# Instrument Development for Determining High School Students' Epistemological and Ontological Beliefs Regarding Photography

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# INSTRUMENT DEVELOPMENT FOR DETERMINING HIGH SCHOOL STUDENTS' EPISTEMOLOGICAL AND ONTOLOGICAL BELIEFS REGARDING PHOTOGRAPHY

by

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# ABSTRACT


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Regarding Photography

by

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Since the 1950s, researchers have explored how individuals' beliefs about knowledge acquisition, or personal epistemology, affect their learning and academic achievement. Students with more sophisticated beliefs about knowledge tend to learn more readily and perform better academically. Despite these insights, creating instruments to consistently measure personal epistemology has proven challenging. Additionally, research often connects personal epistemology with personal ontology—beliefs about the nature of existence and reality.

This study aimed to validate two instruments: the Photographic Reality Questionnaire (PRQ) to measure high school students' personal ontological beliefs and the Photographic Knowledge Questionnaire (PKQ) to measure their personal epistemological beliefs. Photography was chosen as the focus subject due to its inherent connection to epistemological and ontological questions, representing reality in a static, two-dimensional form.

The study involved expert reviews, pilot tests with 39 students, and field tests with 106 students, using exploratory and confirmatory factor analyses to assess validity, and Cronbach's alpha to assess reliability. The PRQ was found to be a valid and reliable instrument, while the PKQ showed significant validity issues.

These results suggest that personal ontological beliefs can be assessed independently from epistemological beliefs. This finding opens avenues for future research to develop a model of personal ontological beliefs and explore their impact on academic achievement. Further refinement of the PKQ is necessary to enhance its validity, with recommendations provided for its improvement.

This study contributes to educational measurement by offering new tools and insights into students' beliefs about knowledge and reality, potentially informing teaching strategies to foster more sophisticated epistemological and ontological understanding.

(159 pages)

# PUBLIC ABSTRACT

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Regarding Photography

Earl Stanford Maeser Jr.

Research in educational psychology has shown that students' beliefs about knowledge—known as personal epistemology—significantly impact their academic success. However, accurately measuring these beliefs has proven to be challenging due to the lack of reliable and valid tools. This study addresses this gap by developing and testing two tools aimed at assessing high school students' beliefs about knowledge and reality in the context of photography: the Photographic Knowledge Questionnaire (PKQ) and the Photographic Reality Questionnaire (PRQ).

Photography, with its strong ties to reality and representation, provides a unique way to explore personal beliefs about the nature of reality and how knowledge of that reality is acquired. The PKQ looks at students' beliefs about photographic knowledge, while the PRQ examines their beliefs about photographic reality. The study involved three stages: a preparatory stage to refine the tools, a pilot test with 39 students, and a field test with 106 students.

Results from the analyses showed that the PRQ is both a valid and reliable measure of beliefs about photographic reality, while the PKQ needs further refinement to reach a similar level of validity. These findings suggest that beliefs about reality can be assessed separately from beliefs about knowledge, opening new opportunities for

research and educational practice. Future research could focus on developing a theoretical model for personal beliefs about reality and exploring their impact on academic achievement. Additionally, improving the PKQ could provide a more credible tool for understanding how specific beliefs about knowledge influence learning in photography.

This study not only contributes to the field of educational measurement but also offers practical insights for educators seeking to enhance students' understanding of knowledge and reality through photography.

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Stan Maeser

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# CHAPTER I

# INTRODUCTION

## Background and Setting

What makes some students more academically successful than others? Why do some students tend to get better test scores, better grades, or seem to learn more readily than their peers? Are they inherently smarter? Do they work harder? Or do they work smarter? Among the many potential reasons for this seeming inequity in academic success is a difference in the conceptualization of knowledge and its acquisition possessed by higher-achieving students. Studies have consistently found that a person's conceptualization of knowledge, or personal epistemology, is a key factor in effective learning processes and better academic outcomes (Berding et al., 2017; Greene et al., 2010; Perry, 1970; Schommer, 1990).

While research into the nature of personal epistemologies has consistently shown that students with more sophisticated conceptualizations of how knowledge is obtained and justified typically have better academic success than students with less sophisticated conceptualizations, researchers have had a difficult time developing trustworthy instruments with which to measure students' personal epistemologies (Greene et al., 2010; Özmen & Özdemir, 2019). Most often, the instruments used in studies of personal epistemology are self-reporting questionnaires. While this is convenient format for research, these questionnaires sometimes produce inconsistent results (Watson, 2020) or results that are not particularly statistically significant (Schraw, 2013). Perhaps this is because the instruments often used to assess individuals' personal epistemologies are designed to address epistemological beliefs at the general level rather than beliefs about knowledge in a specific field like physics, for example. This practice has become somewhat outdated as more recent research has consistently shown that epistemological beliefs regarding a specific discipline or domain have more weight in influencing student academic outcomes than do beliefs held at the general level (Berding et al., 2017; Greene et al., 2010; Muis et al., 2006)

One field that would seem a fitting choice for a study of domain-specific epistemological beliefs would be photography. As the name suggests, photography involves drawing with light to create depictions of the real world. Indeed, it is the light bouncing off objects in the real world that creates photographs. Consequently, photography as a discipline has always been concerned with representing or altering what is real and what is perceived to be real. This leads to obvious epistemological and ontological questions regarding photography and photographs; for example, how can photography change our perceptions and beliefs of what is real and what is not real (Kember, 2008). Or how do photographs influence how we remember the things we have experienced and envision the actuality of things we have not (Azoulay, 2010).

Some research has been done on the intersection of photography and personal ontology/epistemology. However, that research is concerned with the impact of the personal epistemologies of photographers and photography students on how they perceive the purposes of their work and how they bring those purposes about. (Fusari, 2017; Huang, 2018). At present, no research has focused on understanding how the practice of editing photographs might impact or alter the personal epistemologies or ontologies of photographers and students of photography.

## Problem Statement

Research indicates that personal epistemology impacts academic success and that domain-specific epistemological beliefs are more influential on academic success than generally held beliefs (Berding et al., 2017; Greene et al., 2010; Perry, 1970; Schommer, 1990). Still, most established self-reporting questionnaires designed to assess personal epistemology are general in nature rather than being aimed at a specific domain or subject. Also, these self-reporting questionnaires sometimes have problems with validity and reliability, resulting in findings that are hard to replicate and that don't align with the model of epistemic beliefs that constitutes the theoretical framework on which the instrument was based (Cartiff et al., 2021; Hofer, 2001; Özmen & Özdemir, 2019). Researchers may continue to gather evidence about the influence or impact of personal epistemology on student academic success, but they will have a difficult time explaining the nature of those influences if the results produced by their research instruments are inconsistent and continue to have validity and reliability issues.

There is also a gap in current literature regarding personal epistemology in photography. Using the search terms *Personal, Epistemology, Ontology,* and *Photography* in March of 2024 in search engines such as Google Scholar or ERIC located a few research studies done on the impact of photographers and photography students' personal epistemologies on their work, specifically on the ways they compose and edit their photos (Fusari, 2017; Huang, 2018). However, the use of those search terms did not locate any articles on the impact of learning to edit photos on students' and practitioners' personal epistemologies. One study was found concerning the impact of previously edited photos on high school students' historical consciousness or how they thought about historical events (Varga, 2024), but those photos were not edited by the students, and even though the study addressed students' perception of a body of knowledge, the term "personal epistemology" was not used in the article. In short, while the impact of personal epistemology on editing photographs has been studied to some degree, the impact of editing photographs on personal epistemology has not. This is significant due to the ubiquitous nature of photo editing technologies and the sheer number of individuals, especially those of school age, who regularly edit photos.

## Purpose

This study sought to establish the validity and reliability of two instruments designed to measure individuals' personal ontologies and personal epistemologies related to the field of photography. If found to be reliable and valid, these instruments might be used in the future to assess the progression of high school students' personal ontologies and epistemologies relating to photography, perhaps in a longitudinal study, as they become more familiar with photographic knowledge and specifically with photo editing. They might also be used as a model on which to base similar questionnaires focused on other domains or disciplines.

## Research Questions

1. To what extent is an instrument designed to measure high school students' ontological beliefs regarding photographic reality valid and reliable?

2. To what extent is an instrument designed to measure high school students' epistemological beliefs regarding photographic knowledge valid and reliable?

## Definition of Terms

The following terms are used throughout the study.

- Contextualism: The view that knowledge is a constructed base and that individuals experience a negotiated, consensual reality within a specific context (Schraw, 2013, p. 3)
- Dimension of Epistemic Belief: A category of epistemological beliefs that make up a broader personal epistemology (e.g., beliefs about how knowledge does or does not change over time) (Schraw, 2013)
- Domain: a specified sphere of activity or knowledge (Merriam-Webster, n.d.)
- Epistemological Beliefs: Specific beliefs about some aspect of knowledge that is part of a broader personal epistemology (e.g., some people are just born knowing how to do math) (Schraw, 2013, p. 2)
- Epistemological Position: A broader system of epistemological beliefs which governs how one perceives and seeks out knowledge (e.g., Contextualism)
- Epistemology: The study of knowledge and beliefs about knowledge (Schraw, 2013, p. 3)
- Ontological Beliefs: A specific belief about some aspect of reality (e.g., realism) (Schraw, 2013, p. 2)
- Ontology: The study of the nature of reality and being (Schraw, 2013, p. 3)

- Personal Epistemology: The beliefs and theories individuals hold regarding the nature of knowledge and the process of knowing (Bråten, 2010, p. 211)
- Personal Ontology: The beliefs and theories individuals hold regarding the nature of existence and reality (Bråten, 2010)
- Photographic Reality: The reality that is perceived to exist in a photograph
- Photographic Knowledge: The body of knowledge that makes up the discipline of photography
- Real: Having an objective, independent existence. Not artificial, fraudulent, or illusory (Merriam-Webster, n.d.)
- Realism (Absolutism): The view that all individuals share a common knowledge base and experience a similar reality (Schraw, 2013, p. 3)
- Reality: The quality or state of being real. The totality of real things and events (Merriam-Webster, n.d.)
- Relativism: The view that individuals construct a unique knowledge base and experience a unique reality even within a shared context (Schraw, 2013, p. 3)

## Limitations

The sample groups for this study were recruited by Centiment, a company that provides specific sample groups based on criteria such as number, age, profession, or location. It was not possible for Centiment to filter 14- to 18-year-olds who had completed a photography course. A larger sample may have resulted in a larger group that had completed a photography course, perhaps impacting the validity of the photographic knowledge assessment, but budget constraints kept the sample size at acceptable levels for the planned analysis. While data was collected on their participation in a photography course, the resulting number was too low to conduct further analysis for assessment validity using only participants with photography education experience.

