to the NDSU IRB for review. According to NDSU, if no person affiliated with NDSU will be directly involved in the research process, then no NDSU IRB review is necessary (Appendix B). The student investigator will be distributing and collecting the study packet (Appendix A) so no NDSU personnel will be involved in this study.
2. On the scheduled dates and times arranged with the seven course coordinators, the student investigator will provide a brief introduction of the study to the potential subjects using a script (Appendix C). After the student investigator introduces the study, the student investigator will distribute the study packet (Appendix A). The total anticipated time for providing the introduction, distributing the study packet, and completing of the study packet by the subjects is 15–60 minutes.
3. The student investigator will collect the study packets from the subjects immediately upon subject completion.

7.4 List and attach all instruments associated with this research study:

1. The Malaria Critical Thinking Test (Included as one of the four documents in the study packet: Appendix A)
2. Script for Reliability and Construct Validity Testing (Appendix C)

7.5 Will subjects be recorded? ☒ No ☐ Yes, audio ☐ Yes, video

8. Consent

8.1 Describe the consent process(es) for enrolling each subject population into the study.

Content Validity Testing
An email was sent to each expert who met certain qualifications. The email explained the purpose of the study and asked each expert if he/she would commit to review the MCTT and provide feedback. If the expert responded to the initial email and requested the documents for item review, consent into the study was implied. No documents were sent without the expert's request in response to the initial email.

Reliability and Construct Validity Testing
The subjects will receive a brief introduction to my study (Appendix C). Then, a study packet (Appendix A) will be distributed to each potential subject. The consent will be written in English. English is the primary language of the subjects for this study and the ability to read and write in English is a requirement of the baccalaureate nursing program. Potential subjects will be instructed to complete the consent form to participate in the study.

8.2 Describe where the consent process(es) take place.

Content Validity Testing
Consent was implied if the expert responded to the initial email and requested that the student investigator send the content validity documents for review.

Reliability and Construct Validity Testing
The consent process will occur in the regularly assigned classroom of the subjects' nursing courses at the university.

8.3 Will any information about the research purpose and/or design be withheld from potential or participating subjects at any time during the study? ☐ Yes ☒ No

8.3.1 Explain and justify the non-disclosure and describe plans for post-study debriefing.

8.4 Is a waiver of the signature requirement on the informed consent being requested? ☐ Yes ☒ No

8.4.1 Explain why the waiver of signature is being requested.

9. Project Site(s) *(Check all that apply)*

☐ University of Nevada, Las Vegas (UNLV) – Please check the specific campus.
☐ Maryland Campus (main) ☐ Shadow Lane Campus

☒ Online only ☒ Other: (Specify and Explain all):
Content Validity Testing: The project site is online.
Reliability and Construct Validity Testing: The project sites will be at the NDSU-Fargo and NDSU-Bismarck campuses.

NOTE: If the project site is other than UNLV or online, Facility Authorization Letter must be submitted.

10. Privacy and Confidentiality

Privacy *refers to a person's desire to control the access of others to themselves. Privacy relates to the subject.*
Confidentiality *refers to the researcher's agreement with the subject about how the subject's identifiable private information will be handled, managed, and disseminated. Confidentiality relates to a subject's information.*

10.1 In regards to the above definition, how will you protect the privacy of the participants?

Content Validity Testing
Because the experts performed the review at a distance, the student investigator did not have the ability to control privacy.

Reliability and Construct Validity Testing
The student investigator will manage each subject's privacy.

10.2 In regards to the above definition, how will you ensure confidentiality of the data obtained?

Content Validity Testing
Expert feedback will be presented using numbers and no direct statements from the experts regarding the specific critical thinking items will be disclosed to anyone outside of the research team. Electronic feedback from the experts will be secured on a personal laptop with a unique username and password. Paper data will be stored at the student investigator's residence in a locked cabinet.

Reliability and Construct Validity Testing
No names will be requested on the nine-item demographic survey or the MCTT. Data will be presented as anonymous. Additionally, any data entered electronically will be protected on a computer with a unique username and password.

10.3 Where will all data be stored? (for review/audit purposes, a copy of all records must be kept in a location accessible by the PI on UNLV property):

☐ PI's office (bldg/room): ☐ PI's laboratory (bldg/room): ☒ Other (bldg/room): Paper data will be stored at the student investigator's residence office in a locked file cabinet. Electronic data will be stored on the student investigator's personal computer with a unique username and password to access the file. Paper and electronic data will be immediately destroyed upon dissertation acceptance by the Graduate College.

10.4 How long will identifiable AND de-identified data be stored? Identifiable data and de-identifiable data will be stored for the duration of the study and then will be destroyed immediately upon dissertation acceptance by the Graduate College.

10.5 What are the plans for the final disposition or destruction of identifiable and de-identified data?

The student investigator will shred identifiable paper data and signed consents after the Graduate College accepts the dissertation. The student investigator will permanently delete de-identifiable electronic data after the Graduate College accepts the dissertation.

11. Medical Devices

Are you using a medical device? ☐ Yes ☒ No (If yes, please complete the supplement "Medical Device.")

12. Risks

12.1 Summarize the nature and amount of risk (including side effects, stress, and discomfort). Examples of risk include physical risks, psychological risks (such as stress, discomfort, or invasion of privacy) and social risks (such as jeopardy to insurability or employability).

Content Validity Testing
The risk to the expert is minimal. The time it takes for the expert to review the instrument will vary in length. It is anticipated that an expert may take a minimum of an hour to review the MCTT. Some experts may experience physical discomfort from sitting for an extended period of time as they review the individual questions and provide typed feedback. The psychological and social risks of experts who participate in the content validity testing portion of the study are low considering these are experts in the field.

