RE-CONCEPTUALIZING AND MEASURING TACIT KNOWLEDGE

by

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For my Thaima.

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ABSTRACT

This study attempted to develop a new measure of tacit knowledge based on an updated definition that distinguishes tacit knowledge and explicit knowledge which we built based on Taylor's taxonomy (2007). Since tacit knowledge is domain specific, we also propose a new method of measuring tacit knowledge that can be replicated across domains. This study occurs in two stages. The participants in the first stage will be recruited from the field of research methodology. The second stage is the validation of the new scale.

In the first study, we collected critical incidents from SMEs about their experiences in research. Based on this, we created the new tacit knowledge measure. We also relied on textbooks to create an explicit measure. In the second study, we examine the factor structure of this new measure. We also analyze the relationship of the new measure with research performance, expertise, mindfulness, and metacognition. We did not find any strong or moderate relationships. We found some support for the link between tacit knowledge and mindfulness.

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CHAPTER I: INTRODUCTION

Tacit knowledge is an elusive construct. There is no single appropriate definition of the construct that has consensus. However, researchers do agree that tacit knowledge is of immense strategic importance to organizations (Horvath, 2000; Matthew & Sternberg, 2009). Tacit knowledge is the basis of expertise (Collins, 2018). As such, it is a highly valuable resource to organizations. Yet, there is a lack of suitable measures that are reliable and valid and can be used across different knowledge domains. One aspect of creating a measure is first clearly defining the construct. In this paper, we offer an updated definition of tacit knowledge, drawing from the work of Taylor (2007), who argued that tacit knowledge represents implicitly held complex mental models that can be hard to articulate. By offering an updated definition, we clearly make the distinction between tacit knowledge and tacit skills and between tacit knowledge and explicit knowledge. We then propose a new method of developing a tacit knowledge measure that is applicable across domains of expertise and provide a demonstration of the method with a measure in the domain of psychological research methods. This method aims to distinguish the explicit and tacit aspects of one's knowledge. Explicit aspects are assumed to be the knowledge that one has derived from formal study and instruction (i.e., through explicit learning; Taylor, 2007). Tacit components are assumed to have been derived from experience, on the job training, and practice over a period (i.e., through implicit learning). Implicit learning refers to process of acquiring knowledge about the underlying patterns and structures of complex stimuli that takes place beyond one's conscious awareness (Ellis, 2015; Reber, 1989). In the workplace and in professions, implicit learning would happen through various experiences that would allow individuals to develop proficiency through the formation of complex mental structures (Bennet & Bennet, 2008).

Additionally, there is an added layer of complexity when we consider that explicit knowledge can become internalized over a period of time as practitioners become accustomed to using and manipulating a base of technical and abstract information over and over until it becomes automatic (Taylor, 2007). The identification and measurement of this type of knowledge is beyond the scope of this study. Instead, this study attempts to demonstrate that tacit knowledge and explicit knowledge are separable based on how the knowledge is traditionally learned (e.g., in the classroom versus on the job). And, it can be argued that it is practically more significant to identify and measure both explicit and tacit knowledge as separable constructs because this is what differentiates what can be taught in the classroom versus what is acquired with expertise. In other words, this is was separates the high performers or experts from novices (Cianciolo et al., 2012). What we are doing is essentially quantifying years of experience and knowledge derived from practice.

Since there is no available measure of tacit knowledge in the first place, there is a paucity of research regarding antecedent variables that influence the level of tacit knowledge. A secondary purpose of this paper is to identify various variables that could potentially predict tacit knowledge and includes an analysis of mindfulness as a potential antecedent. Based on the componential theory of cognition (Sternberg, 1985), we argue that mindfulness plays a role in the formation and acquisition of tacit knowledge through its metacognitive properties.

Literature Review

Tacit Knowledge

Tacit knowledge was a concept first introduced by Michael Polanyi in 1958. According to Polanyi (1962, p. 239) "There are things that we know but cannot tell". This philosophical assertion has today been extended to form various definitions of tacit knowledge, not all of them

equal. For instance, Howells (1996, p. 92) defines tacit knowledge as "non–codified, disembodied know–how that is acquired via the informal take–up of learned behavior and procedure". Many researchers conceptualize tacit knowledge as "know-how" or "procedural knowledge" (Ambrosini & Bowman, 2001), but this definition can be likened to tacit skills rather than tacit knowledge.

Tacit knowledge takes the form of ingrained mental models and perspectives (Nonaka, 1991). Explicit knowledge, on the other hand, has been described as "know-what" (Ryle, 2009) and often takes the form of technical or academic information (Smith, 2001). It can be expressed easily through formal language shared via different forms of media and lends itself easily to codification and storage (Smith, 2001) and can be readily articulated (Taylor, 2007).

Despite the differences between explicit knowledge and tacit knowledge, it would be wrong to conclude that both are separate and mutually exclusive classifications of knowledge. It would be more appropriate to think of knowledge as a spectrum. When synthesizing the research on the various conceptualizations of tacit knowledge, there are different terms used for tacit knowledge that cover slightly different variations of the same underlying concept of "hard to articulate and learned through experience and doing" (Taylor, 2007). In order to clarify the various expressions of knowledge, Taylor (2007) does not utilize just two distinct categories of explicit and implicit knowledge. Instead, she makes several distinctions about knowledge overall according to how it was learned, how it is held, and how it is expressed and transferred. It should be noted that according to Taylor (2007) knowledge is implicitly held, harder to articulate, then it is more tacit.

First, Taylor (2007) says that knowledge can be implicitly learned and implicitly held. This type of operationalization can vary in its level of tacitness. It might be very nearly

impossible to articulate and can only be expressed by application of the knowledge through demonstrations, observations, practice, and behavioral modelling. This kind of knowledge is the basis for tacit skills. For example, it is hard to explain to someone how one should balance while riding a bike and can only be demonstrated or experienced. Sometimes, tacit knowledge can be partially articulated. In fact, Buchanan et al. (2006) argue that expert knowledge, that is learned from years of experience, is often articulable and that what is often regarded as intuition or instinct is knowledge left unexamined. One can use techniques like critical incidents, metaphors, analogies, and storytelling to elicit and transfer this sort of knowledge.

Second, Taylor (2007) says that knowledge can be explicitly learned and implicitly held. This is essentially knowledge that has been taught and learned explicitly that has been "internalized" but can be articulated and transferred through elicitation and probing. This type of knowledge is demonstrated through commonly held understanding of technical and abstract knowledge in specific domains (Taylor, 2007). An example of this is learning the basic rules of accounting and using them over a period of time to solve complex problems. After a while, the rules become so internalized that one does not consciously even remember them while solving a problem.

Finally, Taylor (2007) talks about knowledge that is explicitly learned and explicitly held. This knowledge is acquired through classes, reading, and formal training. It is knowledge that one is conscious of and can be articulated very easily. For instance, learning about the historical events that led up to the first world war is explicit knowledge. Using the driving example from the previous paragraph, explicitly learned and held knowledge would include the knowledge acquired from a driver's education class that is then measured through the driver's licensure exam.

For the purposes of this study, tacit knowledge will be defined as complex mental models that are learned implicitly through experience. The defining features are that it is implicitly learned and hard to articulate. Unlike Taylor, we do not make assumptions about how it is held. Evidence shows that knowledge learned implicitly can be made explicit (hence it would be held explicitly) through reflection (Matthew & Sternberg, 2009); however, we would still consider this to be tacit. It is of greater practical importance to quantify knowledge that is implicitly learned through experience as this is the knowledge that separates high performers or experts and novices, whether it be held implicitly or explicitly. We define explicit knowledge as knowledge learned through formal instruction or from codified information that may be explicitly or implicitly held. Taylor (2007) thinks that knowledge learned explicitly can become internalized and hard to articulate, and hence could be regarded as tacit knowledge. However, we propose that this is a separate construct, under explicit knowledge- "automatized explicit knowledge" (Suzuki & DeKeyser, 2017). The taxonomy we propose distinguishes knowledge on the basis of how it was learned rather than how it is held as this is more practically useful for us.

Tacit Knowledge Outcomes

Tacit knowledge leads to sustainable competitive advantage as it is not easily transferable or replicable (Grant, 1996). It can be viewed as a valuable resource (Spender, 1993) for organizations. Nonaka (1991) echoes this assertion by arguing that a successful company is one that reliably creates and disseminates new knowledge throughout the organization that eventually and quickly gets embodied into new technologies and products. This statement implies that tacit knowledge can drive innovation. Indeed, Horvath (2000) agrees and argues that tacit knowledge also helps in formulating internal best practices, developing core competencies, and preventing imitation by competitors.

Tacit knowledge is associated with a variety of performance outcomes, including job performance. For instance, scores on a psychology tacit knowledge inventory among psychology professors were positively correlated with the number of citations for professors (Wagner, 1985). Wagner and Sternberg (1985) have also used a tacit-knowledge inventory for managers amongst a group of business managers to show that scores correlated with salary and rank within the company. The same inventory was administered to a sample of bank managers, and the researchers found that tacit knowledge was correlated with salary increases, success in generating new business, personnel management capability, and ability to implement company policy (1985). Tan and Libby (1997) found that the level of tacit knowledge could distinguish high and low performance but only for upper level managers. Legree et al. (2003) demonstrated that tacit knowledge for driving among army personnel was strongly related to driver at fault crash rates. Thus, it seems tacit knowledge does have meaningful outcomes, and organizations should aim to help employees increase their tacit job knowledge.

Tacit Knowledge Acquisition

Learning leads to tacit knowledge. As described previously, tacit knowledge is knowledge that can be acquired implicitly. Implicit learning is the process of unconsciously acquiring knowledge without a conscious attempt to do so (Reber, 1989). This nonconscious process makes it hard to articulate the resulting knowledge that develops through the implicit learning phase. A notable example of this is learning a language during childhood. Patterson et al., (2010) say that implicit learning is unconscious knowledge acquisition of statistical patterns and features, leading to the creation of tacit knowledge. Experience is key to notice this underlying statistical pattern across different situations (Bennet & Bennet, 2008). From Taylor's (2007) research, we can conclude that implicit learning leads to implicitly held or tacit

knowledge. Implicit learning can be contrasted with explicit learning, which is conscious learning usually through formalized learning settings. However, as mentioned previously, explicit can become internalized over a period of time. This kind of automatized explicit knowledge develops through different experiences that allow the individual to become increasingly proficient (Bennet & Bennet, 2008). As proficiency increases, the neural pattern slowly becomes embedded to the unconscious, transforming to something more automatic. As a result, the explicit aspects of the knowledge become obscured from the conscious mind (Bennet & Bennet, 2008). As we argued previously, this should still be categorized as explicit knowledge as it was learned explicitly. Overall, learning leads to the creation of a tacit knowledge and explicit knowledge base.

Two prominent models have been proposed to explain how learning leads to tacit knowledge (Taylor, 2007). One such model is the skill acquisition model (Anderson, 1982). This model purports that knowledge acquisition and application is a 3-stage process: 1) Acquisition of declarative knowledge. This draws parallel to know-what (Ryle, 2009), 2) Acquisition of procedural knowledge. This corresponds to know-how (Ryle, 2009). It is the practical ability to apply the knowledge gained in the first stage, and 3) Fine-tuning stage. This is automatic and nonconscious. This relates more to the construct of automatized explicit learning (which is similar to Taylor's distinction of explicitly learned knowledge that is implicitly held) rather than tacit knowledge. Knowledge initially learned explicitly (declarative) ultimately leads to knowledge that becomes ingrained and hard to codify or articulate. This model is merely used to imply how skills are acquired through first obtaining declarative or explicit knowledge and then learning how to apply them. Overtime, the learning becomes tacit and automatic. Further, this model focuses on skills rather than tacit knowledge. For skills to come about, we need

knowledge. Acquisition of knowledge is a prerequisite to its application, which, in other words is skilled behavior (Willingham, 2019). This applies to tacit knowledge as well; acquisition of tacit knowledge is a prerequisite for the application of tacit knowledge. While procedural knowledge and the fine-tuning stage of the model capture the concept of skills, declarative knowledge far from captures the nuances of tacit knowledge. Declarative knowledge is just knowledge of facts or know-what whereas tacit knowledge is more likened to a base of complex mental structures based on extensive experience and learning that is held implicitly and is hard to articulate. Hence, this model fails to explain how tacit knowledge can be developed, nor how tacit knowledge leads to tacit skills. Rather, it explains automatized explicit knowledge and how explicit knowledge can lead to the development of skills.