## Delimitations

This study sought to establish a means for measuring conceptual change in high school students' personal epistemologies and ontologies in photography. This group was selected because the conceptual framework suggested that measuring these two areas could explain higher academic achievement by students and because this group takes a lot of photos. The study did not address any negative effects students may suffer from learning to edit photos, such as a psychosocial blurring of the lines that distinguish objective reality from virtual reality. It did not attempt to place value judgments on student photo editing skills or their capacity to distinguish between photos that have been edited and those that have not. It also did not attempt to decide which personal epistemologies and ontologies are correct and which are not.

Since the primary purpose of this research was the validation of a personal epistemology instrument and an ontology instrument, it was not necessary to divide the sample of high school students into treatment and non-treatment groups. However, it was anticipated that participants in the sample groups may have had varying levels of photography experience, some having had photography classes and some not.

The sample groups for this study were recruited through Centiment from high school-age students living in the United States that had internet access. Consequently, rather than being an unbiased sample of all high school students, these sample groups were made up of students who self-selected and were perhaps more tech-savvy than average high school students, as they had the capacity to access and complete the questionnaires involved in this study without outside assistance. Furthermore, as the population for this study is specific to high-school-age students, the findings have limited application for populations outside of this demographic.

Because the methodology for this study involved determining the reliability and validity of two research instruments, there are some parameters inherent in this study that may seem problematic but are necessary facets. One of those is the sample size. This study involved creating two groups of participants. The first group, selected for the pilot test, was between 35 and 40, and the second group, selected for the field test, needed to be at least 100. These sample sizes were initially selected based on the recommendations of experts in validating research instruments (Pernegar et al., 2014; Ruel et al., 2016). However, these recommendations are useful when the entire sample size meets all of the selection criteria. The instruments designed for this study were intended to measure the personal epistemological and ontological beliefs of high school age photography students. However, the way in which the sample groups for this study were recruited made it impossible to include only participants who had completed at least one photography course. Had the sample groups been comprised of only students who met this criterion, this study might have yielded different statistical results.

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## Assumptions

It was assumed that the participants for this study would answer the questionnaires used in this study honestly, knowledgeably, and purposefully. This is an important assumption as it is the only way in which the validity and reliability of the instruments in question can be effectively established. It is also an important assumption as high school students often act in ways that are not honest, knowledgeable, or purposeful.

It was also assumed that the sample selected by Centiment would be reasonably representative of the larger population of high school age students in terms of race, gender, and other significant demographic indicators.

## Significance of the Research

This research sought to develop valid measures to aid in determining the impact formal photography education has on the personal epistemologies and ontologies of high school students. The study documented the process used to establish the reliability and validity of two research instruments; 1) an instrument designed to measure participants' epistemological beliefs regarding the subject of photography; 2) an instrument designed to measure participants' ontological beliefs regarding photography. Once the validity and reliability of these instruments has been established, the instruments could be used to add to existing literature by demonstrating whether student perceptions of photographic reality (personal ontology) and photographic knowledge (personal epistemology) become conceptually more sophisticated as they learn how to alter photographs and gain in photographic knowledge (Greene et al., 2010; Huang, 2018; Stahl & Bromme, 2007).

# CHAPTER II

# LITERATURE REVIEW

## Chapter Overview

Research into individuals' personally held epistemological beliefs has been conducted since the 1950s. As part of their studies, researchers have proposed various models of personal epistemic beliefs in an attempt to describe the systems used by individuals to decide what constitutes knowledge, how it is obtained, and how it is justified. Those models usually fall into one of two camps. They are either organized around dimensions of personal epistemological beliefs, or they are made up of a series of stages or positions of personal epistemological beliefs. Which type of model a researcher proposes typically determines how they believe individuals acquire knowledge and, consequently, the role of schools and educators in the teaching/learning process.

Originally, researchers devised models of personal epistemic beliefs that described those beliefs in general terms, meaning that what a person believed about knowledge in one field would be essentially the same as what they believed about knowledge in every other field. Within the past few decades, researchers have found that individuals can hold epistemic beliefs related to one field or domain that are inconsistent with their beliefs about knowledge in other domains. It appears that whether researchers use a model of epistemic dimensions or stages or positions, they consider personal ontological beliefs to be a part of personal epistemic beliefs and that their attempts to measure one include attempts to measure the other.

The conceptual framework of this study consists of the combination of a model of epistemological dimensions with a model of epistemological stages or positions and proposes that the model of dimensions might be used to define an individual's position or stage of epistemological development.

## Literature Review

The first research on personal epistemologies and ontologies was done by William Perry in the early 1950s. His research was originally conceived as a study of personality differences between students who were successful in navigating the pluralistic educational experience of higher education and those who were less successful. Perry found that successful students, rather than having personality types that differed from those of less successful students, instead had different conceptualizations of knowledge and learning. Perry led two longitudinal studies at Harvard University in which he performed annual interviews with groups of selected students, asking them open-ended questions like "Would you like to say what has stood out for you this year?" (Perry, 1970, p. 8). These interviews led Perry and his staff "to conclude that college students' ways of construing their world were not so much a matter of personality as evidence of a logically coherent cognitive developmental process" (Hofer & Pintrich, 1997, p. 90). Perry's research led him to propose a personal epistemology model in which college students typically progressed through a series of nine stages or positions as they gained knowledge and maturity over the course of their university experience.

Following Perry's research, many researchers have proposed different models with the goal of better defining the nature of personal epistemologies and ontologies and directing future research concerning the nature of knowledge and individuals' perceptions of reality (Hofer & Pintrich, 1997; Schommer, 1990). These models do not try to prove universal epistemological truths; rather, they attempt to explain how human beings perceive knowledge and their own capacity to obtain, justify, and validate it.

Most of these models take one of two forms. One of these forms is an organized system of continua or dimensions of personal epistemic beliefs designed to explain how people perceive knowledge to exist and be acquired. The other form is comprised of a system of developmental stages or positions through which individuals naturally progress as they gain experience and knowledge.

Those researchers who have proposed systems of epistemic dimensions tend to see personal epistemologies as a group of somewhat disconnected beliefs about where knowledge comes from, how it is acquired, and how it is validated (Hofer & Pintrich, 1997; Schraw et al., 2002; Schommer, 1990; Stahl & Bromme, 2007). One of these comprehensive models of epistemological dimensions was proposed by Hofer and Pintrich in 1997 and is called the dimensions of epistemic belief model. It was initially conceived as a consolidation of previous models by Belenky et al. (1986), King and Kitchener (1990), Kuhn (1992), and Baxter Magolda (1992), and It has since been used in several studies, such as Carberry (2010), Lee and Chan (2015), and Berding et al. (2017), and is generally found to be a valid and reliable model. The dimensions proposed in this model are *certainty of knowledge*, *simplicity of knowledge*, *source of knowledge*, and *justification of knowing*.

Within the dimensions of the epistemic belief model, *certainty of knowledge* implies that a person's conceptualization of knowledge lies somewhere on a continuum between being fixed and being fluid. A person with a simpler conceptualization of knowledge's certainty would see knowledge as something immutable that exists with absolute veracity. Conversely, a person with a more sophisticated conceptualization would see knowledge as something that evolves, or changes based on context.

*Simplicity of knowledge* is similarly conceptualized as a continuum, in this case, between discrete facts and interrelated concepts. A more naïve conceptualization of knowledge would lean toward the idea that knowledge is a collection of isolated facts, whereas a more nuanced view would recognize knowledge as being an associated or interconnected network of information.

The dimension of *source of knowledge* has to do with where knowledge originates in relation to the knower. If knowledge is perceived as residing within an authority figure and external to the learner, that perception is considered to be simplistic compared to the perception that knowledge can be obtained, constructed, and controlled by the learner.

*Justification of knowing* considers how individuals judge the validity of knowledge, use evidence, and value expertise and authority. Those with simpler conceptualizations of knowledge justify knowledge based on "observation of authority or on the basis of what feels right" (Hofer, 2000, p. 381). A person with a more sophisticated conceptualization of knowledge would "use rules of inquiry and begin to personally evaluate and integrate views of experts" (Hofer, 2000, p. 381).

As mentioned earlier, instead of using dimensions of the epistemic/ontological belief model, some researchers propose that individuals' personal epistemologies can be organized as systems of epistemic positions or stages through which they progress as a natural consequence of time and personal experience (Greene et al., 2010, Kuhn et al., 2000). For these researchers, this progress is a matter of cognitive and emotional development dependent on the maturation, education, and life experience of the individual, much like the Piagetian model of cognitive development (Hofer & Pintrich 1997). For example, Perry's original model of personal epistemology included nine sequential positions or stances that characterized study participants' general epistemological and ontological belief systems (Perry, 1970). After Perry, many researchers developed their own models to include categories or positions into which, theoretically, individuals' personal epistemologies would naturally fall (Greene et al., 2010; Schraw, 2013). Schraw (2013), in a summary and consolidation of existing models of epistemological positions, developed a system of three world views. The term *world views* used by Schraw equates with the term *positions* used by Perry and other researchers. These world views (positions) are *realist*, *contextualist,* and *relativist.* These terms are included in the definitions section of Chapter I.

A person with a *realist* world view sees knowledge as an unchanging, independent accumulation of important truths upon which all authorities can agree. They would be likely to believe, "It is important for students to acquire this knowledge exactly as it is" (Schraw, 2013, p.13), and the best way to do that is from an expert like a teacher.

A *contextualist* world view, on the other hand, would be one in which students can and should construct their own understanding based on the options before them. A person with a *contextualist* world view would likely believe that "while . . . knowledge is subject to interpretation, . . . some conclusions are better than others" and "students need to understand how to gather and evaluate evidence so they can distinguish good from poor arguments" (Schraw, 2013, p. 13).