Reliability and Construct Validity Testing
The amount of risk to subjects is low. Some subjects may experience physical fatigue from completing the study packet (Appendix A). Participation or non-participation has no impact on the subject's standing in the nursing program.

12.2 Estimate the probability (e.g. not likely, likely, etc.) that a given harm may/will occur, its severity, and its potential reversibility.

Content Validity Testing

Although the student investigator acknowledges that any research has potential harm, the estimated probability that a given harm may occur with this study is not likely for content validity testing of the MCTT. If any harm would occur, it is anticipated that it would be minimal and would be reversible.

Reliability and Construct Validity Testing
Although the student investigator acknowledges that any research has potential harm, the estimated probability that a given harm may occur with this study is not likely for construct validity testing and reliability testing of the MCTT. If any harm would occur, it is anticipated that it would be minimal and would be reversible.

12.3 What procedure(s) will be utilized to prevent/minimize any potential risks?

Content Validity Testing
If the expert feels that he/she will encounter any risk, he/she may stop the review process and not continue.

Reliability and Construct Validity Testing
Risks of participation in this study are no greater than those found in everyday university activities. If a subject experiences any distress during the study, the subject will be given the option to stop.

13. Benefits

13.1 Describe any probable benefits of the research for the individual subject(s). (Do not address compensation)

One probable benefit for the individual subjects is that students' critical thinking regarding malaria might be expanded especially because there is insufficient malaria content in most nursing curricula.

13.2 Describe the probable benefits of the research for society.

In 2012, an estimated 207 million cases of malaria were reported worldwide. Therefore, malaria is an important tropical disease that warrants attention from health care professionals, especially nurses. Developing the MCTT for nursing education might increase nursing students' critical thinking abilities about malaria so that infected individuals might be diagnosed and treated sooner.

14. Cost/Compensation

14.1 Describe the total amount of participation time, followed by breakdowns of this time (if necessary):

Content Validity Testing
It is anticipated that an expert may take a minimum of an hour to review the MCTT.

Reliability and Construct Validity Testing
It is anticipated that the participation time for each subject will be 15–60 minutes.

14.2 Are there financial costs to the subject? ☐ Yes ☒ No If yes, explain:

14.3 Will subjects be paid or otherwise compensated for research participation? This may be monetary OR non-monetary.
☒ Yes ☐ No

14.3.1 If yes, please respond to the following questions:
a) Describe the nature of any compensation to subjects. Include cash, gifts, research credit, etc.

Content Validity Testing
Experts were not compensated for their time.

Reliability and Construct Validity Testing
The subjects will receive a $5.00 gift card to Starbucks upon completion of the MCTT.

b) Provide a dollar amount, if applicable, and indicate method of payment. $5.00
☐ Cash ☐ Check ☐ Research Credit ☒ Other: Starbucks Gift Card

c) Explain when and how the compensation is provided to the subject. The gift card will be distributed to each subject upon completion of the MCTT.

d) Describe the alternative option offered to subjects if the potential subject does not wish to participate in the research. An alternative option offered is nonparticipation in the study.

15. Funding

15.1 Is there any internal or external funding (e.g., grants, contracts, gifts, etc.) ☒ Yes ☐No

15.1.1 If yes, Name of Sponsor or UNLV Grant Program PhD/DNP STUDENT DISSERTATION/PROJECT AWARD from the UNLV School of Nursing

Attach a copy of the proposal and/or award document (the budget must be included).

16. Conflict of Interest

16.1 Does a conflict of interest exist with this study? ☒ No ☐ Yes, explain:

16.2 Do you or any member of the research team have an authoritative role over the research subjects? ☐ Yes ☒ No

16.2.1 If yes, please explain:

17. Signatures of Assurance

A. Investigator's Assurance:

I certify that the information provided in this application is complete and accurate. As Principal Investigator, I have ultimate responsibility for the conduct of this study, the ethical performance of the project, the protection of the rights and welfare of human subjects and strict adherence to any stipulations designated by the IRB. I agree to comply with all UNLV policies and procedures, as well as with all applicable Federal, State and local laws regarding the protection of human subjects in research including, but not limited to the following:

- Performing the project by qualified personnel according to the approved protocol.
- Not changing the approved protocol or consent form without prior IRB approval (except in an emergency, if necessary, to safeguard the well-being of human subjects).
- Obtaining proper informed consent from human subjects or their legally responsible representative, using only the currently approved, stamped consent form.
- Promptly reporting adverse events to the ORI – Human Subjects in writing according to IRB guidelines.
- Arranging for a co-investigator to assume direct responsibility, if the PI will be unavailable to direct this research personally, as when on sabbatical leave or vacation.

***FACULTY ADVISOR** (IF APPLICABLE)**:** By my signature as Principal Investigator on this research application, I certify that the student/fellow investigator is knowledgeable about the regulations and policies governing research with human subjects and has sufficient training and experience to conduct this particular study in accordance with the approved protocol. In addition:

- I agree to act as the liaison between the IRB and the student/fellow investigator with all written and verbal communications.
- I agree to meet with the student/fellow investigator on a regular basis to monitor the progress of the study.
- I agree to be available and to personally supervise the student/fellow investigator in solving problems, as they arise.
- I assure that the student/fellow investigator will promptly report adverse events to the ORI – Human Subjects according to IRB guidelines.
- I will arrange for an alternate faculty advisor to assume responsibility if I become unavailable, as when on sabbatical leave or vacation.
- I assure that the student/fellow investigator will follow through with the storage and destruction of data as outlined in the protocol.
- By submitting this form electronically, I agree to the assurance as stated above.