Tacit knowledge is better explained through the knowledge acquisition components model (Clarke & Sternberg, 1986). The components comprise of three processes: selective encoding, selective combination, and selective comparison. Selective encoding refers to selectively filtering only relevant information from the environment. For instance, while solving a math question, one has to know what pieces of information or what variables are relevant to solve a given problem. It can be pointless to try to solve for all variables. Selective combination means assimilating the pieces of information from the encoding stage into meaningful patterns and structures of knowledge. Sternberg's (1986) example for selective combination was Darwin's formulation of the theory of evolution. Darwin was able to meaningfully combine information from his findings and that of others to form a cohesive theory. Selective comparison is the comparison of those patterns and structures to previously formed patterns and knowledge structures. An example provided by Sternberg (1986) was Kekule's discovery of the structure of the benzene ring. After a dream in which he saw a snake curling backwards and biting its own

tail, he realized that it was an apt visual metaphor for the benzene ring structure. He was able to make a comparison through forming an analogy between a previous experience and a new one.

The knowledge acquisition components model also illustrates the deeply intertwined nature of tacit knowledge and tacit skills. Most researchers in fact assume tacit knowledge itself to be procedural in nature instead of making the distinction between knowledge and skill (Ambrosini & Bowman, 2001). The reason tacit knowledge and tacit skills are so closely intertwined is because tacit skills (i.e., applying tacit knowledge) expands and improves the tacit knowledge base one has. When confronted with novel experiences, one calls upon previously accumulated tacit knowledge to inform the problem-solving approach (Matthew & Sternberg, 2009)If the previous tacit knowledge is appropriate and has been acquired effectively, then it contributes positively to problem solving (Matthew & Sternberg, 2009). Conversely, when tacit knowledge has not been appropriately acquired or when it ceases to be relevant, it hampers performance. Each begets the other. To practice and increase one's tacit skills means that one is using their tacit knowledge because as mentioned before, knowledge precedes skill. And to acquire tacit knowledge means that one is creating, modifying, and refining knowledge structures through the application of tacit skills (Matthew & Sternberg, 2009). This is exactly what the knowledge acquisition components model illustrates (Willingham, 2019). The skill acquisition model presents not only how tacit knowledge is acquired but also how one's current level of tacit knowledge determines their approach to a novel scenario that requires tacit skill (Matthew & Sternberg, 2009).

Selective encoding is the filtering process to determine only seemingly relevant information. This new information is then compared to one's current level of information to see how the pieces of information are related to each other (selective comparison) and how they can

be integrated to form new and better structures (selective combination), in order to form a new and better base of tacit knowledge. However, applying this new base helps finetune the above process. After action, if the outcome was not as desired, one can reflect on what they did right and what they did wrong. (Matthew & Sternberg, 2009). This will inform and improve future selective encoding, selective comparison, and selective combination. Overall, the knowledge acquisition model effectively illustrates how tacit knowledge is acquired, used, and expanded.

Tacit Knowledge Antecedents

An important antecedent to the development of tacit knowledge is communities of practice (Cianciolo et al., 2012). Communities of practice are informal groups of individuals who gather in order to facilitate the exchange of knowledge and experiences in a particular domain in order to develop capabilities (Cianciolo et al., 2012). Since different levels of expertise are acquired through experience, promoting discussions between individuals of the different backgrounds about what they are doing and why they do it can facilitate the development of expertise (Cianciolo et al., 2012). Hence, can infer that articulating tacit knowledge through discussions will lead to expertise. A key component of this idea is "reflection". Matthew and Sternberg (2009) explored the role of tacit knowledge reflection training on tacit knowledge scores and found modest support. Reflection works by enhancing the introspective view of one's problem solving or cognitive experience, which may lead to making tacit knowledge explicit and available (Matthew & Sternberg, 2009). Further, we mentioned above that reflecting on how one has applied tacit knowledge, leads to improving one's current stock of tacit knowledge. Sternberg and Matthew (2009) touch upon how Epstein (1999) explores the role of critical mindfulness practice as a means for reflection on medical professional practice. Indeed, conceptually speaking, it is easy to see how mindfulness relates with the discussion of reflection.

The key dimensions of mindfulness practice are attention and awareness (Glomb et al., 2011), as will be explained in the mindfulness section below. Both of these dimensions, like reflection, involve the observation of specific aspects of one's experience of something.

Tacit Knowledge Measures

The most common form of tacit knowledge measures within a particular domain are self-report situational judgment tests (SJTs). An SJT is a set of simulations in which respondents need to select the best answer to hypothetical situational issues. The answers are scored by comparison to previously determined answers from subject matter experts, theory, or empirical validation (Jackson et al., 2017). The tacit knowledge inventory for managers is one such scale and has been used extensively to measure tacit knowledge amongst managers in the workplace (Wagner & Sternberg, 1985). The tacit knowledge inventory for managers (Wagner & Sternberg, 1985) showed moderately high correlation with certain indicators of managerial performance like salary and years of management experience. However, it should be noted that reliabilities for many of the items were quite poor. A cross validation study using performance appraisal measures was conducted that showed moderate correlations between the inventory scores and performance indicators like personnel management and generating new business. The adaptation of this inventory in the context of audit (Tan & Libby, 1997) showed that the inventory scores distinguished the best and worst performers at the higher levels of management but not for the lower management and staff. This a reasonable because the inventory used was primarily assessing management knowledge-even if it had been altered to fit the audit context-which has not yet been developed at the lower ranks. They also had a technical test which showed opposite results; the level of technical knowledge distinguished the best and worst at the lower management and staff but not for top management. It would have been interesting to see how

tacit knowledge in auditing itself would have distinguished performers. Management and auditing are two separate domains and testing the tacit knowledge on one domain and technical knowledge on another domain and then making comparisons does not tell us much. That is what this paper proposes, a measure that captures the level of explicit knowledge and the level of tacit knowledge in a given domain. The tacit knowledge for military leader's inventory (Antonakis et al., 2002) was created for the purpose of keying in on the tacit knowledge that military leaders accumulated that leads to successful leadership. The scale was able to effectively distinguish between more experienced officers and less experienced. An inventory developed and used in an academic setting is the academic tacit knowledge scale (Leonard & Insch, 2005; Somech & Bogler, 1999). Somech and Bogler (1999) first developed a scale for tacit knowledge in academia and this scale showed that academic tacit knowledge is positively related to higher grades. Leonard and Insch (2005) later replicated this scale and also created a new academic tacit knowledge scale based on a 6 factor structure. However, it is questionable if both these scales tap into tacit knowledge. They merely ask students about the frequency of certain ideal habits as exhibited by high performers. The Safe Speed Knowledge Test developed by Legree et al. (2003) was used to test tacit knowledge in the arena of driving. Participants were given scenarios describing various weather conditions, mood of the driver, and traffic. The participants had to respond how much they would adjust their speed. The scores were obtained by subtracting an individual's speed adjustment response from the average experimental speed adjustment response. They found that the scores were related to driver at- fault crash rate. For all of these scales, experts were initially interviewed to elicit the content and structure of the knowledge. From this mass of qualitative data, items were developed and selected to be part of the inventories. The scales were then administered to samples for validation.

Case studies are another method of assessing tacit knowledge. Case studies are scenarios that provide detailed information about a realistic problem (Cianciolo et al., 2012). After reading the details of a specific realistic case, respondents answer a set of open-ended questions that are meant to evaluate their usage of knowledge acquisition components (Cianciolo et al., 2012). The method of developing case-study scenarios is similar to that of SJTs. Subject Matter Experts (SMEs) are interviewed in order to develop the cases by considering multiple perspectives, courses of action, and pertinent information. As a result, case study scenarios are often more insightful into the cognitive mechanisms that lead to problem solving (Cianciolo et al., 2012).

This paper proposes to develop a new measure of tacit knowledge based on a more appropriate definition of the construct building off of Taylor's taxonomy. To reiterate, our definition of tacit knowledge is the complex mental models that are learned implicitly and hard to articulate. The issue with previous measures is that they are based on ill-defined conceptualizations of tacit knowledge. For example, Wagner (1985) proposed that tacit knowledge is essentially how one manages self, relationships, and tasks. The tacit knowledge inventory for managers was based on this framework, and it makes sense given that Wagner (1985) describes tacit knowledge as informal knowledge that is practical rather than academic and that has not been explicitly taught. However, this is not an accurate definition of what tacit knowledge is. Wagner is describing a construct that has some overlap with tacit knowledge but should be called something else like 'practical knowledge' or 'common sense knowledge'.

Further, there is a need to better ascertain whether the construct we are measuring is indeed tacit knowledge rather than explicit. According to our operation, this would mean measuring knowledge that is implicitly learned. Our approach involves isolating knowledge on the basis of how it was learned, within a particular domain, research methods. Specifically, we

seek to identify implicitly learned knowledge and measure it separately from explicitly learned knowledge. Once again, we emphasize that we are not concerned with how it is held because it is not practically significant. Implicitly learned knowledge can be held implicitly or explicitly. Likewise, explicitly learned knowledge can be held implicitly or explicitly. It is more practically valuable to quantify the products of implicit learning as they are a better indicator of an individual's capabilities. It distinguishes an expert-someone who performs better than the average individual and has an immense amount of experience and learning such that they can discern patterns quickly-from a person who is merely knowledgeable (Cianciolo et al., 2012).

> *Hypothesis 1:* The new test will yield a two-factor structure for knowledge (tacit and explicit knowledge).
>
> *Hypothesis 2:* Expertise is positively associated with tacit knowledge.
>
> *Hypothesis 3:* Tacit knowledge will predict professional and research performance.
>
> *Hypothesis 4:* Tacit knowledge factor will predict additional variance in performance beyond the explicit knowledge factor.

Since tacit knowledge is domain specific, in this paper we are proposing a new method of measuring tacit knowledge that can be replicated across domains. The development method is similar to existing methods; we use critical incidents and produce a situational judgement test. However, our measure is based on a more apt definition of tacit knowledge and we construct it in a way such that we can clearly distinguish it from explicit knowledge. We obtain the tacit knowledge piece from Subject Matter Experts with years of experience on the job. The explicit piece is obtained from the available codified information provided through formal training. In this study, the formal training is the training of students in psychological research methods.

Mindfulness

Dane (2011, p. 1000) defines mindfulness as "a state of consciousness in which attention is focused on present-moment phenomena occurring both externally and internally." Mindfulness as a concept and practice emerged from Buddhism (Purser & Milillo, 2015). It entered the mainstream western culture during late 20th century when Zen Buddhism gained popularity and led to extensive research (Keng et al., 2011). The five dimensions of Mindfulness as per Buddhist traditions are "…(1) awareness, (2) perceptual sensitivity to stimuli, (3) deliberate attention to the present moment, (4) intimacy or closeness to one's subjective experience, and (5) curiosity" (Tanay & Bernstein, 2013, p. 1287). Today's understanding of mindfulness practices in medical literature embody attention, awareness, and acceptance (Stremic, 2020). Awareness refers to the subjective experience of internal and external phenomena, and attention refers to the activity of focusing on selected aspects of that reality, thus determining that which is included in awareness (Glomb et al., 2011). Finally, acceptance refers to an open, receptive, or nonjudgmental attention to and awareness of present moment consciousness (Glomb et al., 2011).

Since its inception, researchers have operationalized mindfulness as either a trait (Cardaciotto et al., 2008; Lakey et al., 2007; Walsh et al., 2009; Way et al., 2011), state (Brown & Ryan, 2003; Glomb et al., 2011) or skill (Stremic, 2020; Baer et al., 2004). In this paper, mindfulness is operationalized as a skill. Stremic (2020) defends this operationalization through reasoning that if mindfulness was a trait, it would remain relatively stable over time. However, research has shown that mindfulness training improves mindfulness in a relatively short amount of time (Walach et al., 2001; Lau et al, 2006). This would be unlikely if it were a trait, especially given that traits are relatively enduring patterns of emotions, thoughts, and behaviors (Roberts & Mroczek, 2008). Further, if mindfulness was a state, then it should behave similarly to other

states, like emotions. After all, psychological states are transient in nature (Nezlek, 2007). If a

mindfulness state were to be temporarily induced through mindfulness meditation or other

practices, then it should follow that this state should not last long after the session and that

people cannot improve in retaining the state. However, there is research evidence showing just

the contrary (Mathew et al., 2010; Solhaug et al., 2019). Additionally, if mindfulness is indeed a

state, there would not be different levels of ability and it would not make sense to train people to

improve. Yet, we do see varying levels of capability and we do train people improve in

mindfulness (Bishop et al., 2004). Given that skills are defined as proficiencies in performing

certain behaviors (Noe, 2020), and the strong evidence that people can and do improve on

measures of mindfulness, mindfulness should be operationalized as a skill.