An individual with a *relativist* world view would likely believe that there are “a variety of different ways to understand things” and that, “knowledge comes and goes, and what the so-called experts consider the truth today will be viewed with suspicion tomorrow” (Schraw, 2013, p. 13). This view would dictate that students learn to think for themselves, question authority, and consider how beliefs and events affect their own lives. For a relativist, the teacher’s role is to create a class setting in which students can think and act independently and don’t have to rely on an authority figure for the right answers (Schraw 2013).

As has been mentioned, research has consistently demonstrated that students with more sophisticated personal epistemologies (*contextualist* and *relativist*) are more successful learners who tend to have better academic outcomes (Greene et al., 2010; Perry, 1970; Schommer & Dunnell, 1994). The goal of education, then, should be to get students to progress from a more naïve or *realist* conceptualization of knowledge to one that is more sophisticated. The question is, how might that be accomplished? That would depend on how personal epistemologies are perceived by the educator.

If an educator views personal epistemology as a collection of independent theories or beliefs, as is typical in the models that utilize dimensions of epistemic belief mentioned earlier, they would conclude that it is the learner’s specific beliefs about knowledge that impact their capacity to learn. Under these dimensions of epistemic belief models, teaching strategies would attempt to directly change students’ personal epistemologies before changing their knowledge base. These types of strategies would include things like teaching students critical thinking skills and cognitive processing strategies (Kardash & Howell, 2000) or specific study skills (Schommer, 1993).

If, however, the educator views personal epistemology as a matter of cognitive development, like the models of epistemic positions mentioned, then stages such as *realist*, *contextualist*, and *relativist* are steps through which human beings progress naturally because of maturation and experience. This means that a student's increase in knowledge would tend to result in epistemological advancement innately and, consequently, that fostering this epistemological advancement would then be a natural aim and result of education (Hofer, 2000). According to this conceptualization of personal epistemology, the educator's role would be to provide students with learning opportunities that would increase their knowledge in a given field as well as opportunities to understand how knowledge in that field is created and organized using constructivist teaching methods. These methods would include strategies like encouraging student questions and comments, providing opportunities to construct meaning with peers (Baxter Magloda, 1992), and connecting what they have learned across courses and disciplines (Bondy et al., 2007).

Based on the research findings of Hofer, Baxter Magloda and Bondy et al., and the researcher's experience as an educator, he believe that an individual's personal epistemology evolves alongside their cognitive development and that the progression from stage to stage is dependent on personal experience and growth. My experience has been that individuals are capable of learning what they are developmentally ready to learn and that presenting them with learning opportunities and activities for which they are not cognitively prepared ends in frustration for both students and teachers. Furthermore, it is my experience that learning activities that are cross-curricular or that encourage students to create their own meaning tend to be more effective than teaching subject specific study skills, for example. These are more effective learning activities because they give students insight into how knowledge in a given subject is constructed and organized, allowing them to ultimately construct their own knowledge of that subject for themselves. Following this line of reasoning, the purpose of education is to encourage students' developmental progress from a more simplistic stage of personal epistemology, in which they view knowledge as something created and controlled by experts, to a more sophisticated stage, in which they believe they have a level of control over the knowledge they possess of the world around them.

### General and Domain-Specific Epistemic Beliefs

Both approaches to personal epistemology usually consider how individuals conceive and utilize epistemological beliefs at a general level. However, some researchers who examine personal epistemologies and ontologies have recently begun to look at the nature of general ontological and epistemological beliefs in contrast to the beliefs that have to do with specific domains and even specific topics (Berding et al., 2017; Muis et al., 2006). Their studies have found that people can hold beliefs at the general or world view level that are independent of and often inconsistent with their own domain or topic-specific beliefs (Schraw, 2013). Additionally, researchers have found that beliefs held at the domain level are more influential on people's capacity to learn than are generally held beliefs, with topic-specific beliefs being the most influential (Muis et al., 2006). This hierarchy suggests a learner's epistemic/ontological beliefs about a single discipline, like photography, would exercise more influence over their learning habits and academic achievement within that discipline than their generally held epistemic/ontological beliefs.

While researchers have investigated the differences between generally held and domain-specific ontological and epistemological beliefs, the instruments they have developed to measure these beliefs are often general in nature. That is, the questions on these personal epistemology questionnaires refer to knowledge in general, how knowledge, in general, is acquired, how it is validated, and how it is demonstrated (Greene et al., 2010; Hofer & Pintrich, 1997; Schommer, 1990). Still, there are some personal epistemology questionnaires that address domain-specific types of knowledge that ask how one might know about algebra or computer programming, for example. But even then, they typically ask questions that are hypothetical rather than specific in nature (Hofer, 2000; Muis et al., 2006; Özmen & Özdemir, 2019.

In addition to the orientation of some personal epistemology questionnaires towards general knowledge, there are also frequent problems involving reliability and validity with studies that use self-reporting questionnaires. These problems are often acknowledged by the researchers choosing to use these instruments in their studies (Greene, 2013; Hofer, 2001; Özmen & Özdemir, 2019; Watson, 2020). In studies of personal epistemology using self-reporting questionnaires, it is often difficult to reproduce the same results with different populations or even with the same populations under different circumstances (Leal-Soto & Ferrer-Urbina, 2017; Schraw, 2013), which raises concerns about these studies' findings. The problems with validity usually involve alignment of the instrument being used with the theoretical framework and/or model of epistemological dimensions upon which it is based.

Commonly, researchers begin their study with an idea of what dimensions they believe define personal epistemology and then develop or adopt a self-reporting questionnaire to measure participants' epistemic beliefs along those dimensions. They then test the results of their questionnaire against the model of dimensions they espouse using factor analysis, oftentimes finding that the model and the results do not match (Schraw, 2013; Watson, 2020). The predicted dimensions are sometimes found to have only weak associations with the items on the questionnaire intended to measure them (Watson, 2020). Sometimes, the questionnaires are found to have items that align with epistemic dimensions that are not part of the models upon which they are based (Leal-Soto & Ferrer-Urbina, 2017; Stahl, 2013). Problems related to reliability and validity have led some researchers to question the use of self-reporting questionnaires in studies of personal epistemology (Özmen & Özdemir, 2019; Schraw, 2013; Watson, 2020). This disconnect between the apparent impact of personal epistemologies on learning outcomes and the sometimes faulty methods used to measure personal epistemologies is problematic because it muddies any potential insight into teaching methods that might advance epistemological beliefs and, thereby, student learning.

## Photographic Reality and Photographic Knowledge

In the third decade of the 21st Century, digital technologies are potentially a part of nearly every activity in which we engage, be that work or hobbies, traveling or relaxing at home, eating, or sleeping. The photographs that we take, for whatever purpose, are no exception. Making photographs originally involved a chemical reaction caused by light bouncing off a physical object, traveling through a lens into a camera body, and being absorbed by a layer of silver nitrate coating on a metal plate. Contemporary digital photography takes the same light bouncing off real objects and transforms it into a combination of immaterial ones and zeros organized to represent those objects as squares of light or pigment (Kember, 2008). Traditional film photography had an already enigmatic relationship with the reality that it depicted, but digital photography has a connection to reality that is even more challenging to define due to the methods of its creation and the facility with which it can be significantly altered (Mitchell, 1992; Strutt, 2019).

Compared to students of past generations, today's high school students have, because of cell phone cameras, tablets, and related technologies, a powerful affinity for and capacity to take photographs (Glum, 2015). The average high school girl, for example, takes between three and eight selfies a day and, at that rate, will take 25,000 photos of herself over her lifetime (Glum, 2015; Graff, 2018). Not only do these teenagers have easy access to taking photos of themselves, but they also have access to tools that allow them to easily edit their photos to change the colors, change the contours, remove imperfections, or insert images that didn't exist in the original photo. This ability to alter their own images may have the unintended result of changing these adolescents' perception of their own reality (Carter, 2020). Evidence of this shift in perception seems to be manifest in the number of teens who struggle to psychologically balance two versions of themselves: a corporeal entity and an online, virtual avatar (Green et al., 2021).

Much has been written about the emblematic nature of photography and its ontological meaning to both photographers and viewers (Huang, 2018; Kember, 2008;

Mitchell, 1992). These articles and books often treat the philosophical and psychological impact of photography as a technology and art form from its inception to the present day, including its transition from an analog to a digital product (Mitchell, 1992). However, most of these writings are philosophical or editorial in nature and have very little actual evidence to validate the various authors' claims. Consequently, there is not much research on the connection between changing photographic technologies and changing personal ontologies. The research that exists addresses the impact of photographers' personal ontologies on their photographs and the ways in which their conceptualization of what is real impacts the way they choose to use photo editing software (Fusari, 2017; Huang, 2018). There are a limited number of research studies that explore how the ability to edit photographs impacts the personal ontologies of photographers or students of photography. In short, existing research addresses how personal ontology influences the manipulation of digital photographs; it does not address how the manipulation of digital photographs influences personal ontology.

As has been referred to previously, there is a large body of research on developing personal ontologies and epistemologies in general. This research often mentions personal ontological beliefs in connection with epistemology, but ontology is rarely treated as an independent topic, and there is very little research specifically about personal ontologies (Schraw, 2013). The research that treats epistemology and ontology together doesn't often attempt to analyze their effects on student learning separately and doesn't usually attempt to determine which is more influential (Schraw, 2013). Such research also does not often attempt to determine the impact that personal ontological beliefs have on personal epistemological beliefs or vice versa.

## Conceptual Framework

The conceptual framework for this study combines two epistemological/ ontological models, one of epistemic dimensions and the other of epistemic positions.

The term *dimension*, as it applies to epistemology, is used to "refer to a specific belief about some aspect of knowledge that is part of a broader epistemology" (Schraw, 2013, p. 2). This means that individuals have more than one epistemic belief and that these beliefs can be defined by type or dimension. It also means that these dimensions, taken together, can be described as an individual's personal epistemology.

The model of epistemological dimensions that was used in this study is the dimensions of epistemic belief developed in 1997 by Hofer and Pintrich. This model proposes that there are four dimensions of epistemological belief that help define an individual's personal epistemology. For each dimension, there exists a continuum between two extremes, with a person's beliefs about the nature of knowledge relative to that dimension lying somewhere on that continuum. For example, within the dimension of *certainty of knowledge*, the proposed continuum ranges between *fixed* and *fluid*. A person's beliefs about the nature of knowledge should lie somewhere between the idea that knowledge is fixed or unchanging and the idea that knowledge is fluid or evolving over time. The dimensions that make up the dimensions of the epistemic belief model are *certainty* of knowledge (fixed vs. fluid), *simplicity* of knowledge (disconnected vs. connected), *source* of knowledge (external vs. internal), and *justification* of knowing (dualistic vs. multiplistic).