A-33: PhD/DNP STUDENT DISSERTATION/PROJECT AWARD
ATTACHMENT #1

APPLICATION FORM

Name ___Tally Tinjum_____ Date __4-April-2016_____

Anticipated Date of Graduation ___December 2016_____

Project Title __Psychometric Testing of the Malaria Critical Thinking Test_____

Proposed Budget

Item State quantity and cost/unit.	**Rationale**	**Total Cost**
250 $5 Starbucks Gift Cards	Reliability and construct validity testing of the Malaria Critical Thinking Test (MCTT) will require participation of up to 250 baccalaureate nursing student subjects. Nominal compensation of subjects' time to complete the MCTT has been recommended by my dissertation committee.	$1250.00
(394 miles x $0.54/mile) x 2 roundtrips	Round-trip mileage for travel from student's residence to NDSU-Bismarck campus for data collection. Mileage rate reflects the 2016 federal standard mileage rate.	$425.52
250 black/white study packets with 8 pages/packet x $0.11/page	Study will require participation of up to 250 student subjects. Recommended to print 250 study packets (8 pages/packet). Cost per page quote is from OfficeMax®.	$220.00
Total		$1895.52

Total Budget ____$1895.52_____ Total Amount Requested __$1895.52_____

Other Funding Sources

Source	**Amount**
None	

PhD/DNP Student Signature Tally Tinjum

Advisory Committee Chair Barbara S Schneider
Name Signature

ABSTRACT

Psychometric Testing of the Malaria Critical Thinking Test

By

Tally Rae Tinjum

Background, Rationale, and Significance

Accrediting bodies of baccalaureate nursing programs require quantified assessment of critical thinking in students. Strategies have been implemented to assess critical thinking in baccalaureate nursing students, but these strategies vary in specificity in assessing the unique critical thinking abilities in nursing students and lack methodological rigor. Additionally, many baccalaureate nursing programs face time constraints that limit the amount of material that can be reasonably covered in each course. Tropical and infectious diseases are topics that are insufficiently covered in most baccalaureate programs, yet the ability to critically think about these diseases is important for improving patient outcomes. Students with the ability to critically think about malaria, a disease that affects millions of people worldwide, have the ability to improve patient outcomes associated with this detrimental disease.

To illustrate the global health impact of malaria, in 2012, an estimated 207 million cases of malaria were reported worldwide, with over half of the world's population at risk for contracting malaria. Therefore, the purpose of this study is to develop a reliable and valid critical thinking test that can be implemented in baccalaureate curricula to assess students' critical thinking abilities about this important global disease.

Specific Aims

The specific aims of this study are to (a) test the content validity of the Malaria Critical Thinking Test (MCTT), and (b) test the reliability and construct validity of the MCTT.

Methods

A cross-sectional survey research design will be used to test the psychometric properties of the MCTT. Content validity of the MCTT will be established through three stages of item expert review. Reliability and construct validity will be tested by administering the MCTT to third-year and fourth-year baccalaureate nursing students from two campuses at one university in the Midwest. If the specific aims of the study are achieved, there will be evidence that the MCTT is a valid and reliable instrument to assess critical thinking ability about malaria prevention strategies in baccalaureate nursing students. Reliability will be computed using the Kuder–Richardson Formula 20. Exploratory Factor Analysis (EFA) will be used to identify a viable factor structure of the 12 items comprising the MCTT. Confirmatory Factor Analysis with Structural Equation Modeling will be used to determine if the EFA requires modification.

UNLV School of NURSING
University of Nevada, Las Vegas

4-Apr-16

To: Dean Yucha

From: Barbara St. Pierre Schneider BSS

Re: PhD Student Dissertation Award Application –Tally Tinjum

As the chairperson of Tally Tinjum's dissertation committee, I am writing this letter of support for Tally's PhD Student Dissertation Award application. Tally's dissertation involves developing a malaria critical thinking test for nursing students. As malaria content is restricted within nursing programs because of limited time, this test may be one learning strategy to develop nursing students' competency in primary and secondary prevention of malaria.

On 30-March-16, Tally received UNLV IRB exempt approval to conduct her dissertation study. Tally has started scheduling visits to complete data collection so I am confident that Tally will complete her study.

Thank you for your consideration.

Box 453018 • 4505 S. Maryland Parkway • Las Vegas, NV 89154-3018
http://nursing.unlv.edu/

APPENDIX A: STUDY PACKET

UNLV

INFORMED CONSENT

School of Nursing

TITLE OF STUDY: Psychometric Testing of the Malaria Critical Thinking Test

INVESTIGATOR(S): Barbara St. Pierre Schneider, PhD, RN (Principal Investigator); Tally R. Tinjum (Student Investigator).

For questions or concerns about the study, you may contact the principal investigator, Barbara St. Pierre Schneider at (702) 895-1216 or barbara.stpierreschneider@unlv.edu and/or the student investigator, Tally Tinjum, at (218) 731-9073 or tinjumt@unlv.nevada.edu.

For questions regarding the rights of research subjects, any complaints or comments regarding the manner in which the study is being conducted, contact the UNLV Office of Research Integrity – Human Subjects at 702-895-2794, toll free at 877-895-2794 or via email at IRB@unlv.edu.

Purpose of the Study

You are invited to participate in a research study. The purpose of the study is to determine if the Malaria Critical Thinking Test (MCTT) consistently and accurately measures the concept of critical thinking on the topic of malaria in baccalaureate nursing students.

Participants

You are being asked to participate in the study because you meet these criteria: student enrolled in either junior or senior level nursing courses, have not had a diagnosis of malaria, have not had any prior experience working with malaria (either in the field or in the research setting), and/or have not had any prior professional experience working in infection control.

Procedures

If you volunteer to participate in this study, you will be asked to do the following: provide consent, complete a nine-item demographic survey, read a one-page "The Buzz on Malaria" fact sheet, and complete the 12-item MCTT. The total time anticipated for the study is 15 to 60 minutes.

Benefits of Participation

As a participant of this study, you will have an opportunity to think critically about malaria.