Mindfulness Practices

Today, mindfulness practices take two prominent forms. The first is the Mindfulness-

based Stress Reduction (MBSR) technique that was pioneered and developed by the researcher

Kabat-Zinn (2005). MSBR interventions aim to reduce stress, anxiety, and pain in both clinical

and non-clinical populations (Grossman et al., 2004). MSBR is traditionally a structured group

intervention, taught by certified trainers that has a duration of 8-10 weeks (Kabat-Zinn, 1990). It

is comprised of weekly sessions that are 2.5 hours long. Additionally, there is one all-day session

per program. Sessions are unique in that each explores distinct exercises and activities, such as

mediation, yoga poses, body scanning, and techniques to use in stressful situations (Kabat-Zinn,

1990). Additionally, participants are required to complete short homework assignments in the

form of meditation or yoga to gain the true benefit of repeated mindfulness practice (Grossman

et al., 2004). The second well known mindfulness program is mindfulness-based cognitive

therapy (MBCT) which integrates mindfulness with cognitive therapy for clinical populations.

Evidence shows that it can reduce clinical symptoms (Chiesa & Serretti, 2010). Like MSBR, it is an 8-week group intervention. It teaches individuals with psychological issues, like depression. to change their cognitive patterns and to engage with thoughts in a more detached and objective manner (Chiesa & Serretti, 2010).

Apart from these more common formal programs, mindfulness can also take the form of shorter, standalone practices. Mindful practices can include yoga, tai chi, qigong, prayers, chanting, and meditation (Dan Siegel, 2018). Some experiments test the effectiveness of short interventions, such as keeping a mindfulness diary, meditation, body scanning (O'Leary & Dockray, 2015), and breath counting (Gorman & Green, 2016). Another way to practice mindfulness that is gaining popularity is through using apps, such as Headspace and Calm, designed to aid frequent mindfulness practice when it is more convenient to practice or when people feel like they need the practice. Various studies have captured the benefits and effectiveness of using these apps to meditate (J. Clarke & Draper, 2020; Economides et al., 2018). Finally, according to Thich Nhat Hanh (2002), mindfulness can be practiced in everything we do, including walking, sitting, eating, drinking, writing, and talking. In fact, Hanh (2002) argues that the goal should be to live an overall mindful life and reap the benefits of a mindful lifestyle.

Mindfulness Outcomes

Mindfulness is associated with many positive outcomes. However, it is worth noting that studies vary in the way they operationalize and measure mindfulness. This should be considered when interpreting the results of any study related to mindfulness. Additionally, while some studies temporarily induce mindfulness or measure trait mindfulness, some studies address the impacts of formal mindfulness trainings such as MSBR and MBCT.

Mindfulness has important job-related outcomes. Dane and Brummel (2014) tested how mindfulness as a trait impacts job performance in a dynamic work sector. They found that trait mindfulness has a positive relationship with job performance. Hülsheger et al (2013) found that both trait mindfulness and state mindfulness leads to decrease in surface acting, emotional exhaustion, and an increase in job satisfaction. Studies have also found that when a leader embodies more mindfulness, employees tend to show lower exhaustion (Birdie, 2015).

Mindfulness also has important individual outcomes. Hafenbrack et al. (2014) demonstrated that state mindfulness (induced through a short meditation) leads to a deepened awareness of the present moment and reduced negative affectivity. Howell, Digdon, Buro, and Sheptycki (2008) found that trait mindfulness is directly and indirectly (via sleep quality) associated with well-being. Both trait and state mindfulness have been showed to be negatively associated with hostility and aggression (Heppner et al., 2008). MBSR has been linked to effective moral reasoning and decision making over a period of time (Shapiro et al., 2012). It has also been shown to decrease anxiety (Biegel et al., 2009) and stress Bränström et al., 2010). Other mindfulness-based interventions have been linked to reduced alcohol and substance abuse (Chiesa & Serretti, 2010), increased hope (Sears & Kraus, 2010), lower perceived stress (Klatt et al., 2009), and increase in social connectedness (Hutcherson et al., 2008).

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Mindfulness and the Development of Tacit Knowledge

We know from Kabat-Zinn's definition that mindfulness is the embodiment of non-judgmental attention and awareness of the present moment. This awareness and attention refer to both internal and external phenomena. The attention and awareness of internal phenomena can be likened to metacognition. Metacognition refers to "thinking about thinking" (Ganapati &

Mostafavi, 2018, p. 4). More in line with mindfulness, Kuhn and Dean (2004, p. 270) refer to metacognition as "awareness and management of one's own thought." Viewing mindfulness as sharing commonalities with metacognition emphasizes the cognitive skills that mindfulness practice fosters, such as alertness and sustained attention (Hussain, 2015).

Further, metacognition has also been used as a term to call the intentional reflection of the various pieces or features of knowing and learning (Flavell, 1981). In efforts to develop a theory of metacognition and executive-level processing, Clements and Nastasi (1999) drew upon Sternberg's (1985) componential theory of cognition which includes performance components, meta-components, and knowledge acquisition components. Meta-components are essentially the executive processes that are used for planning, monitoring, and decision making when one is engaged in task execution (Clements & Nastasi, 1999). This essentially aids and supplements the knowledge acquisition components. It can be hypothesized that mindfulness enhances the knowledge acquisition process by promoting metacognition and metacomponents. With mindfulness, one can be more aware and attentive of what they think in the environment is relevant (selective encoding), how they combine information (selective combination), and how they compare it to previous information (selective comparison). The whole process would be enhanced due to the metacognitive aspect of mindfulness, because now it is more intentional and careful. There is some research that supports this. Antonakis et al. (2002) found that experienced officers differed from lieutenants in the way they regulated their problem-solving strategies. They differed in the way they diagnosed and solved problems. This could mean that mindfulness skill could be a predictor of how well individuals are able to acquire knowledge and hence how much tacit knowledge they have. In this paper, we argue that mindfulness skill predicts tacit knowledge inventory scores. If mindfulness improves the processes involved in knowledge

acquisition (through metacognition), then this should be reflected in the tacit knowledge scores that an individual attains.

Hypothesis 5: Mindfulness skills and tacit knowledge are positively correlated

Hypothesis 6: Metacognition skills and tacit knowledge are positively correlated

CHAPTER II: METHOD

Study 1: Creating the Tacit Knowledge Test

Participants

The first stage required input from various SMEs in the field of research methodology to create the tacit component of the new test. It also involved using explicit knowledge via textbooks to develop the explicit component of the new test. Participants were recruited using social media (LinkedIn and Reddit) and emails from various universities and colleges from different countries to ensure that the obtained data is representative of research perspectives from different cultural backgrounds. The qualitative data obtained from 20 subject matter experts were used for the development of about 20 situational judgement scenarios (each SME will be asked to contribute a minimum of four scenarios).

Measures

The responses will be acquired through a questionnaire administered on Qualtrics. The main sections of the questionnaire are the consent form, demographic questions, questions regarding the extent of research experience, the critical incidents questions, and a debrief description. See Appendix A, Appendix B, and Appendix C for more details.

Procedure

A questionnaire was sent out to several identified SMEs via email and LinkedIn messages to obtain critical incidents from their experiences with research methodology. The questionnaire was also posted on Reddit. Participants first filled out a consent form. Then, they were asked to provide critical incidents of times when they used their tacit research knowledge, such as, "*Tell us about two situations where you worked on a research project and you had to use knowledge gained from practical experience in order to succeed and/or overcome an issue.*

Were there other courses of actions available to you? If so, what were they" and "*Tell us about two situations where you worked on a research project and you did something wrong. What were the options available to you? What could you have done to prevent this failure?* They then filled out demographic questions and questions to check data quality. Finally, they were debriefed about how their responses will be used to build a measure of tacit knowledge.

These responses served as templates for 20 Situational Judgement Questions that will be used for the tacit component of the test (Appendix D). The questions were reviewed by a panel of SMEs before validation to develop a scoring key for the new test. Simultaneously, a list of 20 explicit questions were developed as well using psychology research methodology textbooks (Appendix E).

Study 2: Validation of the Tacit Knowledge Test

Participants

535 participants with varying degrees of research experience were recruited using email and social media for the validation of the newly developed measure of tacit knowledge. Comrey and Lee (1992) rated a sample size of 300 as "good" for factor analytic studies to obtain stable solutions. The final sample consisted of data from 301 participants with 173 people who identified as a man (57.0%), 91 people who identified as a woman (52.6%), 2 people who identify as transgender (0.6%), 3 people who identify as other (0.9%), 7 people who preferred not to identify (2.3%), and 27 people who didn't respond (8.9%). 232 participants were removed due to missing data and data integrity issues (e.g., they reported they were not paying attention or were clicking randomly). The sample was relatively homogenous, with 75% White, followed by African American (5.9%), Native American (2.9%), Asians (2.3%), Hispanic (2.3%), mixed (0.3%), and 26 nonresponses. The age ranged between 18 to 74 ($M = 29.19$, $SD = 7.59$). The

majority of the participants were in North America (58.7%). About 2.3% of the participants had not completed high school, 5.6% had completed high school, 13.5% had completed some college, 13.8% had an associate degree, 33% had a bachelor's degree, 11.2% had a master's degree, 10% had a doctoral degree, 0.6% had a professional degree, and 10% of participants did not answer. In terms of work status, 42.5% were employed, 10.5% were self-employed, 15.5% were interning, 10.5% were working part-time, 12.2% did not have a job, 4.9% were full time students, and 3.9% were other.

Measures

      Kentucky Inventory of Mindfulness Skills (KIMS). The KIMS (Baer, Smith, Allen, 2004) is one of the few scales that measures mindfulness as a skill. It comprises of 39 questions that are answered on a 5-point Likert scale ranging from Items are rated on a 5 point Likert scale ranging from 1 (*never*) to 5 (*almost always*). It has 4 dimensions: observing, describing, acting with awareness, and accepting without judgement. Some examples of questions on the KIMS are: "I'm good at finding the words to describe my feelings" and "When I do things, my mind wanders off and I'm easily distracted." The scores are computed separately for each dimension by averaging them. The KIMS had a high internal consistency estimate of $\alpha = .93$. High scores on the KIMS are supposed to indicate higher levels of mindfulness skill. See Appendix F for this measure.

      The Mindfulness Skill Scale (MSS). The MSS (Stremic, 2020), is another newer scale that also measures mindfulness as a skill. Stremic (2020) argued that the KIMS measures the frequency of mindfulness behaviors rather than skill level, and hence she developed a new mindfulness skill measure. The questionnaire consists of 22 questions that questions are rated on a 5-point Likert scale ranging from 1 (*not at all skilled*) to 5 (*extremely skilled*). The MSS has a

2-factor structure: A present-moment awareness factor and an acceptance factor. Some examples

of questions are: "Accepting my negative thoughts" or "Curiously observing my negative

thoughts". The MSS has high internal reliability for the acceptance dimension (α = .93) and the

present-moment awareness dimension (α = .90) as well as the overall scale (α = .95). The

average is computed for the final score. High scores on the MSS signify higher levels of skill.

See Appendix G for this measure.

Metacognitive Assessment Ability (MAI). The MAI (Schraw & Dennison, 1994) is a

measure of awareness of one's own metacognition in various contexts and overall learning

strategies and processes. The questionnaire consists of 52 items and is rated on 5-point Likert

scale which ranges from 1 (*a lot like me*) to 5 (*not at all like me*) to signify respondents' level of

agreement with the questions. It measures two primary components: 1) Knowledge about one's

own cognition, and 2) regulation or monitoring of one's own cognition. Some examples of the

questions are: "I understand my intellectual strengths and weaknesses," "I am aware of what

strategies I use when I study," and "I ask myself questions about the material before I begin".

Schraw and Dennison (1994) have demonstrated the strong relationship between both the

components. However, the final factorial structure found eight subcomponents: conditional

knowledge, declarative knowledge, procedural knowledge, planning, monitoring, information

management strategies, debugging strategies, and evaluation of learning, respectively (Sperling

et al., 2004). Each major component demonstrates good reliability: knowledge of cognition (α =

.91) and regulation of cognition (α = .91). The alpha for the whole measure is α = .95. Final

scores are computed by adding items on both domains. Scores range from 52 to 260, with higher

scores indicating greater metacognitive awareness. See Appendix H for this measure.