The term *epistemological position* refers to "an individual's collective beliefs about the nature and acquisition of knowledge" (Schraw, 2013, p. 2). It is synonymous with terms like *epistemological stance* or *world view* used by other researchers (Greene, 2010; Schraw, 2013). This term includes a set of personal beliefs regarding knowledge that are both explicit and implicit.

The model of epistemological positions that was used in this study is the epistemological world views model first proposed by Schraw (2013) and is a combination of positions originally proposed and studied by other researchers (Greene et al., 2010; Kuhn et al., 2000; Muis et al., 2006; Schommer, 1990; Schraw et al., 2002). The positions included in this model are *realist, contextualist,* and *relativist.* A brief description of each of these positions, along with an explanation of the educational approaches implied by each position, are included below.

A person who holds the position of an epistemological *realist* would see knowledge as being an absolute that has always existed as it exists now. In education, it is the role of the teacher to disseminate that knowledge, and it is the role of the student to absorb it as taught.

A person who holds a *contextualist* position would see knowledge as being socially created and that its value or truthfulness depends on the context in which it is known. The role of a teacher within this epistemic position is as a guide that leads students to the best answers from among many possibilities and helps them discover or construct knowledge for themselves.

In comparison to a *realist* or *contextualist,* a person with a *relativist* epistemological position would view knowledge as being indefinite and open to differing interpretations. From this viewpoint, in education, the teacher helps students ask questions and evaluate the answers to find what they believe knowledge to be for themselves. Students then need to be prepared to think, judge, and act independently based on the options before them.

The conceptual framework for this study includes a combination of the dimensions of the epistemic belief model coupled with the model of epistemological world views or positions. The goal is to determine individual-specific epistemological beliefs according to the dimensions of the epistemic belief model and thereby align their overall belief system with the epistemological position in the epistemological world views model that provides the best fit. For example, if an individual believes that knowledge is a fixed body (*certainty*), unrelated from one discipline to another (*simplicity*), originating from teachers, parents, and other authority figures (*source*), and sees competing knowledge options as either completely right or completely wrong (*justification*), that person would be described as having a *realist* or absolutist epistemological position. Table 1 provides a graphic representation of the orientation of these two models to each other.

**Table 1**

*Alignment of Epistemological Positions with Dimensions of Epistemic Belief*

| Epistemological World Views/ Positions (Schraw, 2013) | Dimensions of Epistemic Belief (Hofer & Pintrich, 1997) | | | |
|---|---|---|---|---|
| | **Simplicity** | **Certainty** | **Source** | **Justification** |
| **Realist** | Simple | Certain | Objective | Authoritative |
| **Contextualist** | Complex | Conditionally Certain or Tentative | Conditionally Objective or Subjective | Conditionally Personal or Authoritative |
| **Relativist** | Complex | Tentative | Subjective | Personal |

The two models being combined to create this conceptual framework each includes the words *epistemological* or *epistemic* in their respective titles. So, these two models clearly address individuals' personal epistemologies in terms of dimensions and positions, respectively. However, there is no explicit mention in either model of ontological world views, positions, or dimensions. In the work of the researchers who developed these two models (Hofer & Pintrich, 1997; Schraw, 2013), individuals' ontological beliefs were considered, but they were addressed only in connection with epistemological beliefs. For example, in defining the relationship between ontological and epistemological beliefs, Schraw (2013) wrote:

> I assume that an individual's ontological beliefs collectively comprise a personal ontology. Like epistemology, ontological beliefs and world views may be tacit or explicit in part or whole. I also assume the epistemological and ontological world views work in tandem to determine an individual's beliefs about learning and instruction. (p. 2)

Hofer and Pintrich (1997) also commented on how ontological and epistemological beliefs work in concert in their dimensions of the epistemic belief model, explaining that:

> It does appear that if an individual makes an ontological commitment to a particular stance regarding the certainty of knowledge (i.e., absolutist versus relativistic), then they will perceive and think about their experience in a certain manner. This supports the idea that individuals' epistemological beliefs can function as a theory, which can guide their subsequent thinking as in other theory-driven processes. (p. 31)

While this study attempted to assess participants' personal epistemologies separately from their personal ontologies, the models used to create the conceptual framework for this study treat personal ontologies and epistemologies as inherently linked. The purpose of separating epistemological and ontological beliefs in this study was to show the degree to which the conceptual link between personal ontology and personal epistemology was corroborated or refuted.

This was one of the purposes behind developing two instruments for this study. One of the instruments is intended to measure high school students' personal ontological beliefs relating to photography, and the other is intended to measure their personal epistemological beliefs about that subject. If the instruments are found to be valid and reliable, the next research step would be to determine if the results can predict academic performance. This finding would provide educators with sound reasoning to focus on the learning process in addition to the content, essentially to develop more complex thinkers who can improve their academic achievement.

# CHAPTER III

# METHODOLOGY

## Chapter Overview

Existing research into the nature of personal epistemologies often uses self-reporting questionnaires to measure individuals' epistemic beliefs. These questionnaires sometimes produce results that are only marginally significant and that are inconsistent from study to study.

Two research instruments were developed for this study. The first, which was designed to measure high school students' personal epistemologies regarding photography, used the novel approach of asking specific questions about participants' beliefs related to specific photographic skills and concepts. The second was designed to measure high school students' personal ontological beliefs about the reality (or lack of reality) of 15 portrait photographs. The purpose of this latter instrument was to determine if participants' ontological beliefs could be successfully gauged independently of their epistemological beliefs. This chapter will discuss the development of these two instruments as well as other surveys that were created to help validate. Primarily, this chapter will describe the methods used to determine the degree to which these instruments can be considered valid and reliable.

## Research Design

This research sought to establish the reliability and validity of two instruments designed to differentiate between the levels of sophistication present in the personal epistemologies or ontologies of high school students involving photography. This is an important differentiation because students with more sophisticated personal epistemologies tend to have better academic outcomes. The goal of these instruments, once their validity and reliability have been determined, is to see if they can be used to predict academic outcomes. If these instruments are found to predict academic performance, educators will have research-based reasons to adjust their instruction to develop students who are more sophisticated thinkers in terms of personal epistemology. The instruments developed for this study are based on the work of other researchers who have used similar approaches to measure personal epistemology (Duell & Schommer, 2001; Greene et al., 2010; Leal-Soto & Ferrer-Urbina, 2017; Özmen & Özdemir, 2019; Schraw et al., 2002).

The design of this study included a pilot test, and a field test stages to establish the validity and reliability of the research instruments. The format of a pilot test followed by a field test is in keeping with the recommended method for establishing the validity and reliability of these types of research instruments (Pernegar et al., 2014; Ruel et al., 2016).

## Research Questions

1. To what extent is an instrument designed to measure high school students' ontological beliefs regarding photographic reality valid and reliable?
2. To what extent is an instrument designed to measure high school students' epistemological beliefs regarding photographic knowledge valid and reliable?

## Threats to Internal Validity and External Validity

This study was not an attempt to establish a cause-and-effect relationship. Rather, this study sought to develop valid and reliable instruments using a relatively small sample ($n$ = 100) in the field test. This is the recommended size for sample groups in a study of this nature, one tasked with establishing the overall validity and reliability of questionnaire instruments (Pernegar et al., 2014; Ruel et al., 2016).

However, the validation of this research might threaten external validity given that the population of students used in this study opted into taking a somewhat lengthy questionnaire online and were likely to be at least relatively computer literate. This self-selection on the part of participants might have led to sampling bias in that they may not be representative of the total high school population.

## Population and Sampling

The target population included high school-age students who may or may not have taken a photography course at some point between the $9^{th}$ and $12^{th}$ grades. The sample was provided by Centiment, a company that provides specific sample groups based on criteria such as number, age, profession, or location. For this study, Centiment provided access to a group of 35-40 high school students for the pilot test stage and access to a group of at least 100 students for the field test stage. To be included in one of those two test groups, participants had to have internet access, be between the ages of 15 and 18, and live in the United States. Some of these students had one or more photography classes during their years in high school ($n$ = 58), and some did not. The same criteria were used to select both the pilot test and field test participants.

## Instrumentation

Two instruments were developed by the researcher: the Photographic Reality Questionnaire (PRQ) and the Photographic Knowledge Questionnaire (PKQ). Each had a different role in answering the study's research questions. Two additional surveys were used to ascertain the validity of these new instruments: an Expert Panel Survey and a Response Process Survey. These two surveys were not developed specifically for this study; rather, they represent established methods for measuring the face and content validity of new research instruments (Taherdoost, 2016; Yusoff, 2019).

### The Photographic Reality Questionnaire (PRQ): Development and Purpose

The Photographic Reality Questionnaire (PRQ) was used to address the first research question of this study directly. Past studies involving personal epistemologies have usually considered participants' ontological beliefs to be connected in some way to their epistemological beliefs, and attempts have rarely been made to assess them separately. The PRQ was constructed to evaluate participants' ontological perceptions or beliefs regarding photographic reality without any connection to their epistemological perceptions or beliefs.

To gauge student perceptions of what constitutes photographic reality, students were shown a series of 15 portrait photographs and asked how real they considered each photo to be. The photos in this questionnaire ranged from being completely unedited to being highly edited. Three photos had the colors modified, three had the features distorted, three had the face combined with other images, three had lines and shapes added to the face, and three were unaltered. In the instructions for this instrument, the participants were asked to use the following definition for the term *real*; “Having objective, independent existence; not artificial, fake or deceptive.” Participants indicated how real they considered each photo to be using a 5-point Likert-type scale, with one being *very unreal* and five being *very real.* For each item, a score of 1 represented a simpler, more concrete perception of photographic reality, whereas a score of 5 represented a more complex, abstract perception of that reality. Participants were given a one through five score based on the average of their responses on all 15 items. In this way, participant responses and scores demonstrated the level of sophistication they possessed regarding their perception of photographic reality. Those who responded most often that only the photos that are unaltered or less altered are “real” received a lower average score as they demonstrated a less sophisticated personal ontology regarding photographic reality. Participants who responded that the highly altered photos were also “real” demonstrated a more sophisticated or nuanced understanding of the reality of those photos and received a higher score.