Risks of Participation

There are risks involved in all research studies. This study may include only minimal risks. The anticipated level of risk to you is low.

Cost /Compensation

There is no financial cost to you to participate in this study. The study will take approximately 15 to 60 minutes of your time. Upon completion of the demographic survey and the MCTT, you will receive a $5.00 Starbucks gift card as compensation for your time.

Confidentiality

All information gathered in this study will be kept as confidential as possible. No reference will be made in written or oral materials that could link you to this study. Paper data will be shredded upon completion of the study and electronically stored data will be permanently deleted upon completion of the study.

Voluntary Participation

Your participation in this study is voluntary. You may refuse to participate in this study or in any part of this study. You may withdraw at any time without prejudice to your relations with UNLV. You are encouraged to ask questions about this study at the beginning or any time during the research study.

Participant Consent

I have read the above information and agree to participate in this study. I have been able to ask questions about the research study. I am at least 18 years of age. A copy of this form has been given to me. I understand that my completion and return of the study packet indicates my consent to participate in the study.

Demographic Survey

1. Age in years: _____

2. Gender: _____ Male _____ Female

3. What year of study are you in and which campus do you attend?

_____ Junior _____ NDSU-Bismarck _____ NDSU-Fargo _____ Concordia

_____ Senior _____ NDSU-Bismarck _____ NDSU-Fargo _____ Concordia

4. What is your race?

_____ White/Caucasian

_____ African American

_____ Hispanic

_____ Asian

_____ Native American

_____ Pacific Islander

_____ Other, please specify: _____

5. Have any of your past travel destinations involved areas in which there is malaria transmission?

_____ Yes

_____ No

_____ I do not know

6. Do you have any current plans to travel to a destination in which there is malaria transmission?

_____ Yes

_____ No

_____ I do not know

If yes, within how many months from today do you plan to travel to the destination in which there is malaria transmission?

_____ Months (< than 1 month from today, 1 month from today, 2 months from today, etc.)

7. Have you ever been diagnosed with malaria?

_____ Yes (**If yes**, thank you for your participation. You may end the study at this time).

_____ No

8. Do you have prior experience working with malaria either in the field or in the research setting?

_____ Yes (**If yes**, thank you for your participation. You may end the study at this time).

_____ No

9. Do you have any prior professional experience working in infection control?

_____ Yes (**If yes**, thank you for your participation. You may end the study at this time).

_____ No

The Buzz on Malaria

What is malaria?

- An infection of both humans and animals caused by a microscopic parasite.

How do I get malaria?

- Malaria is most often transmitted to humans by female mosquitoes of the genus *Anopheles*.
- Occasionally transmission occurs through blood transfusion, organ transplant, needle sharing, or from mother to fetus.

How do I know I have malaria?

- Illness can vary from mild to fatal, and can progress rapidly. Permanent disability can occur.
- Usual symptoms include chills, fever, headache, body aches, and sometimes nausea/vomiting or diarrhea.
- Later signs include confusion, convulsions, coma, organ failure, and death.
- Blood will be examined under the microscope for confirmation of the infection.

How is malaria treated?

- Many anti-parasite medications can be used to treat malaria.
- Treatment is needed as soon as you know you have malaria to prevent serious complications.

Can malaria be prevented?

- Yes, but no prevention plan is 100% effective.

How can I lower my risk for malaria when traveling?

- Consider taking malaria prevention medications specific to your malaria travel risk region.
- Pregnant women and young children may be more susceptible and should use caution in known malaria risk regions.
- Employ methods to prevent mosquito bites when traveling to known malaria risk regions:
  - Use bed nets;
  - Minimize amount of skin exposed;
  - Apply insecticides and repellents to clothing and exposed skin; and
  - Ensure adequate protection when vector mosquitoes are most active from dusk to dawn.

Source:
Centers for Disease Control and Prevention. (2015). *Malaria.* Retrieved from http://www.cdc.gov/malaria/

Malaria Critical Thinking Test

Please answer the following questions to the best of your ability. Please select only one answer for each question.

1. A community health nursing instructor is teaching a group of student nurses about safe travel practices to a known malaria risk region. Which practice should the students identify as a measure to reduce the risk of malaria transmission?

A. Drink bottled water or boil tap water.
B. Wash hands after being around animals.
C. Obtain a malaria vaccine before departure.
D. Use permethrin spray (an insecticide) on clothing and bed nets.

2. A nurse is providing information to a client who has a new prescription for anti-malarial medication prior to travel to a malaria risk region. Which of the following explanations by the nurse describes the purpose of this prescription?

A. It prevents infectious organisms from entering the body.
B. It is required to enter a country where malaria is endemic.
C. It provides protection against serious illness after malaria infection occurs.
D. It eliminates the need to take further protective measures against malaria transmission.

3. A nurse is caring for a client who is concerned about contracting malaria and asks the nurse how it is diagnosed. The nurse explains that which of the following tests confirms the diagnosis?

A. Urine test
B. Blood test
C. Chest x-ray
D. Skin biopsy

4. A nurse is talking with a group of friends about her plan to travel to a malaria risk region. Which statement by the nurse indicates the nurse understands the risk for a malaria infection?

A. Pregnancy protects against the disease.
B. Healthy people are less likely to be infected.
C. Children have decreased risk due to less exposure.
D. Nearly half of the world's population is at risk for the disease.

5. The nurse is teaching students about the course of malaria. Which statement made by a student indicates an understanding of the discussion?

A. "A vaccine is available to prevent infection."
B. "Complications are more likely during a second infection."
C. "Once you contract malaria, you become immune for life."
D. "Symptoms can be experienced repeatedly over a lifetime."

6. A nurse educator is traveling with a group of students and conducts a seminar to discuss the consequences of malaria infection. Which statement by the nurse educator explains the consequence of malaria infection?