Procedure

Participants first filled out a consent form (See Appendix I), followed by the new tacit knowledge scale, the Kentucky Inventory of Mindfulness Skills (Baer, Smith, Allen, 2004), the Mindfulness Skill Scale (Stremic, 2020), and the Metacognitive Assessment Ability (Schraw & Dennison, 1994). Next, they were asked demographic information questions, questions regarding their professional and academic performance in research (See Appendix J), self- assessment questions regarding their research (See Appendix K), and attention check questions (See Appendix L). Demographic questions included gender, ethnicity, job title, country of residence, age, and maximum level of education attained. Questions regarding their performance in research will include: "*Please list the number of conferences you have presented at,*" and "*Please list the number of times you have published your research work in journals.*" Questions asking the participants to provide assessments of themselves included: "*Rate the quality of your research performance,*" and "*Rate your research productivity.*" Next, the attention check questions were intended to ask participants about the quality of data they provided. For instance, participants were asked if they actually paid attention or if they were just clicking randomly Finally, they were thanked for their participation (See Appendix M) and given a separate link if they want to enter their email for a lucky draw of $50.

CHAPTER III: RESULTS

Analyses were completed using AMOS, SPSS, and R. Prior to data analysis, 234 participants were removed based on responses to the data integrity questions and for not responding to a large portion of the survey. The descriptives are reported in Appendix N and the correlation matrix is reported in Appendix O. Correlations, ANOVA, and regressions were run on the remaining sample ($n = 301$). The scores for the tacit knowledge test were calculated by adding the absolute value difference between rankings made by participants and the SMEs for each option, for each question. The consequent distance scores represent the deviation from the actual answers. In other words, the extent to which their answers differed from the actual answers. In other words, the scores represented the extent to which the scores were wrong. These scores were then reverse coded to obtain scores that represent the correct answers. Responses for research performance indicators like conferences attended, books authored, and publications were summed to obtain one variable: Research performance. Another indicator used for research performance was research productivity. This was calculated by calculating the average score of self-assessment questions that participant's answered regarding their research productivity.

Research years and research projects required log transformations before running analyses as they were heavily skewed. Prior to that, a constant of one was added to eradicate zeroes in the data Research years and research projects were used as alternative indicators for research expertise. This was done because group membership (undergraduate, graduate, faculty, and nonacademic researchers) was often unclear. Their responses to the question, "What is your research level" (they had to select one of the above-mentioned groups) often did not coincide with their responses in the demographic section. Participants who left that question blank were coded as a separate group. Since there was no "other" option for that question, it may have been

that those people might have had absolutely no research experience and do not identify with any of the levels.

Reliability analyses conducted on the tacit knowledge test and explicit knowledge test revealed that several items needed to be removed in order to increase reliability. Item 16 of the explicit test was removed, revealing a Cronbach alpha of .60 for the final explicit test. Additionally, items 2,6,12,16, and 19 from the tacit test were removed, pushing the alpha to an acceptable .73.

Test of Hypotheses

Hypothesis 1: The new test will yield a two-factor structure for knowledge (tacit and explicit knowledge).

A confirmatory factor analysis was run in AMOS to test whether the explicit and tacit scales would emerge as their own factors. It was found that the tacit and explicit dimensions of the test did not produce an interpretable factor structure. Rather, the items factored by difficulty rather than content (explicit vs tacit). The RMSE was 0.063 and CFI was 0.501. Hence, Hypothesis 1 was unsupported.

Hypothesis 2: Expertise is positively associated with tacit knowledge.

Three variables were used as indicators of expertise: Research years, research projects, and group membership. Since these variables were not normal, log transformations were run. Prior to that, a constant of one was added to eradicate zeroes in the data. After log transformations were used for research years and research projects, Correlations were run for those two variables against the tacit knowledge scores. Tacit knowledge scores were not statistically significantly related to research years ($r = -.18$, $p = .761$). Tacit knowledge scores were statistically significantly weakly correlated with number of research projects ($r = .12$, $p = 0.042$).

A one-way ANOVA was conducted to explore how tacit knowledge scores differed by expertise group (i.e., undergraduate student, graduate student, faculty, or the unidentified group). The ANOVA was significant $F(5,902) = 3.609$, $p = 0.03$. Post hoc analyses using Tukey HSD correction revealed that there was a statistically significant difference between undergraduates ($M = 60.64$, $SD = 15.54$) and the unidentified group ($M = 46.64$, $SD = 19.66$) of 14, $p = .02$. It is interesting to note that undergraduates scored the highest on the test. No other mean difference was significant. Please refer to Appendix P for the mean differences. Hypothesis 2 had some support.

Hypothesis 3: Tacit knowledge will predict professional and research performance.

Since professional and research performance are a summation of count data (number of conferences, book authorships, and journal publications), we conducted a Poisson linear regression. We found that tacit knowledge scores did not statistically significantly predict research performance, $b = -.01$, $S.E. = .01$, $p = .483$. A simple regression was conducted to assess whether tacit knowledge scores predict research productivity. Research productivity- evaluated by self-assessment questions about research productivity- was used as an alternative variable to assess research performance. No statistically significant relationship was found, $F(1,276) = .71$, $p = .402$, $R^2 = .003$. Hypothesis 3 was unsupported.

Hypothesis 4: Tacit knowledge factor will predict additional variance in performance beyond the explicit knowledge factor.

A Poisson regression was performed to test Hypothesis 4. In accordance with Hypothesis 3, tacit knowledge scores were not a significant predictor (b = -.00, S.E. = .01, p = .779) of research performance. Explicit knowledge scores were also not a significant predictor of research performance (b = .10, S.E.= .06, p = .075). Hypothesis 4 was unsupported.

Hypothesis 5: Mindfulness skills and tacit knowledge are positively correlated

Correlational analyses were run between the tacit knowledge scores, the MSS scores, and the KIMS scores. Tacit knowledge scores were statistically significantly, weakly, and negatively related to MSS scores ($r = -.12$, $p = .048$) scores. Tacit knowledge scores were statistically significantly weakly correlated with the KIMS ($r = .20$, $p = .001$) scores. Hence, there was very weak support for hypothesis 5.

Hypothesis 6: Metacognition skills and tacit knowledge are positively correlated

Correlational analyses were run between the tacit knowledge scores and the MAI. The correlation was not statistically significant; furthermore, it was negative, ($r = -.30$, $p = .610$). Hence, Hypothesis 6 was not supported.

CHAPTER IV: DISCUSSION

The purpose of this study was to provide a well-researched definition of tacit knowledge – knowledge learned implicitly – and develop a test to measure tacit knowledge based on this definition. Further, there was also a need to better establish whether the construct we are measuring is indeed tacit knowledge rather than explicit. Hence, our measure included an explicit component as well. We attempted to isolate knowledge based on how it was learned, within a particular domain, research methods.

We first tested Hypothesis1 by examining whether a two-factor (explicit and tacit) structure would emerge for the test. However, no significant interpretable factor structure could be found. Items tended to be correlated on the item difficulty rather than item content. Hypothesis 1 was unsupported. Next, we tested Hypothesis 2 by examining the relationship between expertise and tacit knowledge. Number of years spent in research were not related to the tacit knowledge scores. The number of research projects completed was very weakly related to research performance. These two variables, although not ideal, were used as alternative indicators for expertise because the intended variable, group membership, did not yield cleanly separable groups as many people left the question blank. In terms of group membership, undergraduate researchers differed significantly from those who did not identify with any level of research. From this information, it is possible to assume that people who did not answer the research group question have little to no research experience. It was also interesting to note that undergraduate students scored highest on the test, although the differences between undergraduates and the other identified groups were not significant.

Neither Hypothesis 3 nor hypothesis 4 was supported. Tacit knowledge and explicit knowledge did not predict research performance. This runs contradictory to previous research

(Wagner, 1985; Wagner & Sternberg, 1985; Tan & Libby, 1997; Legree et al., 2003). Hypothesis 5 was somewhat supported; the KIMS mindfulness scale was positively correlated with the tacit knowledge score, albeit, weakly. However, the MSS was negatively related, also weakly. There was no significant relationship between the metacognition scale and the tacit knowledge scores. Finally, hypothesis 6 was unsupported. The MAI was unrelated to tacit knowledge scores.

Theoretical and Practical Implications

This study failed to provide evidence that knowledge can be separated into two categories. We did not find a two-dimensional factor structure for knowledge. We also found that the tacit knowledge scores were not predictive of performance. This runs contradictory to previous research (Wagner, 1985; Wagner & Sternberg, 1985; Tan & Libby, 1997; Legree et al., 2003). Also, expertise, at least in the way it was operationalized in this study, was not related to tacit knowledge. Perhaps, the relationship would change if non-biodata based indicators of expertise were used. Further, this study also provides some evidence that mindfulness may be related to tacit knowledge. Future studies should examine the directionality of this relationship and include more measures of mindfulness. We also provide evidence that there is no relationship between metacognition and tacit knowledge, despite theoretical justification.

A practical implication of the results of this study is that it provides a case for *not* using tacit knowledge as a predictor or indicator of performance. However, more evidence is needed to generalize this finding to other fields and areas of expertise. After all, operationalizations of performance can vary from field to field. Further, domains differ in how easy it is to capture tacit knowledge. Finally, different samples could yield very different results. Ideally, the subgroups within the sample need to be equal. Another practical implication is that explicit knowledge also seems to be unrelated to performance. Hence, managers may have to reevaluate the efficacy of

knowledge tests to evaluate job performance. However, the same concerns of external validity also apply to this finding. Research is something that even students can engage in. So, this study did not really observe "job performance" but research performance. Essentially, we just examined performance in a particular domain. Job performance encompasses a broader scope of behaviors that our measures for the independent variable and the dependent variables did not tap into.

Limitations and Future Research

The scoring process was a significant limitation of this study. Only two SMEs from MTSU were used to score the test and create an answer key. In the future, scoring should involve many more SMEs from a variety of different backgrounds. More SMEs are needed to increase the reliability and accuracy of the answer key. Replication studies should involve more SMEs to create the scoring of the SJT. Further, the creation of the instrument was performed by a master's level student. And although the situations were based on experiences provided by experienced SMEs, the response options were developed by the master's level student. The response options could have been very different if developed by an individual with greater tacit knowledge. This leads to the question: are the response options inclusive of what an expert would do in each situation? The two SMEs who scored the test might have just best rank ordering of options given the available options. But perhaps, in that situation, they might have done something else that was not reflected in the choices. Further researchers should investigate ways to make the response options more content valid. The content validity of the measure can always be improved by including situations from more SMEs from more diverse backgrounds to include a great array of situations.

There may have been issues with the data regarding conference presentations, publications, book authorship, and grants. Especially for faculty, it is hard to remember the details of a lifelong career. Also, either due to data entry error or because of a few exceptional individuals, the data contained several outliers that might have skewed the results. Further, when we obtained the research performance score, we did not weigh any individual category more than the other. We assumed that publishing in journals, authoring books, and presenting in conferences are all equal in difficulty when that is likely not the case. Even different conferences and journals have variability in terms of difficulty. Our measure could not capture these nuances. We were also unable to use grant information provided as some participants responded in dollar amount while others responded in counts. Further, we also did not take a more holistic perspective of performance; we could not include things like peer and supervisor ratings. We could only assess the quantity of their research rather than the quality.

Undergraduate researchers were the largest participant group in the study. Recruitment emails were sent out to undergraduate students, graduate students, and faculty. And since there are significantly more undergraduate students than graduate students or faculty, the probability is that our sample would have a greater number of undergraduates than other subgroups. Future research should ensure more equal distribution between the different groups or find ways to better differentiate experts from novices.

Another important limitation of this study is that a lot of people reported that they referred to outside sources in the data quality check questions. This likely lowered the reliability of the measure. However, this involved removing too many participants, so all the participants were included in the analyses, regardless of cheating. In the future, participants should be timed to avoid cheating to obtain more accurate measurements of tacit and explicit knowledge.

Finally, while this study points to the likelihood that no relationship exists between metacognition and tacit knowledge, it is important to note that by the time participants take the MAI, the study might have started to become tedious, leading to survey fatigue. In fact, survey fatigue may have even started prior to taking MAI; that is, when they were taking the MSS since tacit knowledge also related negatively to the MSS. This contradicts both theory and the fact that MSS was positively related to the KIMS. Participants may have started feeling some level of irritation which may have reflected in the scores.

Conclusion

We proposed that knowledge may have a two structure model: Explicit and Tacit. We failed to demonstrate this model and we also found insufficient evidence to support relationships between tacit knowledge and performance as well as tacit knowledge and expertise. We did find some evidence that tacit knowledge may be linked to mindfulness. It is important to reassess if tacit knowledge indeed predicts performance and if there are better ways to measure it. However, the limitations of this study may likely be obscuring the true relationship of all the variables.