It should be noted that, aside from being given the definition for the term *real*, participants were not instructed as to how they should determine a photo's reality in this instrument. That decision was left entirely up to them, which is in keeping with the purpose of this questionnaire. There is no right way to judge the reality of a photograph. As was mentioned in the literature review, the reality depicted in a photograph has always been difficult to define, and the advent of digital photography and photo editing software has made that definition even more difficult. The point of this questionnaire was not to determine if participants can correctly judge which photos are real and which are not. Again, there is no way to correctly make such a judgment. The purpose of this instrument is to determine which photos participants decide they should deem real (having objective, independent existence; not artificial, fake, or deceptive) and which they should not.

The processes used to establish the reliability and different forms of validity of this instrument are explained in the data collection and analysis subsections of each of the stages outlined in this document. The PRQ can be found in Appendix A.

**The Photographic Knowledge Questionnaire (PKQ): Development and Purpose**

The Photographic Knowledge Questionnaire (PKQ) addressed this study's second research question. When this study was initially conceived, the intention was to use a version of an existing questionnaire of personal epistemology, the Connotative Aspects of Epistemological Belief (CAEB), adapted for the subject of photography. During the process of adaptation, however, it became evident that the resulting questionnaire was going to be overly vague and difficult for high school students to interpret through their own experience with digital photography. As a result, the Photographic Knowledge Questionnaire was developed to ask questions about participants' experiences with specific photographic skills and concepts instead of questions about general, theoretical situations with which participants may or may not have a degree of familiarity.

Structurally, the PKQ is organized into seven sections. In section one, participants are asked to rate how much they feel they know about six photographic concepts and skills on a 5-point Likert-type scale. Two of the terms in this first section are compositional concepts (rule of thirds and repetition), two are technical terms relating to camera operation (aperture and ISO), and two are procedural terms having to do with the performance of photography-related tasks (how to use a tripod and how to print a photo).

The remaining sections have multiple-choice questions about each concept and skill presented in the first section of the questionnaire. The five possible responses to each of the items in sections two through seven represent five possible points on a continuum between simple epistemic beliefs on one end and more complex epistemic beliefs on the other. This makes it possible to use a 5-point scale to describe the simplicity or complexity of the students' epistemological positions.

For example, in section two, participants are asked questions about the rule of thirds relative to each of the dimensions included in the dimensions of the epistemic belief model (Hofer and Pintrich, 1997), which is one of the foundational pieces of this study's conceptual framework. The question in this example is intended to measure the participant's understanding of the *source of knowledge* (from the dimensions of the epistemic belief model) regarding the subject of photography.

> *If I wanted to learn more about the rule of thirds, which of these would be the best option?*

a. *From a photography teacher*
b. *From another student*
c. *From an online tutorial about the rule of thirds*
d. *From an instructional video about the rule of thirds*
e. *By using the rule of thirds in my own photos*

Choosing Option A (From a photography teacher) suggests that the participant views photographic knowledge as something imparted by an authority figure to a student. Conversely, choosing Option E (by using the rule of thirds in my own photos) suggests that the participant sees photographic knowledge as something that can be independently acquired or discovered without an authority figure's mediation. Options B, C, and D represent intermediate steps between A and E, indicating a gradual shift from relying on authority figures for knowledge to valuing personal experience or opinion as valid sources of knowledge.

Sections three through seven of the PKQ, like section two, each pair one of the specific photographic concepts or skills mentioned earlier (repetition, how to use a printer, how to use a tripod, ISO, and aperture) with the dimensions that make up the dimensions of epistemic belief model. The result is that the participants are asked specific questions about their epistemological beliefs regarding each of the six skills and concepts related to *certainty of knowledge, simplicity of knowledge, source of knowledge*, and *justification of knowledge*.

This can be considered an innovative approach because, unlike other personal epistemology questionnaires, the PKQ contains questions about specific skills and vocabulary from the domain or discipline of photography. Other questionnaires that address personal epistemology typically ask questions about how knowledge, in general, is acquired, justified, or demonstrated rather than questions about the knowledge of specific subjects or topics. These other questionnaires also usually employ Likert scales and ask participants how much they agree or disagree with a given statement. For example, the Epistemic Beliefs Inventory (EBI), as developed by Schraw et al. (2002), asks participants to gauge their level of agreement with statements regarding general knowledge using a 5-point Likert scale, such as, *"Smart people are born that way"* or "*If you do not learn something quickly, you will never learn it.*"

As the participants consider these statements, they would need to reflect on their own experience with situations in which the statements were true and situations in which they were not. They would then need to calculate how often their experience aligned with the statement and how often it did not. From this experiential calculation, they would have to determine how much they agree or disagree with the statement. Perhaps because of the general nature of this type of questionnaire and the level of mental processing they require, studies that utilize questions about general epistemological experiences, like the EBI, sometimes have issues with reliability and validity (Cartiff et al., 2021; Özmen & Özdemir, 2019; Watson, 2020).

In contrast to questionnaires like the EBI, the PKQ asked participants specific questions related to their knowledge of specific topics within the domain of photography. The participants should not have been confused about how their experiences and beliefs aligned with the questions, and they should not have been overly frustrated with the act of completing it. Hopefully, these factors led to careful self-reflection by participants and more accurate and consistent answers.

As was the case with the PRQ concerning participants' personal ontologies, the purpose of the PKQ was only to assess participants' personal epistemologies, specifically their perceptions and beliefs concerning how knowledge in photography is obtained and justified. As with the PRQ, they were disabused of the idea that there was one “right” answer to any of these survey questions. The questionnaire did not imply or assume that any set of epistemological beliefs regarding photography were more correct or acceptable than any other such beliefs. Again, the point was to determine what participants’ epistemic beliefs were, not to determine if those beliefs were “right.”

Since the possible responses on the PKQ are structured as a 5-point Likert scale, each participant received a score between 1 and 5 for each skill and concept addressed in the PKQ (rule of thirds, repetition, using a tripod, using a printer, ISO, and aperture) based on the average of their responses in that section of the questionnaire. They also received an overall score between one and five derived from an average of their responses on the entire questionnaire.

The reliability and validity of the PKQ were assessed according to the processes explained in the data collection and analysis subsections of both the pilot test and field test stages. The PKQ instrument can be found in Appendix A.

**Expert Panel Survey**

A panel of five experts evaluated the PKQ and PRQ instruments to provide feedback on each of the items in these instruments. These experts were recruited from high school and university photography instructors and personal epistemology experts. In terms of content, the panel of experts was also asked to rate each item in both instruments as either “not essential,” “useful but not essential,” or “essential.” These answers were then analyzed to determine which items the experts deemed necessary and which they did not. This procedure was used to establish the content validity of each instrument (Taherdoost, 2016). These experts were also asked their opinion regarding the format of each questionnaire in terms of appearance, the overall layout, the fonts, and the graphics used to help establish the face validity of each instrument. As with the questionnaires given to the high-school-age participants, the expert survey, along with a reference version of the PKQ and PRQ, was made available to this panel via Qualtrics, and their responses were downloaded from Qualtrics as CSV files.

The responses garnered from the expert surveys were analyzed using Lawshe's method to determine the content validity ratio for each item (Taherdoost, 2016, p. 29). This ratio demonstrates how many of the experts surveyed agreed that a particular item is essential. Given the number of experts who participated using this method, the minimum value required to keep any item was .62 (Taherdoost, 2016). Items deemed non-essential (below .62) would be removed if possible or rewritten to meet the experts' suggestions. The panel's recommendations would also have been followed regarding the format of each instrument and changes made accordingly. However, no suggestions of this type were made, and so neither instrument was altered. Appendix B has the survey given to the panel of experts.

**Response Process Survey**

In addition to the PKQ and PRQ, there was a separate survey meant to assess the understandability of the items on the PKQ. The purpose of this survey was to establish the validity of the response process of this instrument, with response process validity being a form of face validity (Yusoff, 2019). According to Yusoff, response process validity “refers to the degree to which test respondents view the content of a test and its items as relevant to the context in which the test is administered” (2019, p. 55). In this survey, participants were asked to reflect on their experience in answering each of the questionnaire’s items. Specifically, they were asked to rate each item on a 4-point scale of “clarity and comprehension” (Yusoff, 2019, p. 57) as follows:

1. *the item is not clear and understandable*
2. *the item is somewhat clear and understandable*
3. *the item is clear and understandable*
4. *the item is very clear and understandable*

While Yusoff named this a scale of “clarity and comprehension,” it should be noted that in the actual surveys used in this study, the term *understandability* was used instead of *comprehension* because the researcher believed it to be more grammatically correct and more understandable for high school students.

From participant responses to the Response Process Survey, each of the items in the PKQ was given a rating for understandability. These ratings were meant to quantify the thought processes of participants as they interacted with the instrument in question and lead to a face validity index (FVI) (Yusoff, 2019) for each item and for the instrument overall. Two forms of FVI were calculated for this study: an FVI for each item (I-FVI) and a scale-level FVI (S-FVI). The I-FVI is based on the proportion of participants that gave an item a clarity and comprehensibility score of 3 or 4. To arrive at an I-FVI score, the item was given a 1 for each participant that rated it as either a 3 or 4 and a 0 for each participant that rated it as a 1 or 2. Those numbers were then added up and divided by the number of participants. For Response Process Surveys administered online, such as the survey in this study, it is suggested that an I-FVI score of .80 and above be regarded as acceptable for an item to be included in the instrument being examined (Yusoff, 2019).

The S-FVI was calculated by adding up the I-FVI scores for all the items in an instrument and dividing that sum by the number of items. This gave the instrument an overall score. A score of .80 was considered the minimum necessary for the instrument to show sufficient response process validity or face validity (Yusoff, 2019).

Because the Response Process Survey attached to the PKQ was repetitive, and the experts gave each item a satisfactory I-FVI score, only a sample of what they were asked is included in Appendix C.

There was no Response Process Survey developed to accompany the PRQ because that questionnaire is essentially 15 identically worded questions, with a different photo connected to each of them, making all these items equally understandable.