A. "Long term problems include skin scarring."
B. "Loss of vision is likely without immediate treatment."
C. "A healthy young person is unlikely to experience symptoms."
D. "A healthy young person can die of malaria within a day after the onset of symptoms."

7. A senior nursing student is traveling in a malaria risk region and informs a health professional about symptoms he is experiencing. Which symptom would warrant investigation of malaria infection?

A. Joint pain
B. Fever with chills
C. Weight loss due to diarrhea
D. Painful lumps under the skin

8. A nurse is taking an antimalarial medication daily while sharing a sleeping space with a person who is not taking antimalarial medication. This person later contracts malaria and receives treatment. Which action should the nurse take to reduce the risk for malaria transmission?

A. Ask the roommate to move to a hotel.
B. Wash sheets and towels in hot soapy water.
C. Urgently obtain malaria treatment medication for all contacts.
D. Make no changes while continuing malaria prevention activities.

9. A nursing student who recently returned from a malaria risk region has developed flu-like symptoms and makes an appointment at student health services. Which of the following is the priority information to be obtained by health services personnel during the student's visit?

A. Family history
B. Past history of influenza infection
C. Date and time of last physical exam
D. Travel destinations and activities within the past year

10. A nurse working in a triage center in Uganda notes an increase in clients presenting with fever, chills, headaches, nausea, vomiting, and body aches. Which of the following is the priority teaching action by the nurse for clients who present with symptoms compatible with malaria infection?

A. Obtain diagnostic testing on an emergency basis.
B. Continue normal activities while taking ibuprofen.
C. Obtain a telephone prescription to treat the symptoms.
D. Avoid close contact with others having similar symptoms.

11. The nurse conducts an education seminar for students traveling to Ghana. What information should the nurse include about symptoms that are characteristic of malaria infection?

A. Symptoms recur each night.
B. Symptoms are continuous until treated.
C. Symptoms are cyclic, repeating every 2-3 days.
D. Symptoms self-resolve without treatment in 5-7 days.

12. A nurse is teaching a group of students who will be traveling to a high-risk malaria region. The nurse recognizes that teaching is effective when a student states that transmission of malaria most likely occurs in which situation?

A. During the day
B. At high altitude
C. During the night
D. In colder climates

APPENDIX B: NORTH DAKOTA STATE UNIVERSITY IRB

RB Information for Outside Researcher

Tally Tinjum <tinjumt@unlv.nevada.edu> 10/12/15

to kristy.shirley

Dear Kristy,

We spoke on the phone regarding my proposed research including NDSU (Fargo and Bismarck campuses) baccalaureate nursing students as participants. I inquired about the IRB approval process at NDSU to see if NDSU required submission to 2 IRBs (Fargo campus and Bismarck campus) for study approval. We discussed that since I was an outside researcher as a PhD student at the University of Las Vegas, Nevada, and with no researcher from NDSU directly involved in my study, IRB approval from NDSU may not be necessary.

In order to convey this procedure unique to NDSU, I would appreciate if you might send an email to my committee advisor at your convenience. My advisor's name is Dr. Barbara St. Pierre-Schneider and she can be reached at the following email address: barbara.stpierreschneider@unlv.edu.

Thank you for your time.

Sincerely,
Tally Tinjum

Kristy Shirley <kristy.shirley@ndsu.edu> 10/26/15

to barbara.stpier., me

Ms. Tinjum and Dr. St. Pierre-Schneider,
I apologize for my delayed response. As Tally indicated, it is the policy of the NDSU IRB to review only research in which NDSU faculty, staff or students are engaged in the conduct. Review and approval by the UNLV IRB is all that is required for conducting your research on our campuses.

Please feel free to contact me with any questions or concerns.
Best,

Kristy

Kristy Shirley, CIP
Research Compliance Administrator / Institutional Review Board
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APPENDIX C

SCRIPT FOR RELIABILITY TESTING AND CONSTRUCT VALIDITY TESTING

Good morning (afternoon). My name is Tally Tinjum and I am a PhD nursing student from the University of Nevada, Las Vegas. I am currently in the dissertation phase of my education and conducting a research study to determine whether a 12-item multiple-choice test that I created consistently and accurately measures the concept of critical thinking on the topic of malaria in baccalaureate nursing students.

I chose the topic of malaria because over 3.4 billion people worldwide are at risk for contracting this potentially fatal infection. In addition, I have found that due to time constraints, tropical diseases and infectious diseases, such as malaria, are topics that are insufficiently covered in most baccalaureate nursing programs. However, I feel it is important for nursing students to critically think about malaria because this infection is commonly acquired when traveling abroad. Upon graduation, you may need to make important decisions about these diseases that will directly impact patient outcomes.

Your participation in my study is voluntary, but important as I would like to learn more about critical thinking abilities of nursing students on the topic of malaria prevention. If you do decide to participate in my study, you will be asked to read an informed consent, complete a nine question demographics survey, read a one-page information sheet about malaria, and complete a 12-item multiple-choice malaria critical thinking test. To show my appreciation for your time, upon completion of the study you will receive a $5 Starbucks gift card. I truly thank you for your consideration to join my study.

At this time, I will pass out the study packet. If you would like to participate, please complete the study packet and return to me once completed. If you do not want to participate, please return the unused packet to me anyway. Thank you!

APPENDIX C. CVI RATER PACKET

CVI RATER FORM

You have been identified as someone with expertise on critical thinking and knowledge transfer abilities in undergraduate nursing students.

My dissertation study is entitled, "Learning Domain Prompts in E-learning and Baccalaureate Education". As part of my dissertation study, I am conducting a content validity analysis to see how well my Malaria Critical Thinking and Knowledge Transfer Questions reflect higher levels of thinking according to Bloom's Revised Cognitive Dimensions Taxonomy (Anderson et al., 2001).