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APPENDICES

APPENDIX A: QUESTIONS IN STUDY 1 FOR SMEs

Instructions: In this survey, we would like you to look back on your research experiences in either academia and/or work. We will ask you to describe four situations. Please answer with as much relevant detail as possible:

1. Tell us about two situations where you worked on a research project and you had to use knowledge gained from practical experience in order to succeed and/or overcome an issue. In other words, you used knowledge that you didn't directly learn from a book or that wasn't taught to you during your research training. Were there other courses of actions available to you? If so, what were they?

2. Tell us about two situations where you worked on a research project and you did something wrong or made a mistake. What were the options available to you? What could you have done to prevent this mistake?

APPENDIX B: INFORMED CONSENT FOR STUDY 1

Information and Disclosure Section

The following information is provided to inform you about the research project in which you have been invited to participate. Please read this disclosure and feel free to ask any questions. The investigators must answer all of your questions and please save this page as a PDF for future reference.

- Your participation in this research study is voluntary.
- You are also free to withdraw from this study at any time without loss of any benefits.

For additional information on your rights as a participant in this study, please contact the Middle Tennessee State University (MTSU) Office of Compliance (Telephone: 615-494-8918, email: irb_information@mtsu.edu, or website: http://www.mtsu.edu/irb).

Please read the following and respond to the consent questions in the bottom if you wish to enroll in this study.

Purpose of the study:
The purpose of this study is to obtain critical incidents in the field of research methodology in order to develop a measure of tacit knowledge.

Description of procedures:
You will be asked to write up to four situations about your experience in research. In addition, you will be asked to answer some demographic questions.

IRB Approval Details
Protocol Title: Reconceptualizing and measuring tacit knowledge
Primary Investigator: Mariyam Sumaiya
PI Department & College: Psychology - College of Behavioral and Health Sciences
Faculty Advisor: Alexander Jackson, Ph.D.
Protocol ID: 21-1078 2q
Approval Date: 12/15/2020
Expiration Date: 06/30/2022

Duration:
The study should take approximately 15-20 minutes to complete.

Here are your rights as a participant:

- Your participation in this research is voluntary.
- You may skip any item that you don't want to answer, and you may stop the experiment at any time (but see the note below).
- If you leave an item blank by either not clicking or entering a response, you may be warned that you missed one, just in case it was an accident. But you can continue the study without entering a response if you didn't want to answer any questions.
- Some items may require a response to accurately present the survey.

Risks & Discomforts:
There are no known risks associated with participating in this study.

Benefits:
The potential benefits include improvements in measuring tacit knowledge.

Expected costs:
There are no costs for participating in this study.

Identifiable Information:
You will NOT be asked to provide identifiable personal information.

Compensation for participation:
There is no compensation for your participation. Participation in this study is on a volunteer basis.

Circumstances under which the Principal Investigator may withdraw you from study participation:
The study is restricted to individuals who are fluent in English and at least 18 years old

Contact Information:
If you should have any questions about this research study or possible injury, please feel free to contact Mariyam Sumaiya via email at ms2ca@mtmail.mtsu.edu. For additional information about giving consent or your rights as a participant in this study, please feel free to contact the MTSU Office of Compliance at (615) 494-8918.

Confidentiality:
Your information will be kept confidential. Although your rights and privacy will be

maintained, the Secretary of the Department of Health and Human Services, the MTSU IRB, and personnel particular to this research have access to the study records. Your responses, informed consent document, and records will be kept completely confidential according to current legal requirements. They will not be revealed unless required by law, or as noted above.

By continuing with this survey, you are also acknowledging that you have read and understand this consent form, you are at least 18 years of age, you are fluent in English, and you willingly agree to participate in this study under the terms described.

APPENDIX C: DEBRIEF MESSAGE FOR STUDY 1

Thank you for your participation. If you have any questions concerning any of the measures you took or you would like to know the results of this study, please contact Mariyam Sumaiya (ms2ca@mtsu.edu).

Please do not share any of this information with anybody as it may limit our ability to continue this study. Thank you.

APPENDIX D: TACIT KNOWLEDGE TEST ITEMS

Instructions: The following questions present specific scenarios with research. For each question, please rank order the responses from 1 to 4, 1 being the most appropriate option and 4 being the least appropriate option.

1. Percy is in the data collection stage of his thesis. He has 12 responses so far. As he scans through his data, he noticed that on average, it took participants slightly less than 15 minutes to complete the survey. At the end of the data collection period, he managed to obtain 102 responses. He observed that the average time taken to complete the survey was about 27 minutes. However, he noticed that 28 participants completed the study in less than 7 minutes. Percy does not know if he should keep those responses or not. He is unsure of the data quality of those responses. On the other hand, he needs a large enough sample, so he does not want to unnecessarily delete those responses. What should Percy have done to prevent this situation?

   a. Used attention check questions. If participants failed these, then they would be removed from the analyses
   b. Pilot tested the study so that he is aware of the minimum time it takes to complete the survey.
   c. Placed instructions in the beginning of the survey, imploring participants to focus and pay attention while answering.
   d. He should have planned to collect a larger sample to allow for unexpected situations

2. Marial is a PhD student and is excited about conducting a study about the effects of a new drug on participants with blood cancer. Unfortunately, after a preliminary analysis, Marial doubts her ability to obtain a large enough sample. She almost decides to give up on her study when she was told by her advisor that the practical implications of the drug were too important, even if her sample was too small. She decides to conduct the study anyway and found non-significant results. However, she found a medium-sized effect. She starts trying to find journals that will publish her study. This time, another experienced colleague tells her not to bother looking. He tells her that her time would be much better spent drafting another project as no journal would publish non-significant results. What should Marial do?

   a. The colleague is right. Marial is in a critical point of her academic career and needs to be pursuing projects that have a chance of being published. She should abandon this project.
   b. She should do her part in not succumbing to publication bias and highlight the effect size and rigorous methodology of her study and hope for the best.
   c. She should try to find a low tier journal, with lower standards and higher acceptance rate to publish her work. Since she is just starting her research career, this is a useful steppingstone.
   d. She should continue recruiting participants and checking the data until she has a significant result that she can submit for publication.

3. Moira and her team of management consultants have been working on a turnover model for a large law firm in Washington D.C. The project has a duration of four months. The consultants are expected to provide a report and presentation about their results and recommendations. After three days of intense analyses, they had a few interesting findings. One of the findings was that a particular subsection of employees, all with the same job title and who had been in the company for approximately the same amount of time, were significantly more likely to leave the organization than the other employees. In Moira's experience, the effect size they found was quite large. This finding could have huge implications for the organization. What should Moira and her team do at this point?

   a. She should go back to the company and question the turnover policies and processes that pertain to that particular job title and learn more about the results before reporting out the results.
   b. She should re-run the analyses and then have a second person check the results to ensure objectivity. Then, she can proceed to creating the report and presentation.
   c. She should immediately inform the company, so they can take swift decisions about what to do about that group of employees without wasting anymore time.
   d. She should just proceed as planned and start creating the report and presentation. She should have her team highlight the finding in the report and presentation.

4. Harry is a psychology graduate student who is starting to think about his thesis. He is somewhat interested in several topics like learning, expertise, and skill development. These topics have not been covered in his classes so far. He does not really know how to get started. What should he do at this point?

   a. Continue looking for and thinking about other topics of interest as well because it is better to have a wider range of interests during the initial stages of research.
   b. He should look up those topics in scientific databases and peer reviewed literature to build his initial understanding of the topics.
   c. He should do some google searches for obtaining general background information and key words that people use to address what he's interested in.
   d. He should meet with a potential advisor whose research interests at least somewhat resembles his, so he can discuss his questions and concerns with someone knowledgeable.

5. Meera is collecting data for her dissertation. Her study involves participants coming into the lab a total of three times over the course of an academic year. Meera had an easy time recruiting students, however, retention has been a real issue. Several people did not attend her second session. Now, she is worried because even more people are failing to attend her third session. This could potentially derail her study. The research protocol at the university states that researchers are only allowed to call participants a maximum of two times to recruit people to participate in the study. However, there is no policy regarding the number of times to communicate with participants after they consent to participate. What should Meera do at this point?

    a.   Call the absent participants twice a week until she gets hold of them
    b.   Call the participants a total of two times and leave a voicemail message
    c.   Send them an email with an incentive for participation
    d.   She should address it as a limitation in her study.

6. Ray works as a research assistant in a team-dynamics training laboratory. His work involves maintaining accurate data about team performance in various tasks like finishing puzzles, answering trivia questions, and various other games in a digital environment. As part of the training laboratory, undergraduate students are placed in teams and participate in simulations to help them develop their skills. The team that manages to accomplish the most tasks win. Ray was responsible for taking detailed quantitative notes about the performance of the different teams. He sometimes sits in the room with the students as simulations are taking place. During one simulation he overheard a participant asking his fellow team member to look up something on her phone, which is cheating. Ray had observed before that this particular team almost always came first in the trivia task. The team member agreed to look up the question, and both team members made no effort to hide the fact they were cheating even though they knew Ray was present. Participants in the lab are undergraduate seniors who receive credit for participating, so reporting this behavior could have academic repercussions for the team. What should Ray do?

    a)   Be alert for further cheating behavior. If Ray observes something similar one more time, he should report it.
    b)   He should report their behavior immediately as their actions could lead to inaccurate and invalid data. This could also serve to discourage participants to cheat in the future.
    c)   He should not report it, and not get involved. This is a controlled lab setting and getting involved could lead to demand characteristics.
    d)   He should have a talk with the participants after the session and let them know that cheating is unacceptable but that he's giving them a second chance before reporting them.

7. Carl is an undergraduate student taking a cross-cultural psychology class. The class project is to develop a new scale of a construct. He is assigned to work with Macy and Fred. He has worked with Macy before and has a good working relationship with her. He has never worked with Fred before. As the semester is progressing, Fred is proving to be a huge burden. Fred does not contribute to the project, does not attend meetings, and does not complete assigned tasks. Carl and Macy keep having to pick up Fred's slack and they end up finishing the project on their own. Before submitting the newly created scale, Carl and Macy want to call it "The Carl-Macy Test for collective thinking." Fred takes issue with them leaving his name out of the title as he is also part of the group and brings this up with them. This puts Carl and Macy in an uncomfortable situation, and they are unsure about how to navigate it. What should Carl and Macy do?

    a)   Include Fred's name as the last name in the scale title. Even if he did not contribute, he was still part of the group and it avoids resentment in potential future interactions and projects.
    b)   Have a candid discussion with Fred about why they chose to name the scale that way and be honest about how his lack of contribution had to be compensated by them.
    c)   Bring an outside perspective into this whole situation for objectivity. They could bring up the issue with a professor and ask him to decide what the right course of action is.

    d) Do not include any names as part of the scale to avoid conflict of interest. They could name it something like the "Collective Thinking Inventory"

8. Steven is given the opportunity to travel to Bolivia to conduct a field study, looking at perceptions of a water protection program. He is selected because he is well-qualified and he previously lived in Bolivia for two years from 2014-2016, doing similar field work. Both time and money are scarce in the organization and Steven needs to prepare quickly and efficiently. A colleague informs him that a very similar study had been conducted in Tennessee in 2018 and she gives him the contact details of the researchers. Steven reaches out to them, hoping that they would be willing to send him their materials. Fortunately for him, they reply promptly with an email attachment of their materials. Steven reviews their materials and finds that the questions were prepared with a great deal of thought and research. What is the most ideal course of action for Steven to do if he wants to use these materials as an interview guide?

    a) Leverage his experiences living in Bolivia and previous field work to develop linguistic and culturally appropriate interview guides.
    b) Spend some time reviewing all the research with a colleague to ensure that the materials are based on the most up to date research.
    c) Form a small team of people with various expertise: interviewing, the Bolivian language, and the water protection program. Then the team can review the materials.
    d) Recruit some Bolivians who speak the language and pre-test the guide with them to ensure that the guide is culturally sensitive.

9. Tina works in a small technology start-up company and she wants to create a survey on virtual meeting fatigue in 2021. She is finding it really challenging to find strong literature about this concept. None of the published articles incorporate contextual factors like COVID-19, remote work, or engagement. She finally found one study that used a scale that seemed rigorous enough and relevant to measure virtual meeting fatigue. However, about half of the items seem irrelevant for Tina's purpose. What should she do at this point?

    a) Adapt the items to the organizational context. Draft additional items based on her own experiences and ask colleagues to weigh in to create a more comprehensive measure.
    b) Assemble a small group of participants and pilot the measure to assess how the scale works in the context of her organization.
    c) Extensively review the scale, the literature review, the methods, reliabilities, and validities and then launch the survey measure as is. Changing the items would impact the validity.
    d) Abandon this measure and work with an external consultant or researcher to clearly define the construct and develop new items tailored to fit the organization's needs.