Both instruments (PRQ and PKQ) and the accompanying Response Process Survey for the PKQ were made available to the high school-age participants as a single, ungraded questionnaire online via the Qualtrics experience management software

## Research Stages

This study was divided into three stages. The first was the preparatory stage, in which the elements necessary for completing the subsequent stages, such as Institutional Review Board (IRB) approval, instrument development and expert panel review, and testing logistics setup with Centiment. The second stage was a pilot test in which the validity and reliability of the instruments designed for this study (the PRQ and PKQ) were initially established, and any necessary changes to the instruments were made for greater clarity. The third stage was a field test, which ascertained in more detail the validity and reliability of the instruments designed for this study.

**Preparatory Stage**

In the preparatory stage, all the arrangements necessary for the subsequent stages were made. Because this study involved human participants, approval was obtained from Utah State University's IRB. Toward the beginning of this preparatory stage, the text of each instrument was analyzed using the FORCAST Readability Formula to establish each instrument's level of readability. This formula was created specifically to determine the reading level of the text in technical documents like surveys and questionnaires. A FORCAST grade of 9-10 is ideal for the type of instruments used in this study (Radhakrishna, 2007). It was anticipated that, in this stage, changes would be made to any instrument that didn't fall into the FORCAST grade range of 9-10 to make it fit into that range.

Also in this stage, a version of the PRQ and PKQ intended for the panel of experts was assembled. This was done by putting the items from the PRQ and PKQ together as separate sections of a combined questionnaire and adding an item from the Expert Panel Survey after each of the items in the PRQ and PKQ. For example, item G1 from the PKQ reads:

*G1 If I wanted to learn more about how to print photos, which of these would be the best option?*

- *From a photography teacher*
- *From another student*
- *From an online tutorial about printing photos*
- *From an instructional video about printing photos*

- *By printing my own photos*

The following two items from the Expert Panel Survey were placed immediately following item G1:

*EQ-G1.1 How essential is question G1?*

- *Essential*
- *Useful but not Essential*
- *Not Essential*

*EQ-G1.2 Do you have any comments about question G1?*

This combined version of the instruments used in the pilot test stage was then made available to the panel of experts on the Qualtrics website, and panelists were sent an email providing them with the link to this version of the combined questionnaires. When all the panelists had responded to the questionnaire, the results were downloaded from the Qualtrics website and analyzed using the methods described in the Instrumentation section of this chapter.

In preparation for the pilot test stage, the PRQ and PKQ items were again placed together as separate sections in a joint questionnaire intended for the adolescent participants in the pilot test group. Added to the beginning of this questionnaire was an introductory section, which asked participants for basic demographics about themselves. These demographic questions along with a short explanation to participants about the nature of the study and their part in it is included in Appendix D.

The items from the Response Process Survey were also placed into the PKQ immediately following each of that instrument's question items. Using the same item from the previous example, but this time to show how the Response Process Survey is embedded in the PKQ, question G1 of the PKQ asked,

> *G1 If I wanted to learn more about how to print photos, which of these would be the best option?*
> - *From a photography teacher*
> - *From another student*
> - *From an online tutorial about printing photos*
> - *From an instructional video about printing photos*
> - *By printing my own photos*

This question was immediately followed by this response process question,

*Was the last question clear and understandable?*

> *(4) Extremely clear*
> *(3) Somewhat clear*
> *(2) Somewhat unclear*
> *(1) Extremely unclear.*

The resulting pilot test version of the PKQ and PRQ was then made available on Qualtrics, where the pilot test participants selected by Centiment would have access to complete the joint questionnaire.

## Pilot Test Stage

### *Participants*

Centiment was asked to recruit a group of between 35 and 40 high school-aged students for this stage. Researchers have suggested that this number of participants for a pilot test is the optimal number of participants for the type of study (Pernegar et al., 2014; Ruel et al., 2016). Thirty-nine students successfully completed all the questionnaires associated with the pilot test stage.

### *Data Collection*

As the first step in the data collection for the pilot test stage, participants took the PRQ to establish their existing personal ontologies related to photography. Just after taking the PRQ, participants also took the PKQ to determine their existing personal epistemologies related to photography. Also in the pilot test stage, participants completed the Response Process Survey connected to the PKQ. Students completed all the parts of the combined PRK and PRQ questionnaire at a time of their own choosing once they were recruited by Centiment.

### *Data Analysis*

As part of the pilot stage, the researcher ran an exploratory factor analysis (EFA) to determine how successful the PKQ was at measuring personal epistemologies in alignment with the dimensions of the epistemic belief model developed by Hofer and Pintrich (1997) (*simplicity, certainty, source, and justification*). In each section of the questionnaire, there were a total of five questions: two questions meant to address *simplicity,* one for *certainty,* one for *source*, and one for *justification*. The researcher conducted an EFA to determine the relationships between the variables latent in the items of the PKQ, to determine the number of factors that those variables would best be condensed into, and which questionnaire items should be associated with which factors. In doing so, this factor analysis established a level of construct validity for the PKQ.

The researcher also performed an EFA on the data from the PRQ administered during the pilot test stage. Again, the purpose was to determine the relationship between the latent variables present in that data and to indicate the number of factors found necessary to describe those relationships accurately. The difference between the factor analysis on the PRQ data and the analysis conducted on the PKQ data was that the PRQ was not based on an existing model of personal ontology. A factor analysis was performed, which revealed a specific number of factors. Those factors were then utilized in the field test, as will be described later, and a resultant model became apparent. However, in this stage, no predetermined model was analyzed for the PRQ.

Cronbach's alpha was used to establish the reliability of the PKQ and PRQ. This analysis provided a measurement of the internal consistency for these two instruments in the form of a coefficient. Given the conditions of this study, a Cronbach's alpha value of .70 or more was considered necessary to show an acceptable level of internal consistency and reliability (Yusoff et al., 2021).

Finally, the results of the Response Process Survey were analyzed to determine a rating or index for each item in the PKQ. As described in the Instrumentation section, each item received an I-FVI score that, to be considered acceptable, had to be above .80. The overall PKQ instrument received an S-FVI score, which should also be above .80.

If either instrument had failed to reach the necessary thresholds for the FVI or Cronbach's alpha analyses, the plan was to revise them to improve their face validity and reliability before proceeding to the Field Test stage. The same was true for the EFA analyses meant to establish the instrument's construct validity. If the pilot test had revealed fundamental problems with either instrument's validity or reliability, a major rewrite would have been undertaken on the instrument in question. A second pilot test would then have been conducted using the same methods of data collection and analysis methods used in the first pilot test but with a different sample of 35 to 40 students.

In the pilot test stage, the EFA was performed using the RStudio software package, and the Expert Panel and Response Process Surveys were analyzed using Microsoft Excel.

## Field Test Stage

### *Participants*

Following the criteria mentioned in the Population and Sampling subsection and the additional criteria that none of the students in this group had participated in the pilot stage test group, Centiment recruited student participants for the field test with a guaranteed minimum response rate of 100. Based on the size of the population being studied and the type of instrument being validated, researchers have determined that 100 participants are an acceptable number for establishing instrument validity and reliability (Pernegar et al., 2014; Ruel et al., 2016). The number of participants who satisfactorily completed the PKQ and PRQ in this stage was 106.

### *Data Collection*

As in the pilot test stage, participants took the PRQ and PKQ to determine if these instruments could assess their personal ontologies and epistemologies accurately. In the field test stage, the combined questionnaire did not include response process questions.

### *Data Analysis*

As in the pilot stage, a factor analysis was used to assess the construct validity of the PKQ. However, in the field test stage, a confirmatory factor analysis (CFA) was used for each instrument rather than an EFA. The CFA in this stage utilized the factors revealed through the EFA performed in the pilot test stage on the data from the field test PKQ. This was done to test the degree to which the field test data fit the dimensions of the epistemic belief model, which is part of the conceptual framework for this study.

Similarly, a CFA was performed on the data from the PRQ administered in the field test stage. The factors and alignment of questionnaire items suggested by the EFA performed in the pilot test stage were used as the structure for this CFA. As mentioned in the pilot test stage section, no predetermined model involving dimensions of personal ontology was tested or analyzed through this CFA. Instead, it was used to see if any such model of personal ontological beliefs could be derived from this combination of exploratory and confirmatory factor analyses. A more in-depth explanation of these factor analyses is provided in Chapter IV.

Also, in keeping with the pattern established in the pilot stage, a Cronbach's alpha analysis confirmed the degree of reliability of the PKQ and PRQ. A level of .70 on each of the factors revealed by the pilot test EFA and on the instruments overall was necessary to suggest they are reliable instruments. RStudio was used for all data analyses included in this stage.

At the end of the field test stage, all statistical analyses were evaluated in reference to the research questions. From this evaluation, findings and conclusions were drawn, including suggestions for further research.

# CHAPTER IV

# RESULTS

## Chapter Overview

This study sought to establish the validity and reliability of two instruments designed to measure individuals' personal ontologies and personal epistemologies related to the field of photography. If found to be reliable and valid, these instruments could be used in the future to assess the progression of high school students' personal ontologies and epistemologies connected to photography as they become more familiar with photographic skills and concepts. Finally, the instruments might also be used as a model for other disciplines seeking to develop instruments to measure student perceptions of what can be known and what is real or exists.

## Research Stages

The study began with a preparatory stage, during which essential groundwork was completed, including obtaining IRB approval and arranging testing logistics. During this stage, a panel of experts reviewed both research instruments, and they were subjected to a reading-level analysis. Next was the pilot test stage, where the reliability and validity of the two research instruments were initially examined. Any necessary changes identified during these examinations were implemented. Following the pilot test, a field test was conducted. The analyses that began in the pilot test stage were concluded with a larger group of participants using the same research instruments.

After detailing these stages, the study will explain how the information and data gathered during the preparatory, pilot test, and field test stages addressed the research questions guiding this study.

## Preparatory Stage

During this stage, two important statistical analyses were performed. The first was a rating of each of the items in the Photographic Reality Questionnaire (PRQ) and the Photographic Knowledge Questionnaire (PKQ) by a panel of photography instructors, and the second was a calculation of the reading level of the PRQ & PKQ using the FORCAST readability formula. Both of these analyses were completed using Microsoft Excel.