For this evaluation, please provide the following information:

Rater Name: _____

Email: _____

Phone #: _____

Institution and Title: _____

Areas of Research Expertise: _____

Have you conducted research on the topic of critical thinking and/or knowledge transfer?
(circle one) YES NO

Have you published on the topic of critical thinking and/or knowledge transfer?
(circle one) YES NO

Have you presented on the topic of critical thinking and/or knowledge transfer at a professional conference? (circle one) YES NO

If yes, what is the date of the most recent publication? _____

As you review the Malaria Critical Thinking Questions, please be thorough and honest with your evaluation. Please provide feedback on how representative the items are on the content domain of critical thinking. In addition, please identify which cognitive domain of critical thinking each question falls under. Finally, please provide clarity on the feedback of each item. Additional comments are welcome. If you have any questions, please contact me at: tinjumt@unlv.nevada.edu or by phone at: 218-731-9073.

Thank you very much for your time and contribution,

Tally Tinjum, RN, MSN

Malaria Critical Thinking Test Questions Survey*

Critical Thinking and Knowledge Transfer Items	Representativeness	Cognitive Dimension
Critical thinking definition: All or part of the process of questioning, analysis, synthesis, interpretation, inference, inductive and deductive reasoning, intuition, application, and creativity (American Association of Colleges of Nursing, 1998). Knowledge transfer is conceptually defined as the ability to apply knowledge previously learned in a new situation (Mayer & Wittrock, 2006).	Representativeness 1 = the item is not representative of critical thinking 2 = the item needs major revisions to be representative of critical thinking 3 = the item needs minor revisions to be representative of critical thinking 4 = the item is representative of critical thinking	1 = application 2= analysis 3 = evaluation 4 = creation
1. You are teaching a community health course to baccalaureate nursing students. The students are giving a presentation on malaria and ask the class to identify which of the following as the most important practice to reduce the risk of malaria transmission:	1 2 3 4 Comments:	1 2 3 4 Comments:
2. A nurse recommends a supportive measure to a student that travels outside of the country to a malaria risk region take an anti-malaria medication because:	1 2 3 4 Comments:	1 2 3 4 Comments:

3. You are working as a nurse in a travel medicine clinic at a local hospital. Your patient today is being seen in preparation for travel to Uganda. Your patient asks you, "If I develop symptoms of malaria, how will the diagnosis be confirmed?" You demonstrate your understanding of malaria testing by stating that malaria is diagnosed by which of the following?	1 2 3 4 Comments	1 2 3 4 Comments:
4. Jessica is going to travel to Tanzania to volunteer to work with children at an orphanage. What statement made by Jessica concludes that her understanding about the risk for malaria is accurate?	1 2 3 4 Comments:	1 2 3 4 Comments:
5. You are teaching a preparatory course for college students who will be traveling to a foreign country. You want the students to have at least a basic understanding of the course of malaria. To	1 2 3 4 Comments:	1 2 3 4 Comments:

evaluate their understanding, you ask the following question, "What inferences can you make about the natural course of malaria?" The best answer to this question is:		
6. You are a nurse educator traveling to Malawi with a group of health sciences students. In effort to prepare the students for travel, you hold a seminar to discuss their risk of malaria exposure and infection. Which of the following is true about the consequences of malaria infection?	1 2 3 4 Comments:	1 2 3 4 Comments:
7. Grant is a senior nursing student traveling with you on a service learning experience to Angola. He approaches you at breakfast to inform you about recent symptoms he has been having. What information provided by Grant would further warrant investigation of malaria infection?	1 2 3 4 Comments:	1 2 3 4 Comments:
8. While abroad in Rwanda, Michael is taking an anti-malaria drug daily, but another student sharing his sleeping space is not. This roommate is diagnosed with	1 2 3 4 Comments:	1 2 3 4 Comments:

malaria and receives immediate treatment. Michael's parents are afraid their son may catch malaria from the roommate and want him to return home early. What is most important to advise Michael to do in light of this concern about malaria transmission?		
9. Rachel is a nursing student who has been back in classes for 3 months since her return from a summer session studying Spanish and traveling in Costa Rica. She develops flu-like symptoms and decides to make an appointment at University Health Services. What highest priority information should she volunteer early in the visit, even if the health care provider does not ask for it?	1 2 3 4 Comments:	1 2 3 4 Comments:
10. You are a nurse who is working in a triage center in Uganda. You are noticing an increase in the amount of volunteers who have been presenting with fever, chills, headaches, nausea, vomiting, and body aches. In developing a plan of care, a nurse understands that the highest priority in order to educate a patient who presents with symptoms compatible with malaria infection should be to teach the patient to:	1 2 3 4 Comments:	1 2 3 4 Comments:

11. You are holding an education seminar for student travelers to Ghana. In your presentation, you inform your guests that in order to distinguish malaria transmission versus other illnesses, symptoms of malaria in travelers typically:	1 2 3 4 Comments:	1 2 3 4 Comments:
12. Kim is a baccalaureate nursing student who will be traveling with a small group of students to a high-risk malaria region for a community health experience abroad. You are educating the group for travel and feel your teaching has been effective when Kim states, "I understand that the transmission of malaria is most likely to happen"	1 2 3 4 Comments:	1 2 3 4 Comments:

**Note.* Adapted from Grant, J. S., & Davis, L. L. (1997). Selection and use of content experts for instrument development. *Research in Nursing & Health, 20,* 269-274. Used with permission.

Clarity: Are the critical thinking items well written, distinct, and at an appropriate reading level for baccalaureate nursing students?