10. Shawn is currently in his first job in academia, fresh out of graduate school. He is an assistant professor at a prominent public university. He is offered an opportunity to work with a senior faculty member on a project that involves factor analysis. This was not something he was trained to do in graduate school. What should he do?

a) Avoid projects for which he does not have the necessary expertise. This may lead to faulty conclusions and mistakes that can put his career at risk.
b) Seek information online, purchase books related to factor analysis, meet with experts, and look at tutorials prior to and during the project.
c) Have a discussion with the faculty member who is offering him the opportunity. Let him know about his lack of experience and ask the faculty member if they could mentor Shawn.
d) Tell the faculty member that he will join the project only if he does not need to be involved in the factor analysis component.

11. Remy is doing a survey study on procrastination. He is collecting the data through a survey. He manages to obtain 40 responses. To his dismay, he finds that he did not require a response to the consent form, so several people ended up completing the study without actually providing consent. Remy found that 18 people did not provide consent but completed the study. What should he do?

a. Remove those 18 people from the data because informed consent is a legal requirement and it is unethical to keep that data. Work with the remaining data.
b. Remove those 18 people from the data and fill out a new IRB application to collect more data to make up for the removed data
c. Just move on with the data analysis process because those people would not have taken the survey if they had not actually consented.
d. Reach out to the survey participants individually and ask them to fill in the survey again along with the consent form.

12. Lina is doing her undergraduate honor's thesis on assessment methods in schools. During her literature review, she is delighted to find that the research in this area is extensive. However, she is unsure of how to organize, manage, and retrieve all her sources appropriately. What should she do?

a. Save all her sources in a document and label them with the article title and name of authors. Highlight relevant parts in the articles for easy reference.
b. Prepare an excel document which lists all the sources, the links to those sources, and a brief summary of each, along with some noteworthy points.
c. Print out the articles and highlight relevant parts. Save them in a large binder, separated by some topic area.
d. Use a reference management software, like Mendeley, EndNote, Zotero, or Refworks, to save articles which she can highlight and annotate.

13. Joshua is excited to dive into his survey data that he spent months collecting. He has only a day to clean the data and send it to his two research supervisors for review before data analysis. He downloads the data and gets rid of people who answered fewer than 25% of the survey. Further, he scans the data for problematic responses, like overly consistent data or respondents who failed the attention check. He removes those as well. He sends his data over to one supervisor for review who sends the data back to Joshua. The supervisor states that there were

multiple responses from the same IP address, indicating duplicate responses. Joshua gets rid of these and sends his supervisor the dataset again. The supervisor approves it, and then the dataset is sent to the second supervisor. The second supervisor contacts Joshua and tells him that, given the lengthiness of the survey, the response time for some respondents is unrealistically short and asks Joshua to get rid of those responses. How do you think Joshua should have handled this whole situation better?

    a. Brainstormed with a few other colleagues and come up with a checklist of potential issues with the data that he needs to review while data cleaning before sending it to his supervisors.

    b. Gone through each column and row for trends of anything that may seem odd or inappropriate, given the context of the survey.

    c. Asked one or two of his colleagues to review his data and double check everything before sending it to his supervisors, so that there are several reviews of the data.

    d. He should have provided clear instructions in the survey discouraging unwanted behaviors like taking the survey twice and providing false/inaccurate data.

14. Julio is presenting a paper on narcissism at a national conference. Julio worked on the paper with two other colleagues. Unfortunately, his colleagues are unable to attend the conference. Although Julio played an active role in writing the paper, there are many aspects of the paper that he feels he does not have as firm of a grasp on as his colleagues. After his presentation, someone in the audience brings up a difficult question that he is unsure of how to answer. What should he do?

    a. Let them know that he's unsure of that detail and doesn't want to say the wrong thing.

    b. Make an attempt to answer the question anyway and then steer away from the question.

    c. Let them know that his colleagues would know that better, but unfortunately, they did not attend.

    d. Tell them that he's unsure of that detail and then make an attempt to answer the question with a disclaimer that he could be wrong.

15. Disha is an HR manager at a small technology business. The CEO assigns Disha to conduct some literature reviews on employee engagement and satisfaction and develop a technical report of some recommendations, tailored to the organization. Disha is hesitant because she has no research training. However, the CEO insists because she thinks Disha is capable. She advises Disha to look at business and organizational psychology journals. Disha has no idea what the most reputable journals are in those fields. What should she do?

a. Check impact scores of journals in the fields. Highest impact scores indicate the best journals

b. Check acceptance rates of journals in the fields. Lower acceptance rates indicate better journals.

c. Contact professors and academic professionals to ask them their insight about the best journals.

d. Search on google for rankings of the top journals in both the fields and select the top three.

16. Jessica is college counsellor who is conducting a survey regarding student well-being. After data collection is well underway, she realizes that the survey respondents may be interpreting and answering a question differently than intended. One example is a question that asked respondents "How many days were you absent from classes during the past month?" She noticed that several respondents were inputting numbers that did not make sense, such as "33 days" or "Tuesday," especially when compared to other students. What should Jessica have done to avoid this situation?

   a. Asked participants to be focused and attentive while answering the survey in the instructions page
   b. Required the participant to provide a numerical answer with an upper limit, like 30, to reduce the instances of unrealistic answers
   c. Conducted a pretest with a small sample of participants to identify problematic questions and revise the questions as needed
   d. Allowed participants to go back and review all answers before submitting the survey.

17. Roger is a new member in a research team that is conducting a repeated measures study. He is responsible for sending out the posttest surveys for three different groups. Each group has to take a particular survey. The surveys are very similar and differ by only two questions. During one session, he notices that he has accidentally sent the wrong survey for a certain group. Some people had already started taking their surveys. However, the two surveys were very similar. What should he do in this situation?

   a. Ignore the issue and pretend like nothing has happened. Later, he can just report that the data was not collected for those two questions pertaining to that simulation
   b. He should let everyone know that he noticed that the wrong survey was sent and emailed out the correct link.
   c. He should have quickly created a document with the two questions pertaining to that simulation and sent it out to participants
   d. He should simply remove the data from the group that received the wrong survey from the results

18. Jane is conducting a study with undergraduate students. She wants to launch a survey to collect data about personally sensitive experiences of students. Jane is concerned about whether she will be able to get a large enough sample from the student research pool. What can Jane do to increase participation rates?

   a. Emphasize that no personally identifying information will be collected and ensure that confidentiality is protected throughout the process
   b. Inform them about the importance of this research in helping improve the student experience
   c. Incentivize participation by offering things like a small prize or entry into a raffle
   d. Ensure that she is presenting herself as a credible and trustworthy professional who is skilled in data analysis and research and who also has the student's best interest

19. Liam is conducting a qualitative study on a very specific and small population. In the study, Liam will conduct 45-minute semi-structured interviews. He realizes that his interview guide may require more piloting before starting data collection. What should he do?

   a. Just proceed with data collection. Piloting would waste potential participants
   b. Pilot with people similar to his target population but not within his target population
   c. Find researchers who have also studied this population and ask them to review his questions
   d. Pilot the study with just two participants because the interview takes so long

20. Vishal is a faculty member who is supervising a study. He is collecting data from students at his university. He hires Justin as a research assistant. The study requires collecting data using a paper and pencil survey. Justin often takes these papers home where enters the data into an excel spreadsheet. After one session, Justin realizes he misplaced the papers. He searches everywhere and could not find them. He realizes he must have left the data on the bus. However, his efforts to track the papers down fails. He reluctantly tells Vishal what happens. What should Vishal do?

   a. Immediately report the incident to IRB
   b. Fire Justin for the mistake
   c. Contact all participants to let them know about the data comprise and apologize
   d. Do nothing. Give Justin another chance and move on with the study.

21. Desi is unhappy with one of her research assistants, Cora. Cora is behind on a lot of her tasks and is falling behind on her deadlines. Desi has a variety of projects to handle, and she needs an assistant who is able to handle the pressure and challenges. She decides to set a meeting with Cora to talk about her performance and fire Cora as a research assistant. However, before the meeting, Desi hears from another research assistant that Cora feels that she has not received enough support and resources from Desi to proceed with the project in a timely manner. She is also not given adequate instructions and structure to complete her tasks. What should Desi do?

   a. Fire Cora anyway and find a better assistant who can meet her needs and rise to the challenges of the academic world.
   b. Fire Cora but ask Cora for feedback as a research supervisor. Use that feedback to handle interactions with the next assistant.
   c. Have a discussion with Cora about both of their needs and reach an agreement about how to proceed.
   d. Evaluate past communications with Cora to assess if Cora's concerns are valid. If they are, then have a discussion with her. If not, let her go.

APPENDIX E: EXPLICIT KNOWLEDGE TEST ITEMS

Instructions: Below are questions about research methods. Please select the correct answer for each question. Please do not refer to any external sources or look up the answers as it will limit our results.

1. I want to create a study where I observe the impact of screen time on sleep quality. What is the independent variable (IV) and dependent variable (DV)?
    a. IV= Screen Time DV= Sleep Quality
    b. IV= Sleep Quality DV= Screen Time
    c. IV= Number of TV shows DV= Number of hours spent sleeping
    d. IV= Ranking of TV shows DV= Number of hours spent sleeping

2. In a company, in the sales department, good performance is seen as higher sales numbers and number of new clients obtained. Higher sales numbers and number of new clients obtained is the _____ of performance.
    a. Conceptualization
    b. Operationalization
    c. Dependent Variable
    d. Contextualization

3. Which of these statements are true?
    a. Internal validity is the level of confidence one can have on the observed causal relationship. External validity is the extent to which the results of a study can be generalized to other studies.
    b. Internal validity refers to the strength of the relationship between all the variables. External validity is the extent to which other studies agree with the results of your study.
    c. Internal validity can be equated to statistical significance. External validity can be equated to the coefficient of determination
    d. Internal validity and external validity are the same thing. It just depends on who is asking the question.

4. If between the pretest and posttest, participants naturally changed in some way (grew older, learned more, etc.), then it may be impossible to rule out whether effects seen in the study were simply because of the effect of time. What is this threat to internal validity called?
    a. History
    b. Maturation
    c. Unstable instrumentation
    d. Selection bias

5. Select the type of validity for the following scenario (drop-down list):

a. Trying to find a correlation between a new measure of aggression and a well-established measure
    Choices: discriminant, convergent, predictive, concurrent

6. Sheila is bored at work and decides to take a BuzzFeed quiz for what Game of Thrones character she is. She got Sansa Stark. The next day she is so bored she took it again and this time she got Jon Snow. This intrigued her and so she took it one last time and got Tyron Lannister. This should lead her to the conclusion that the test is:
    a. unreliable
    b. objective
    c. subjective
    d. valid

7. _ is a necessary but insufficient condition for validity?
    a. Reliability
    b. Statistical significance
    c. Power
    d. Alpha

8. Which of the following statements is incorrect?
    a. Random assignment is an important aspect of experimental design. Random sampling is a probability sampling method.
    b. Random assignment is a step that would follow random sampling, if random sampling was implemented
    c. A study can use both methods, only one, or neither
    d. Both Random assignment and random sampling important prerequisites for establishing causation.