## Expert Panel Review

To recruit a panel of photography experts, high school photography instructors across the state of Utah were sent an email asking them to participate in the study and providing them with a link to the PRQ and PKQ instruments on the Qualtrics website. Expert Panel Survey questions were embedded into the questionnaires, asking experts how essential each of the questions in the PRQ or PKQ was and asking them for comments or suggestions for each item. The format for embedding these survey questions into the research instruments was to present the expert participants with a question from the PRQ or PKQ followed immediately by an Expert Panel Survey question. For a more detailed explanation of this process and an example of the way in which each of the PKQ and PRQ items were followed by an item from the Expert Panel Survey, see the preparatory stage section of Chapter III.

After the expert panel completed this survey, their answers were downloaded and analyzed to find the content validity ratio for each item in both instruments. This analysis is performed by subtracting the number of *Essential* votes for a given item from the number of panelists divided by two and then dividing that number by the number of panelists divided by two. The exact formula is:

$$CVR = \frac{n_e - \frac{N}{2}}{\frac{N}{2}}$$

In this formula, CVR is the content validity ratio for each item, $n_e$ is the number of panel members who responded that an item is *Essential*, and N is the total number of experts who responded to the survey. The purpose of this method is to establish the content validity of the instrument in question, with .62 being the minimum value for an item to be considered acceptable (Taherdoost, 2016). The ratings given to each of the items in the PRQ by the expert panel are shown in Table 2.

**Table 2**

*Expert Panel Item Ratings – PRQ*

| Item | Rating | Item | Rating | Item | Rating |
|---|---|---|---|---|---|
| RQ1 | 1 | RQ6 | 1 | RQ11 | 1 |
| RQ2 | 1 | RQ7 | 1 | RQ12 | 1 |
| RQ3 | 1 | RQ8 | 1 | RQ13 | 1 |
| RQ4 | 1 | RQ9 | .67 | RQ14 | 1 |
| RQ5 | .67 | RQ10 | 1 | RQ15 | 1 |

All the items in the PRQ scored above the suggested minimum of .62, meaning all items on the instrument were deemed essential and acceptable. The ratings given to the items in the PKQ are shown in Table 3.

**Table 3**

*Expert Panel Item Ratings – PKQ*

| Item | Rating | Item | Rating | Item | Rating | Item | Rating |
|---|---|---|---|---|---|---|---|
| A1 | 1 | B1 | .75 | C1 | .75 | D1 | 1 |
| | | B2 | 1 | C2 | 1 | D2 | 1 |
| | | B3 | .75 | C3 | 1 | D3 | 1 |
| | | B4 | .75 | C4 | 1 | D4 | 1 |
| | | B5 | .75 | C5 | 1 | D5 | 1 |
| | | E1 | 1 | F1 | 1 | G1 | 1 |
| | | E2 | 1 | F2 | 1 | G2 | .67 |
| | | E3 | 1 | F3 | 1 | G3 | 1 |
| | | E4 | 1 | F4 | .67 | G4 | 1 |
| | | E5 | .67 | F5 | 1 | G5 | .67 |

All items in the PKQ also scored above the suggested minimum level of .62. There were some positive comments made by the expert panel and a few suggestions, but none of them involved the instruments' formatting, and some of them were not relevant to the intent of the questionnaire. For example, item B3 reads:

*B3: Is it easy or difficult to understand the rule of thirds?*

- *Extremely easy*
- *Somewhat easy*
- *Neither easy nor difficult*
- *Somewhat difficult*
- *Extremely difficult*

In response to this item, one panel member gave this comment:

This doesn't hit at their knowledge of the Rule of Thirds, but rather, their ability to understand and retain their knowledge of the Rule of Thirds. A

> student might say it's difficult to understand because they weren't listening in class or that they don't have much background knowledge about the rules of composition generally. Someone with enough interest in photography composition could simply Google the Rule of Thirds and have more than enough resources to understand the rule from. Understanding is not the issue.

It was evident from this comment that this expert interpreted the purpose of this question differently from its intended purpose. This reviewer was correct that participants' understanding of the Rule of Thirds (something that could not be controlled for) was not the issue. However, whether or not they paid attention in class or looked up how to use the Rule of Thirds via Google was also not the issue. The issue was how simple or complex participants believed this concept to be based on their experience. In cases where comments like this were made, they were simply set aside.

Due to the acceptable CVR scores for each item on the Expert Panel Survey and the lack of workable comments contributed by the members of the expert panel, none of the items on either instrument were modified.

**Readability**

The FORCAST Readability Formula was used to assess the reading levels at which the PRQ & PKQ were written. The method for using this formula is to take a 150-word sample of the text from the document being analyzed and count the number of single-syllable words within that block of text. The number of single-syllable words is then divided by 10 and subtracted from 20 (grade level = 20 - (n/10). For each of the instruments in this study, two samples of 150 words each were used rather than just one sample to get a more accurate picture of their overall readability. The reading level tabulated for the first block of the PRQ was grade 10 and the reading level of the second block was figured to be 9.7. So, both blocks fell within the optimal 9th- to 10th-grade reading level for a questionnaire of this kind intended for use with high school students (Radhakrishna, 2007).

The FORCAST analysis was also performed on the PKQ, with the first block selected being measured at a 9.7 grade level and the second section being measured at 11.5. These two sections were then averaged together to reach the overall grade level of 10.6. That overall rating is slightly above the ideal of a 9th- to 10th-grade reading level. However, this was a small difference, and photography is a technical subject, so the PKQ was not altered.

## Pilot Test Stage

During the pilot stage, two types of analyses were performed: an EFA on the data resulting from the pilot test administration of the PKQ and PRQ, and a response process analysis of each item in the PKQ. The purpose and execution of a Response Process Survey were described in the Instrumentation section of Chapter III. A brief explanation of how and why an EFA is conducted is provided here so that this term will be better understood throughout the remainder of this chapter and Chapter V.

### Exploratory Factor Analysis

Factor analyses are often part of the methodology used in studies of personal epistemology, as described in Chapters I and II (Leal-Soto & Ferrer-Urbina, 2017; Özmen & Özdemir, 2019; Schraw, 2013; Ståhl, 2013; Watson, 2020). To review, studies of this nature usually begin with the researcher selecting or creating a model they believe correctly describes the common features that make up our personal epistemologies. Next, they design a methodology they believe will accurately measure individuals' epistemic beliefs according to their model, often including a self-reporting questionnaire. Factor analyses usually accompany that choice to reveal the underlying, latent factors present in the data produced by their questionnaire. As noted earlier, there appear to be issues with this system that can result in questionable outcomes. However, it is a commonly used method, and it appeared to be the best method available for this study.

The overarching purpose of any factor analysis is to use the correlation structure present between observed variables to reveal a system of latent, unobserved variables or factors. The purpose of an EFA is to discover this system of latent factors in datasets when there is no prior understanding of what those factors might be. In an EFA, the key statistical measures that indicate the level of validity of any instrument being tested are the Eigenvalues, Bartlett's test of sphericity, the Kaiser-Meyer-Olkin test of sampling adequacy, and the cumulative variance. To determine the reliability of the instruments, Cronbach's alpha was calculated (Watkins, 2018). A chart of these key statistics and their suggested levels of acceptability is found in Table 4.

**Table 4**

*Exploratory Factor Analysis: Key Statistics*

| Key EFA Statistic(s) | Ideal Level(s) |
|---|---|
| Eigenvalues | > 1 to be considered a viable factor |
| Bartlett's Test of Sphericity | *p* value ≤ than 0.05 |
| Kaiser-Meyer-Olkin Factor Adequacy | > 0.80 ideal, > .50 acceptable, below .50 unacceptable |
| Standardized Loading | > .30 (The higher, the better) for each item |
| Cumulative Variance | > 0.80 ideal, > .50 acceptable, below .50 unacceptable |
| Cronbach's Alpha | > .70 |

### *Exploratory Factor Analysis Assumptions*

Before an EFA can be attempted, it is generally considered necessary that the dataset being used meet certain assumptions. One of those assumptions is that the dataset is comprised of continuous or ordinal variables. The data produced by this study's instruments was ordinal. Another assumption is that there are no outliers in the data. In this case, the items in each research instrument produced numerical responses between one and five. So, the highest average score a participant could have on either instrument would be a five, and the lowest average score would be a one, both of which are reasonable average responses given the nature of these questionnaires. So, there is really no possibility of outliers in this dataset.

Another assumption to be considered is that the data have no multicollinearity, meaning that no single variable should be predicted by a combination of other variables. Multicollinearity could be demonstrated by a Variance Inflation Factor above 10 for any item or variable (Duda, 2022). The highest VIF for any item in the PRQ was 2.29, and the highest VIF for any item on the PKQ was 10.30, which is above the 10 cutoff. However, the rest of the VIF values for the PKQ fell somewhere between 7 and 3, and a small amount of multicollinearity is expected in a dataset's variables (Duda, 2022). Had there been multiple variables with VIF values above 10, this might have indicated a high degree of multicollinearity, but with only one such value, no serious problem is indicated.

Another assumption that should exist in the data to be used in an EFA is that of Unidimensionality. This is demonstrated by each item loading onto one factor at a level of .30 or above and, ideally, only one factor (Watkins, 2018). Most of the items on both instruments loaded onto factors in exactly this way. There were a few items, which will be discussed specifically later in this chapter, that did not load strongly onto either factor or that loaded at a level above .30 on two different factors. However, there are few such exceptions, and the factor rotations used in the EFA's for both instruments were selected in part because they created factor structures that were relatively simple. That is, they presented the strongest possible cases of unidimensionality. The selection of the rotation methods used in the EFA for both the PKQ and PRQ are discussed in more detail in the PRQ and PKQ pilot test sections of this chapter.

Lastly, there should be an assumption of linear relationships (or Linearity) existing between the variables in the dataset to be used in an EFA. The degree of linearity existing in the relationship between variables can be measured by performing a Pearson's correlation on the variables in the dataset and by creating a series of plots that show graphical representations of the linear relationship between variables. These types of analyses indicate largely linear relationships between the variables for both the PKQ and PRQ. The relationships between variables in the PRQ appear, from the plots created for that instrument, to be very linear in nature. The plots created to describe the relationships between items in the PKQ are linear as well. Many of the lines have a slight curve to them, but overall, they are fairly straight.