_____ Yes, the following items are clear (please indicate the clear items in the space below):

_____

_____ No, some of the items are unclear (please indicate the unclear items in the space below):

_____

Suggestions for making the items more clear:

Cognitive Dimensions, Focus, Activities, and Question Examples of Bloom's Revised Cognitive Dimensions Taxonomy[a]

Cognitive dimension[a]	Focus	Activities	Question stem examples
Application	Solve problems to new situations by applying acquired knowledge, facts, techniques, and rules in a different way. (Anderson et al., 2001)	Apply, choose, illustrate, interpret, practice, solve	What examples can you find to…? What approach would you use to…? What might have happened if…?
Analysis	Examine and break information into parts by identifying motives or causes. Make inferences and find evidence to support generalizations. (Anderson et al., 2001)	Analyze, appraise, compare, contrast, differentiate, discriminate, distinguish, examine, experiment, question, test	What inferences can you make about…? What is the relationship between…? What evidence can you find…?
Evaluation	Present and defend opinions by making judgments about information, validity of ideas or quality of work based on a set of criteria (Anderson et al., 2001).	Appraise, assess, choose, judge, predict, support, evaluate	How could you prove…? How would you prioritize…? What information would you use to support…?
Creation	Compile information together in a different way by combining elements in a new pattern or proposing alternative solutions (Anderson et al., 2001).	Collect, compose, create, construct, develop, formulate, organize, plan, prepare, propose	How would you test…? What outcome would you predict for…? What could be changed to improve…?

Note. [a]Cognitive dimension, focus, activities, and question stem examples as identified by Bloom's Revised Taxonomy (Anderson et al., 2001).

Critical Thinking[a] Test Blueprint

Cognitive dimension[b]	Critical thinking items[c]	Critical thinking[a] component
Application	You are teaching a community health course to baccalaureate nursing students. The students are giving a presentation on malaria and ask the class to identify which of the following as the most important practice to reduce the risk of malaria transmission:	Interpretation
Application	A nurse recommends a supportive measure to a student that travels outside of the country to a malaria risk region take an anti-malaria medication because:	Application
Application	You are working as a nurse in a travel medicine clinic at a local hospital. Your patient today is being seen in preparation for travel to Uganda. Your patient asks you, "If I develop symptoms of malaria, how will the diagnosis be confirmed?" You demonstrate your understanding of malaria testing by stating that malaria is diagnosed by which of the following?	Application
Analysis	Jessica is going to travel to Tanzania to volunteer to work with children at an orphanage. What statement made by Jessica concludes that her understanding about the risk for malaria is accurate?	Inference
Analysis	You are teaching a preparatory course for college students who will be traveling to a foreign country. You want the students to have at least a basic understanding of the course of malaria. To evaluate their understanding, you ask the following question, "What inferences can you make about the natural course of malaria?" The best answer to this question is:	Analysis
Analysis	You are a nurse educator traveling to Malawi with a group of health sciences students. In effort to prepare the students for travel, you hold a seminar to discuss their risk of malaria exposure and infection. Which of the following is true about the consequences of malaria infection?	Questioning
Evaluation	Grant is a senior nursing student traveling with you on a service learning experience to Angola. He approaches you at breakfast to inform you about recent symptoms he has been having. What information provided by Grant would further warrant investigation of malaria infection?	Intuition

Evaluation	While abroad in Rwanda, Michael is taking an anti-malaria drug daily, but another student sharing his sleeping space is not. This roommate is diagnosed with malaria and receives immediate treatment. Michael's parents are afraid their son may catch malaria from the roommate and want him to return home early. What is most important to advise Michael to do in light of this concern about malaria transmission?	Deductive Reasoning
Evaluation	Rachel is a nursing student who has been back in classes for 3 months since her return from a summer session studying Spanish and traveling in Costa Rica. She develops flu-like symptoms and decides to make an appointment at University Health Services. What highest priority information should she volunteer early in the visit, even if the health care provider does not ask for it?	Inductive Reasoning
Creation	You are a nurse who is working in a triage center in Uganda. You are noticing an increase in the amount of volunteers who have been presenting with fever, chills, headaches, nausea, vomiting, and body aches. In developing a plan of care, a nurse understands that the highest priority in order to educate a patient who presents with symptoms compatible with malaria infection should be to teach the patient to:	Creativity
Creation	You are holding an education seminar for student travelers to Ghana. In your presentation, you inform your guests that in order to distinguish malaria transmission versus other illnesses, symptoms of malaria in travelers typically:	Synthesis
Creation	Kim is a baccalaureate nursing student who will be traveling with a small group of students to a high-risk malaria region for a community health experience abroad. You are educating the group for travel and feel your teaching has been effective when Kim states, "I understand that the transmission of malaria is most likely to happen":	Synthesis

Note. [a]Critical thinking is defined as all or part of the process of questioning, analysis, synthesis, interpretation, inference, inductive and deductive reasoning, intuition, application, and creativity (American Association of Colleges of Nursing, 1998). "[b]Cognitive dimension as identified by Bloom's Revised Taxonomy, cognitive processes and levels of knowledge (Anderson et al., 2001). [c]Critical thinking items adapted from malaria knowledge test (Hartjes, 2010) used with permission

Malaria Critical Thinking Test Key

Please answer the following questions to the best of your ability. Please select only one answer for each question.

1. A community health nursing instructor is teaching a group of student nurses about safe travel practices to a known malaria risk region. Which practice should the students identify as a measure to reduce the risk of malaria transmission?

A. Drink bottled water or boil tap water.
B. Wash hands after being around animals.
C. Obtain a malaria vaccine before departure.
D. Use permethrin spray (an insecticide) on clothing and bed nets.*

2. A nurse is providing information to a client who has a new prescription for anti-malarial medication prior to travel to a malaria risk region. Which of the following explanations by the nurse describes the purpose of this prescription?