9. Which of the following is a probability sampling technique?
    a. Quota
    b. Stratified
    c. Convenience
    d. Snowball

10. Which of the following is NOT an essential element for experiments?
    a. Independent variable
    b. Random Sampling
    c. Random Assignment to control and condition groups
    d. dependent variable

11. What is a cross-sectional study design?
    a. A study design implemented by the researcher as a way to cross-test a relationship
    b. A study that compares two or more variables longitudinally

    c. A study design that analyzes a particular segment of the population
    d. A study design that collects data from more than one case at one moment in time

12. Sasha wants to study how contraction of the COVID-19 virus impacts lung capacity in the long run. She recruits people who have tested positive as her participants. During their illness, she asks them to perform a few breathing exercises to measure lung capacity. She records their performances in those exercises; these will serve as the baseline. She will then contact them every two months to check on their performance for the next two years. At the end of this period, she can make conclusions about whether lung capacity increases, stays the same, or decreases after contracting the virus. This study is an example of:
    a. Cross- sectional design
    b. Case study
    c. Longitudinal design
    d. Experimental design

13. What are the requirements to establish causality?
    a. Covariation, statistical significance, and random sampling
    b. Random sampling, temporal precedence, and statistical significance
    c. Covariation, temporal precedence, and the elimination/controlling of alternative explanations
    d. Statistical significance, temporal precedence, and the elimination/controlling of alternative explanations

14. _ is how one variable changes in response to another
    a. Correlation
    b. Alpha
    c. Type 1 error
    d. Standard deviation

15. _ is a type of extraneous variable that systematically impacts the outcomes of the study by varying with the levels of independent variable.
    a. Control variable
    b. Confounding variable
    c. Dependent variable
    d. Manipulated variable

16. _ occurs when individuals or groups in a study differ systematically from the population of interest leading to a systematic error in an association or outcome
    a. Selection bias
    b. Sampling bias
    c. Attrition bias

      d. Maturation effect

17. Which of the following statements explains the Central Limit Theorem?
      a. If the sample is not greater than 15, analyses will likely be inaccurate and be skewed, resulting in the need for transformation
      b. If the mean is greater than the median, then parametric analyses cannot be performed with accuracy.
      c. The sampling distribution of any statistic will be normal or nearly normal, if the sample size is large enough
      d. The sampling distribution of any statistic will be skewed if the sample is greater than 200.

18. Which of the following is true about survey research?
      a. It is easy to control for spurious relationships
      b. It establishes causality
      c. People might not have an accurate perception of their own behaviors
      d. It is inconvenient

19. What is NOT statistical power?
      a. The probability that the study will produce a statistically significant result if the research hypothesis is true
      b. The probability that the test will correctly reject the null hypothesis
      c. The probability of avoiding a type 2 error
      d. The probability of avoiding a type 1 error

20. Select the correct label for each statement (drop down list for each statement)
      a. When we say a drug doesn't work, but in reality, it does
          Choices: Type 1 error, Type 2 error, statistical significance, validity

APPENDIX F: KENTUCKY INVENTORY MINDFULNESS SCALE

Instructions: Please rate each of the following statements using the scale provided. Please rate the following on a scale from: Never or very rarely true, rarely true, sometimes true, often true, very often or always true.

1. I notice changes in my body, such as whether my breathing slows down or speeds up.

2. I'm good at finding the words to describe my feelings.

3. When I do things, my mind wanders off and I'm easily distracted.

4. I criticize myself for having irrational or inappropriate emotions.

5. I pay attention to whether my muscles are tense or relaxed.

6. I can easily put my beliefs, opinions, and expectations into words

7. When I'm doing something, I'm only focused on what I'm doing, nothing else.

8. I tend to evaluate whether my perceptions are right or wrong.

9. When I'm walking, I deliberately notice the sensations of my body moving.

10. I'm good at thinking of words to express my perceptions, such as how things taste, smell, or sound.

11. I drive on "automatic pilot" without paying attention to what I'm doing.

12. I tell myself that I shouldn't be feeling the way I'm feeling.

13. When I take a shower or bath, I stay alert to the sensations of water on my body.

14. It's hard for me to find the words to describe what I'm thinking.

15. When I'm reading, I focus all my attention on what I'm reading.

16. I believe some of my thoughts are abnormal or bad and I shouldn't think that way.

17. I notice how foods and drinks affect my thoughts, bodily sensations, and emotions.

18. I have trouble thinking of the right words to express how I feel about things

19. When I do things, I get totally wrapped up in them and don't think about anything else.

20. I make judgments about whether my thoughts are good or bad.

21. I pay attention to sensations, such as the wind in my hair or sun on my face.

22. When I have a sensation in my body, it's difficult for me to describe it because I can't find the right words.

23. I don't pay attention to what I'm doing because I'm daydreaming, worrying, or otherwise distracted.

24. I tend to make judgments about how worthwhile or worthless my experiences are.

25. I pay attention to sounds, such as clocks ticking, birds chirping, or cars passing.

26. Even when I'm feeling terribly upset, I can find a way to put it into words.

27. When I'm doing chores, such as cleaning or laundry, I tend to daydream or think of other things.

28. I tell myself that I shouldn't be thinking the way I'm thinking

29. I notice the smells and aromas of things.

30. I intentionally stay aware of my feelings.

31. I tend to do several things at once rather than focusing on one thing at a time.

32. I think some of my emotions are bad or inappropriate and I shouldn't feel them.

33. I notice visual elements in art or nature, such as colors, shapes, textures, or patterns of light and shadow

34. My natural tendency is to put my experiences into words.

35. When I'm working on something, part of my mind is occupied with other topics, such as what I'll be doing later, or things I'd rather be doing.

36. I disapprove of myself when I have irrational ideas.

37. I pay attention to how my emotions affect my thoughts and behavior

38. I get completely absorbed in what I'm doing, so that all my attention is focused on it.

39. I notice when my moods begin to change.

Source: Baer, R. A., Smith, G. T., & Allen, K. B. (2004). Assessment of mindfulness by self-report: The Kentucky inventory of mindfulness skills. *Assessment*, *11*(3), 191–206. https://doi.org/10.1177/1073191104268029

APPENDIX G: MINDFULNESS SKILL SCALE

Rate how skilled you are at the following:
(1) Not at all skilled to *(5) Extremely Skilled*

1. Accepting my negative thoughts
2. Accepting my emotions when I feel sad
3. Accepting unpleasant experiences
4. Accepting myself when I'm angry
5. Being aware of my current emotions
6. Centering myself in the present moment
7. Grounding myself in the present moment
8. Allowing thoughts to come and go without assigning judgement to them
9. Letting go of judgement
10. Recognizing that my thoughts are neither "good" or "bad"
11. Understanding that my emotions aren't "good" or "bad"
12. Letting go of criticism
13. Exploring how my emotions impact my day
14. Observing how I'm feeling
15. Observing what I'm experiencing in the moment
16. Observing what my body feels
17. Observing how my body feels
18. Observing my thoughts
19. Curiously observing my thoughts
20. Curiously observing my feelings
21. Keeping track of my feelings
22. Focusing on the present moment

Source: Stremich (2019). Redefining Mindfulness (Master's thesis).

https://jewlscholar.mtsu.edu/bitstream/handle/mtsu/6173/Stremic_mtsu_0170N_11265.pdf?

sequence=1&isAllowed=y

APPENDIX H: METACOGNITIVE AWARENESS INVENTORY

Instructions: Please use the bar to indicate how true or false the following statements are as it applies to you between 0 to 100.

1. I ask myself periodically if I am meeting my goals

2. I consider several alternatives to a problem before I answer

3. I try to use strategies that have worked in the past

4. I pace myself while learning in order to have enough time.

5. I understand my intellectual strengths and weaknesses

6. I think about what I really need to learn before I begin a task.

7. I know how well I did once I finish a test.

8. I set specific goals before I begin a task.

9. I slow down when I encounter important information

10. I know what kind of information is most important to learn.

11. I ask myself if I have considered all options when solving a problem

12. I am good at organizing information.

13. I consciously focus my attention on important information.

14. I have a specific purpose for each strategy I use.

15. I learn best when I know something about the topic

16. I know what the teacher expects me to learn.

17. I am good at remembering information.

18. I use different learning strategies depending on the situation

19. I ask myself if there was an easier way to do things after I finish a task.

20. I have control over how well I learn.

21. I periodically review to help me understand important relationships.

22. I ask myself questions about the material before I begin

23. I think of several ways to solve a problem and choose the best one.

24. I summarize what I've learned after I finish.

25. I ask others for help when I don't understand something

26. I can motivate myself to learn when I need to.

27. I am aware of what strategies I use when I study

28. I find myself analyzing the usefulness of strategies while I study.

29. I use my intellectual strengths to compensate for my weaknesses.

30. I focus on the meaning and significance of new information.

31. I create my own examples to make information more meaningful.

32. I am a good judge of how well I understand something.

34. I find myself using helpful learning strategies automatically.

35. I find myself pausing regularly to check my comprehension.

36. I know when each strategy I use will be most effective.

37. I ask myself how well I accomplish my goals once I'm finished.

38. I draw pictures or diagrams to help me understand while learning.

39. I ask myself if I have considered all options after I solve a problem

40. I try to translate new information into my own words.

41. I change strategies when I fail to understand.

42. I use the organizational structure of the text to help me learn

43. I read instructions carefully before I begin a task.

44. I ask myself if what I'm reading is related to what I already know

45. I reevaluate my assumptions when I get confused.

46. I organize my time to best accomplish my goals.

47. I learn more when I am interested in the topic.

48. I try to break studying down into smaller steps.

49. I focus on overall meaning rather than specifics

50. I ask myself questions about how well I am doing while I am learning something new.

51. I ask myself if I learned as much as I could have once I finish a task.

52. I stop and go back over new information that is not clear.

Source: Schraw, G., & Dennison, R. S. (1994). Assessing metacognitive awareness.

Contemporary Educational Psychology, *19*(4), 460-475.

APPENDIX I: INFORMED CONSENT FOR STUDY 2

Information and Disclosure Section

The following information is provided to inform you about the research project in which you have been invited to participate. Please read this disclosure and feel free to ask any questions. The investigators must answer all of your questions and please save this page as a PDF for future reference.

Your participation in this research study is voluntary. You are also free to withdraw from this study at any time without loss of any benefits.

For additional information on your rights as a participant in this study, please contact the Middle Tennessee State University (MTSU) Office of Compliance (Telephone: 615-494-8918, email: irb_information@mtsu.edu, or website: http://www.mtsu.edu/irb).

Please read the following and respond to the consent questions in the bottom if you wish to enroll in this study.

Purpose of the study:
The purpose of this study is to validate a newly developed tacit knowledge measure for research using experts of different levels (undergraduates, graduate students, and faculty).

Description of procedures:
You will first take the new tacit knowledge and explicit knowledge scale, mindfulness scales, and a metacognition scale. Next, you will be asked demographic information questions, questions regarding your professional and academic achievements in research, self-assessment questions regarding your research, and attention check questions.

IRB Approval Details
Protocol Title: Re-conceptualizing and measuring tacit knowledge
Primary Investigator: Mariyam Sumaiya
PI Department & College: Psychology - College of Behavioral and Health Sciences
Faculty Advisor: Alexander Jackson, Ph.D.
Protocol ID: 21-1166 2q
Approval Date: 04/30/2021
Expiration Date: 12/31/2022

Duration:
The study should take approximately 25-30 minutes to complete.

Here are your rights as a participant:

Your participation in this research is voluntary. You may skip any item that you don't want to answer, and you may stop the experiment at any time (but see the note below). If you leave an item blank by either not clicking or entering a response, you may be warned that you missed one, just in case it was an accident. But you can continue the study without entering a response if you didn't want to answer any questions. Some items may require a response to accurately present the survey.

Risks & Discomforts:
There are no known risks associated with participating in this study.

Benefits:
The potential benefits include improvements in measuring tacit knowledge.

Expected costs:
There are no costs for participating in this study.

Identifiable Information:
You will NOT be asked to provide identifiable personal information. You will however be be given an option to enter your email address if you decide to enroll in a raffle (refer below).

Compensation for participation:
There is no compensation for your participation. Nonetheless, you have the chance to enter into a raffle to win a $50 Amazon gift card. We will be selecting one undergraduate student winner, one graduate student winner, and one faculty/non-academic researcher winner. If you win, you will be contacted via email.

Circumstances under which the Principal Investigator may withdraw you from study participation:
The study is restricted to individuals who are fluent in English and at least 18 years old

Contact Information:

If you should have any questions about this research study or possible injury, please feel free to contact Mariyam Sumaiya via email at ms2ca@mtmail.mtsu.edu. For additional information about giving consent or your rights as a participant in this study, please feel free to contact the MTSU Office of Compliance at (615) 494-8918.

Confidentiality:
Your information will be kept confidential. Although your rights and privacy will be maintained, the Secretary of the Department of Health and Human Services, the MTSU IRB, and personnel particular to this research have access to the study records. Your responses, informed consent document, and records will be kept completely confidential according to current legal requirements. They will not be revealed unless required by law, or as noted above.

You are not required to do anything further if you decide not to enroll in this study. Just quit your browser. Please complete the response section below if you wish to learn more or you wish to take part in this study.

APPENDIX J: RESEARCH EXPERIENCE QUESTIONS

RE1_course

Have you taken a course in research methodology before?

○ Yes

○ No

RE2_years   iQ ★

Approximately how many years of research do you have? Please enter a number. If less than one, please put 0

[ ]

RE3_projects   iQ ★

Approximately how many research projects have you worked on? Please enter a number.

[ ]

RE4_conf1

Have you ever presented at conferences?

○ Yes

○ No

RE5_conf2   iQ

▾ ⤷ Display this question

If   Have you ever presented at conferences?   Yes   Is Selected

How many conferences have you presented at under each category:

Regional	[ ]
State	[ ]
National	[ ]
International	[ ]

RE6_awards   iQ ★

How many awards or recognitions have you received for research?

[ ]

-- Page Break --

RE7_publish1

Have you ever published your research in academic journals?

○ Yes

○ No

RE8_publish2   iQ ★

▾ ⬐ Display this question

If Have you ever published your research in academic journals? Yes Is Selected
In Page Display Logic may behave unexpectedly with Response Validation

How many academic publications do you have?

[   ]

-- Page Break --

RE9_grant1

Have you ever received any grants?

○ Yes
○ No

RE10_grant2   iQ ★

▾ ⬐ Display this question

If Have you ever received any grants? Yes Is Selected
In Page Display Logic may behave unexpectedly with Response Validation

How many grants have you received?

[   ]

RE11_grant3   iQ ★

▾ ⬐ Display this question

If Have you ever received any grants? Yes Is Selected
In Page Display Logic may behave unexpectedly with Response Validation

How much was the largest grant you have received (in dollars)?

[   ]

RE12_book1

Have you ever written a book chapter or shared authorship on one?

○ Yes
○ No

RE13_book2   iQ ★

▾ ⬐ Display this question

If Have you ever written a book chapter or shared authorship on one? Yes Is Selected
In Page Display Logic may behave unexpectedly with Response Validation

How many book chapters have you contributed to?

[   ]

RE14_level

Which of the following best describes your current research level?

○ Faculty or Academic Researcher
○ Graduate PhD Student
○ Graduate Master's Student
○ Undergraduate Student
○ Nonacademic Researcher

APPENDIX K: RESEARCH PRODUCTIVITY QUESTIONS

Please rate the following statements about your research productivity.

	Very low	Low	Slightly low	Neutral	Slightly high	High	Very high
The quality of your research performance	○	○	○	○	○	○	○
Your research productivity	○	○	○	○	○	○	○
The quality of research performance of your peers at work compared with yourself	○	○	○	○	○	○	○
	Very low	Low	Slightly low	Neutral	Slightly high	High	Very high
The quality of your research performance compared with your peers at work	○	○	○	○	○	○	○
Your expertise in research methods	○	○	○	○	○	○	○
	Very low	Low	Slightly low	Neutral	Slightly high	High	Very high

APPENDIX L: ATTENTION CHECK QUESTIONS

Attn1_Click

Did you take this study seriously, or did you click through the responses?

○ Just clicked through

○ Took the study seriously

Attn2_Cheat

Did you refer to any external sources or look up questions to respond to the research methods section?

○ Yes

○ No

Attn3_NOT1

Is there any reason why we should **NOT** use your data?

○ My data should **NOT** be included in the analyses

○ My data should be included in your analyses

Attn4_NOT2

▾ ⤴ Display this question

   If Is there any reason why we should NOT use your data? My data should <u>NOT</u> be included in the analyses Is Selected

Why should we **NOT** include your data in our analyses?

○ I wasn't really paying attention

○ I just clicked randomly

○ I didn't understand the task/questions

○ I didn't really know what I was doing

○ I just skimmed through the questions

○ Other

APPENDIX M: DEBRIEF MESSAGE FOR STUDY 2

Thank you for your participation! Your participation helps validate a new tacit and explicit knowledge measure in research that may serve as a blueprint for replication across domains.

If you have any questions concerning any of the measures you took or you would like to know the results of this study, please contact Mariyam Sumaiya (ms2ca@mtsu.edu). For additional information on your rights as a participant in this study, please contact the Middle Tennessee State University (MTSU) Office of Compliance (Telephone: 615-494-8918, email: irb_information@mtsu.edu, or website: http://www.mtsu.edu/irb).

Please do not share any of this information with anybody as it may limit our ability to continue this study.

Clicking continue one more time will redirect you to a separate survey where you can choose to enter the drawing for one of three $50 Amazon gift cards. Your responses to this survey will not be connected to your email address in any way. We will be selecting one undergraduate student winner, one graduate student winner, and one faculty/non-academic researcher winner. If you win, you will be contacted via email. The drawing will happen in mid-June after data collection.

APPENDIX N: DESCRIPTIVE STATISTICS

Variable	n	Mean	SD	Log Trns Mean	Log Trns SD
Tacit Knowledge Score	301	56.72	3.07	-	-
Explicit Knowledge Score	301	6.94	3.07	-	-
MSS	291	3.10	0.66	-	-
KIMS	290	3.02	0.22	-	-
MAI	275	31.80	19.92	-	-
Research Performance	301	12.02	30.96	-	-
Research Years	280	3.35	5.37	0.45	0.35
Research Projects	280	8.31	60.51	0.54	0.39
Research Productivity	278	4.33	1.05	-	-

Log Trns estimates are after the log transformation for selected variables

APPENDIX O: CORRELATION MATRIX

		1	2	3	4	5	6	7	8	9	10	11
1	Tacit Knowledge	1	**.491**	.034	.115	.125	.023	**.167**	-.050	**.195**	**-.116**	-.031
2	Explicit Knowledge		1	.076	**.292**	**.279**	.017	**.181**	-.031	**.217**	-.026	.019
3	Research Performance			1	**.355**	**.278**	.067	**.450**	**.123**	-.010	.026	.007
4	Research Years				1	**.825**	.108	**.507**	**.136**	.027	-.019	-.027
5	Research Years Log					1	.046	**.445**	**.261**	.022	.045	.021
6	Research Projects						1	**.486**	-0.13	-.039	**-.164**	-.004
7	Research Projects Log							1	.113	.040	-.31	-.121
8	Research Productivity								1	.100	**.468**	.012
9	KIMS									1	**.398**	.090
10	MSS										1	-.038
11	MAI											1

Bolded values are significant correlations at p<.01

APPENDIX P: MEAN DIFFERENCES

Variable	*N*	Mean	*SD*
Faculty	37	56.36	17.06
Graduate (PhD)	46	53.65	13.57
Graduate (masters)	64	56.47	15.49
Undergraduate	112	60.64	15.54
Nonacademic Researcher	20	54.40	16.06
Unidentified	22	46.64	19.66

APPENDIX Q: IRB APPROVAL

IRB
INSTITUTIONAL REVIEW BOARD
Office of Research Compliance,
010A Sam Ingram Building,
2269 Middle Tennessee Blvd
Murfreesboro, TN 37129
FWA: 00005331/IRB Regn.. 0003571

MIDDLE TENNESSEE STATE UNIVERSITY

IRBN007 – EXEMPTION DETERMINATION NOTICE

Friday, April 30, 2021

Protocol Title	*Reconceptualizing and measuring tacit knowledge*
Protocol ID	**21-1166 2q**

Principal Investigator	**Mariyam Sumaiya** (Student)
Faculty Advisor	Alexander Jackson
Co-Investigators	Michael Hein and Aimee Holt
Investigator Email(s)	*ms2ca@mtmail.mtsu.edu; alexander.hackson@mtsu.edu*
Department/Affiliation	Psychology

Dear Investigator(s),

The above identified research proposal has been reviewed by the MTSU Institutional Review Board (IRB) through the **EXEMPT** review mechanism under 45 CFR 46.101(b)(2) within the research category *(2) Educational Tests, surveys, interviews or observations of public behavior (Qualtrics Survey)*. A summary of the IRB action and other particulars of this protocol are shown below:

IRB Action	**EXEMPT from further IRB Review** Exempt from further continuing review but other oversight requirements apply
Date of Expiration	12/31/2022 *Date of Approval:* **4/30/21** *Recent Amendment:* NONE
Sample Size	FIVE HUNDRED (500)
Participant Pool	**Healthy adults (18 or older) - College Students and Faculty**
Exceptions	Online consent followed by internet-based survey using Qualtrics is permitted (Qualtrics links on file).
Type of Interaction	☐ Non-interventional or Data Analysis ☒ Virtual/Remote/Online Interview/survey ☐ In person or physical– Mandatory COVID-19 Management (refer next page)
Mandatory Restrictions	1. All restrictions for exemption apply. 2. The participants must be 18 years or older. 3. Mandatory ACTIVE informed consent. Identifiable information including, names, addresses, voice/video data, must not be obtained. 4. NOT approved for in-person data collection.
Approved IRB Templates	*IRB Templates:* Recruitment Email and Online Informed Consent *Non-MTSU Templates:* Social Media Recruitment
Research Inducement	NONE
Comments	NONE

IRBN007 *(Ver: 2.0; Rev: 08/14/2020)*   FWA: 00005331   IRB Registration. 0003571

Summary of the Post-approval Requirements: The PI and FA must read and abide by the post-approval conditions (Refer "*Quick Links*" in the bottom):

- *Final Report:* The Faculty Advisor (FA) is responsible for submitting a final report to close-out this protocol before 12/31/2022; if more time is needed to complete the data collection, the FA must request an extension by email. REMINDERS WILL NOT BE SENT. **Failure to close-out (or request extension) may result in penalties including cancellation of the data collected using this protocol or withholding student diploma.**
- *Protocol Amendments*: IRB approval must be obtained for all types of amendments, such as:
  - Addition/removal of subject population and sample size.
  - Change in investigators.
  - Changes to the research sites – appropriate permission letter(s) from may be needed.
  - Alternation to funding.
  - Amendments must be clearly described in an addendum request form submitted by the FA.
  - The proposed change must be consistent with the approved protocol and they must comply with exemption requirements.
- *Reporting Adverse Events:* Research-related injuries to the participants and other events , such as, deviations & misconduct, must be reported within 48 hours of such events to compliance@mtsu.edu.
- *Research Participant Compensation:* Compensation for research participation must be awarded as proposed in Chapter 6 of the Exempt protocol. The documentation of the monetary compensation must Appendix J and MUST NOT include protocol details when reporting to the MTSU Business Office.
- *COVID-19:* Regardless whether this study poses a threat to the participants or not, refer to the COVID-19 Management section for important information for the FA.

COVID-19 Management:

The FA must enforce social distancing guidelines and other practices to avoid viral exposure to the participants and other workers when physical contact with the subjects is made during the study.

- The study must be stopped if a participant or an investigator should test positive for COVID-19 within 14 days of the research interaction. This must be reported to the IRB as an "adverse event."
- The FA must enforce the MTSU's "Return-to-work" questionnaire found in Pipeline must be filled and signed by the investigators on the day of the research interaction prior to physical contact.
- PPE must be worn if the participant would be within 6 feet from the each other or with an investigator.
- Physical surfaces that will come in contact with the participants must be sanitized between use
- FA's Responsibility: The FA is given the administrative authority to make emergency changes to protect the wellbeing of the participants and student researchers during the COVID-19 pandemic. However, the FA must notify the IRB after such changes have been made. The IRB will audit the changes at a later date and the PI will be instructed to carryout remedial measures if needed.

Post-approval Protocol Amendments:

The current MTSU IRB policies allow the investigators to implement minor and significant amendments that would not result in the cancellation of the protocol's eligibility for exemption. *Only THREE procedural amendments will be entertained per year (changes like addition/removal of research personnel are not restricted by this rule).*

Date	Amendment(s)	IRB Comments
NONE	NONE.	NONE

Post-approval IRB Actions:

The following actions are done subsequent to the approval of this protocol on request by the PI or on recommendation by the IRB or by both.

Date	IRB Action(s)	IRB Comments
NONE	NONE.	NONE

Mandatory Data Storage Requirement:

All research-related records (signed consent forms, investigator training and etc.) must be retained by the PI or the faculty advisor (if the PI is a student) at the secure location mentioned in the protocol application. The data must be stored for at least three (3) years after the study is closed. Additionally, the Tennessee

State data retention requirement may apply (*refer "Quick Links" below for policy 129*).   Subsequently, the data may be destroyed in a manner that maintains confidentiality and anonymity of the research subjects. **The IRB reserves the right to modify/update the approval criteria or change/cancel the terms listed in this notice.** Be advised that IRB also reserves the right to inspect or audit your records if needed.

Sincerely,

Institutional Review Board
Middle Tennessee State University

Quick Links:
- Post-approval Responsibilities: http://www.mtsu.edu/irb/FAQ/PostApprovalResponsibilities.php
- Exemption Procedures: https://mtsu.edu/irb/ExemptPaperWork.php
- MTSU Policy 129: Records retention & Disposal: https://www.mtsu.edu/policies/general/129.php