A. It prevents infectious organisms from entering the body.
B. It is required to enter a country where malaria is endemic.
C. It provides protection against serious illness after malaria infection occurs.*
D. It eliminates the need to take further protective measures against malaria transmission.

3. A nurse is caring for a client who is concerned about contracting malaria and asks the nurse how it is diagnosed. The nurse explains that which of the following tests confirms the diagnosis?

A. Urine test
B. Blood test*
C. Chest x-ray
D. Skin biopsy

4. A nurse is talking with a group of friends about her plan to travel to a malaria risk region. Which statement by the nurse indicates the nurse understands the risk for a malaria infection?

A. Pregnancy protects against the disease.
B. Healthy people are less likely to be infected.
C. Children have decreased risk due to less exposure.
D. Nearly half of the world's population is at risk for the disease.*

5. The nurse is teaching students about the course of malaria. Which statement made by a student indicates an understanding of the discussion?

A. "A vaccine is available to prevent infection."
B. "Complications are more likely during a second infection."
C. "Once you contract malaria, you become immune for life."
D. "Symptoms can be experienced repeatedly over a lifetime."*

6. A nurse educator is traveling with a group of students and conducts a seminar to discuss the consequences of malaria infection. Which statement by the nurse educator explains the consequence of malaria infection?

A. "Long term problems include skin scarring."
B. "Loss of vision is likely without immediate treatment."
C. "A healthy young person is unlikely to experience symptoms."
D. "A healthy young person can die of malaria within a day after the onset of symptoms."*

7. A senior nursing student is traveling in a malaria risk region and informs a health professional about symptoms he is experiencing. Which symptom would warrant investigation of malaria infection?

A. Joint pain
B. Fever with chills*
C. Weight loss due to diarrhea
D. Painful lumps under the skin

8. A nurse is taking an antimalarial medication daily while sharing a sleeping space with a person who is not taking antimalarial medication. This person later contracts malaria and receives treatment. Which action should the nurse take to reduce the risk for malaria transmission?

A. Ask the roommate to move to a hotel.
B. Wash sheets and towels in hot soapy water.
C. Urgently obtain malaria treatment medication for all contacts.
D. Make no changes while continuing malaria prevention activities.*

9. A nursing student who recently returned from a malaria risk region has developed flu-like symptoms and makes an appointment at student health services. Which of the following is the priority information to be obtained by health services personnel during the student's visit?

A. Family history
B. Past history of influenza infection
C. Date and time of last physical exam
D. Travel destinations and activities within the past year*

10. A nurse working in a triage center in Uganda notes an increase in clients presenting with fever, chills, headaches, nausea, vomiting, and body aches. Which of the following is the priority teaching action by the nurse for clients who present with symptoms compatible with malaria infection?

A. Obtain diagnostic testing on an emergency basis.*
B. Continue normal activities while taking ibuprofen.
C. Obtain a telephone prescription to treat the symptoms.
D. Avoid close contact with others having similar symptoms.

11. The nurse conducts an education seminar for students traveling to Ghana. What information should the nurse include about symptoms that are characteristic of malaria infection?

A. Symptoms recur each night.
B. Symptoms are continuous until treated.
C. Symptoms are cyclic, repeating every 2-3 days.*
D. Symptoms self-resolve without treatment in 5-7 days.

12. A nurse is teaching a group of students who will be traveling to a high-risk malaria region. The nurse recognizes that teaching is effective when a student states that transmission of malaria most likely occurs in which situation?

A. During the day
B. At high altitude
C. During the night*
D. In colder climates

APPENDIX D. STUDY UNIVERSITY CAMPUS A AUTHORIZATION LETTER

NDSU NORTH DAKOTA STATE UNIVERSITY

February 12, 2016

Dear Tally Tinjum,

I received your request to administer a 12-item critical thinking instrument to the junior and senior nursing students at the NDSU Bismarck location. You have my permission to come to campus and administer the questionnaire to our students.

Sincerely,

Karen Latham

Karen Latham, RN, PhD
Chair and Associate Professor of Practice
NDSU Nursing at Sanford Health

NDSU NURSING AT SANFORD HEALTH
512 7th St N | Bismarck ND 58501 | 701.224.3800 | Fax 701.224.3830 | www.ndsu.edu

APPENDIX E. STUDY UNIVERSITY CAMPUS B AUTHORIZATION LETTER

NDSU NORTH DAKOTA STATE UNIVERSITY

Letter of Authorization to Conduct Research at Facility

Office of Research Integrity – Human Subjects
University of Nevada Las Vegas
4505 Maryland Parkway Box 451047
Las Vegas, NV 89154-1047

Subject: Letter of Authorization to Conduct Research at North Dakota State University (NDSU)

Dear Office of Research Integrity – Human Subjects:

This letter will serve as authorization for the University of Nevada, Las Vegas ("UNLV") researcher/research team, Tally Tinjum to conduct the research project entitled Psychometric Testing of the Malaria Critical Thinking Test at the NDSU School of Nursing in Fargo and Bismarck, North Dakota.

The Facility acknowledges that it has reviewed the protocol presented by the researcher, as well as the associated risks to the Facility. The Facility accepts the protocol and the associated risks to the Facility, and authorizes the research project to proceed. The research project may be implemented at the Facility upon approval from the UNLV Institutional Review Board.

If we have any concerns or require additional information, we will contact the researcher and/or the UNLV Office of Research Integrity – Human Subjects.

Sincerely,

Carla Gross — 2/29/2016

Facility's Authorized Signatory — Date

Carla Gross, Associate Dean and Chair, NDSU School of Nursing

Printed Name and Title of Authorized Signatory

SCHOOL OF NURSING
NDSU Dept 2670 | PO Box 6050 | Fargo ND 58108-6050 | 701.231.7395 | Fax 701.231.6257 | www.ndsu.edu

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