Overall, the necessary assumptions were found to be present in the datasets used in the analyses of the PRQ and PKQ. Some of the items had minor problems with multicollinearity and unidimensionality, but those problems were minor, and datasets of this nature do not need to meet these assumptions perfectly prior to use in an EFA as the necessary levels associated with these assumptions are more like guidelines in nature rather than hard fast rules (Duda, 2022).

## Pilot Test Sample Group

Based on the recommendations of experts in assessing the validity and reliability of research instruments (Pernegar et al., 2014; Ruel et al., 2016), a sample of 35 to 40 high-school-age students was deemed necessary as the sample size for the pilot test stage. This sample was recruited by Centiment, a company that recruits participants for business and education surveys. Centiment successfully recruited a sample of 39 participants who completed the combined version of the PKQ and PRQ via the Qualtrics survey management platform. Prior to completing the combined questionnaires, participants gave their assent to participate in the study and answered some basic demographic information questions about themselves. Within this sample group, 19 identified as male, 17 identified as female, and three identified as non-binary. Four of these participants were 15 years old, 13 were 16 years old, 11 were 17 years old, and 11 were 18 years old. In terms of race, 25 participants identified as White, seven identified as Black, three identified as Asian, two as Native American, and two as "other." This demographic information was not an integral part of answering the research questions, but it demonstrates that a diverse group completed the PKQ and PRQ during the pilot test stage.

## Questionnaire Administration

For participant efficiency, both research instruments were presented to participants as one Qualtrics questionnaire. However, as the instruments were each designed to address a different research question and measure different branches of participants' personal philosophical beliefs, they will be discussed separately in this section and in the field test section.

## Photographic Reality Questionnaire

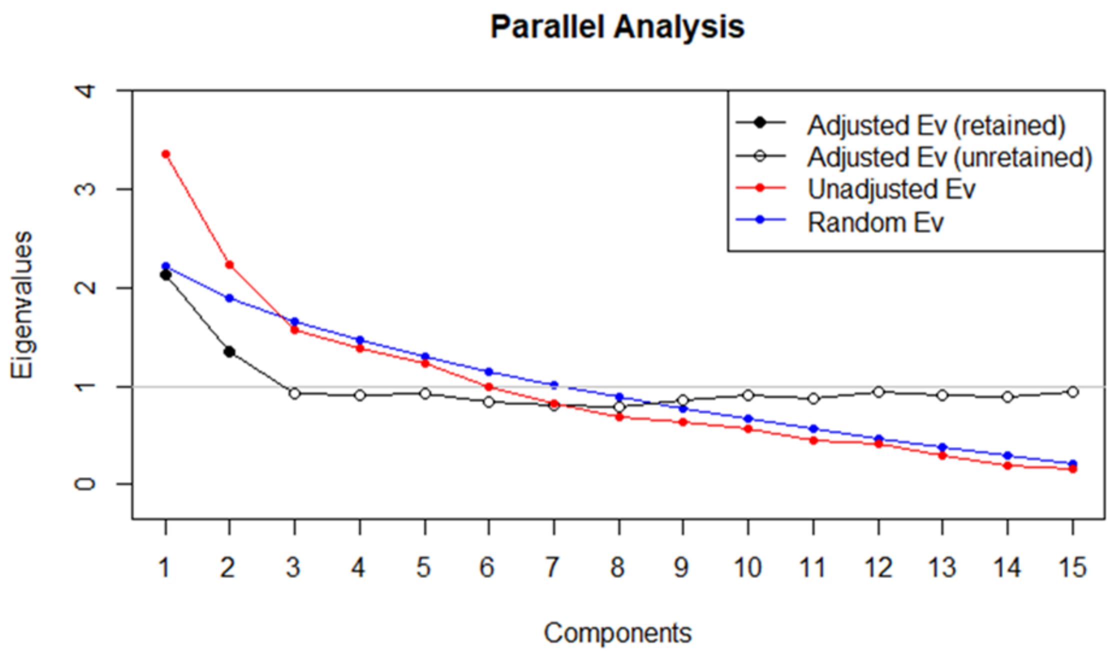
The first section of the joint questionnaire which participants answered was the PRQ. Their answers in this section were downloaded from the Qualtrics website and prepared for the data analyses using Excel. The EFA in this stage was conducted using RStudio.

### *PRQ Pilot Test EFA:*

An EFA was executed first to determine the number of factors to be used as the foundation for the subsequent field test analysis. The scree plot in Figure 1, produced as part of this EFA, shows that a two-factor model was sufficient to adequately describe the data from the pilot test of the PRQ. For reasons which will be explained in detail later, these factors were named *transformed* and *constant.*

**Figure 1**

*Scree Plot of PRQ Pilot Test*




The key statistics produced by the EFA run on this data are included in Tables 5 and 6. Table 5 contains the Eigenvalues, Cumulative Variance, and Cronbach's alpha.

**Table 5**

*PRQ Pilot Test EFA: Eigenvalues, Cumulative Variance, and Cronbach's Alpha*

| Factors | Eigenvalue | % of variance | Cumulative % | Cronbach's alpha |
|---|---|---|---|---|
| Transformed | 2.15 | .22 | .22 | .72 |
| Constant | 1.34 | .15 | .37 | .52 |

Table 6 contains Bartlett's Sphericity, KMO, and a composite rating of the questionnaire's Cronbach's alpha. Cronbach's alpha is included in two forms in these tables. One is a measurement of Cronbach's alpha for each of the factor groupings suggested by the EFA. (Table 5), whereas the other is a measure of Cronbach's alpha for all the items in the questionnaire (Table 6).

**Table 6**

*PRQ Pilot Test EFA: Other Key Exploratory Factor Analysis Statistics*

| Key EFA Statistic(s) | Pilot Test Statistics |
|---|---|
| Bartlett's Test of Sphericity | p = 0.00006 |
| Kaiser-Meyer-Olkin Factor Adequacy | 0.52 |
| Cronbach's Alpha (Composite) | 0.69 |

The statistics shown in these two tables indicate that data used for the pilot test EFA met the acceptable levels in most of the key statistical areas. One exception was the cumulative variance. This number was below the suggested minimum level, in part, because only two factors were indicated by the scree plot and Eigenvalues. When a separate EFA was conducted with four factors, the cumulative variance rose to an acceptable level. However, the resulting 4-factor model was statistically unsound, and the factor loadings forced together items, which did not fit ontologically. Also, the cumulative variance was the only key statistic to indicate the data may not warrant an EFA, while all the other statistics in Tables 5 and 6 (not including Cronbach's alpha statistics, which don't apply in this instance) indicated that an EFA was feasible. For these reasons, the results from the EFA were deemed acceptable for use in the CFA performed in the field test stage.

The second statistic that was a bit low was the Cronbach's alpha coefficient. While lower than the typical cutoff of .70, the composite level of .69 was deemed close enough as this is exploratory research, for which some researchers suggest lower levels to be acceptable (Howard, 2021). The alpha level for the *constant* factor was even lower (.52), which is perhaps due to the small number of items that loaded together on that factor ($n$ = 5). It has been suggested by statisticians that a higher number of items being assessed together tends to lead to a higher Cronbach's alpha value (Howard, 2021).

Table 7 is a pattern matrix that shows how the various items in the PRQ loaded onto the two factors determined in the scree plot and Eigenvalues to explain the latent variables in this instrument. These results were produced by using an orthogonal, equamax rotation.

An equamax rotation was selected because of the results contained in the pattern matrix and the factor correlation matrix presented in Table 8.

The factor loadings in the pattern matrix demonstrate that, for the most part, each item loaded strongly onto one factor and not the other. The exceptions to this rule are item RQ11, which loaded at a level above .30 on both factors, and RQ1 and RQ4, which did not load strongly on either factor. Ideally in an EFA, items should load onto one factor above the cut-off point of .30 and not load onto any other factors above that level (Brown, 2009). According to that standard, any item that loads at a level above .30 on more than one factor is problematic, as is any item that fails to load on any factor with a value above .30. Despite these anomalies, the statistics in Tables 7 and 8 indicate that, in this case, an equamax rotation presents a relatively simple structure to this factor analysis.

**Table 7**

*Results From a Factor Analysis of the Photographic Reality Questionnaire (PRQ)*

| Item | | Factor Loading 1 | Factor Loading 2 | Communality |
|---|---|---|---|---|
| RQ1 | On a scale of 1 to 5, 1 being very unreal and 5 being very real, how real is this photograph? | **.06** | -.20 | .04 |
| RQ2 | On a scale of 1 to 5, 1 being very unreal and 5 being very real, how real is this photograph? | **.48** | -.23 | .29 |
| RQ5 | On a scale of 1 to 5, 1 being very unreal and 5 being very real, how real is this photograph? | **.65** | -.14 | .45 |
| RQ7 | On a scale of 1 to 5, 1 being very unreal and 5 being very real, how real is this photograph? | **.66** | .08 | .44 |
| RQ8 | On a scale of 1 to 5, 1 being very unreal and 5 being very real, how real is this photograph? | **.45** | -.24 | .26 |
| RQ9 | On a scale of 1 to 5, 1 being very unreal and 5 being very real, how real is this photograph? | **.40** | .21 | .20 |
| RQ12 | On a scale of 1 to 5, 1 being very unreal and 5 being very real, how real is this photograph? | **.43** | .13 | .20 |
| RQ13 | On a scale of 1 to 5, 1 being very unreal and 5 being very real, how real is this photograph? | **.48** | -.48 | .46 |
| RQ14 | On a scale of 1 to 5, 1 being very unreal and 5 being very real, how real is this photograph? | **.72** | .09 | .52 |
| RQ15 | On a scale of 1 to 5, 1 being very unreal and 5 being very real, how real is this photograph? | **.34** | -.51 | .37 |
| RQ3 | On a scale of 1 to 5, 1 being very unreal and 5 being very real, how real is this photograph? | .24 | **.33** | .17 |
| RQ4 | On a scale of 1 to 5, 1 being very unreal and 5 being very real, how real is this photograph? | .03 | **-.05** | .00 |
| RQ6 | On a scale of 1 to 5, 1 being very unreal and 5 being very real, how real is this photograph? | -.07 | **.33** | .12 |
| RQ10 | On a scale of 1 to 5, 1 being very unreal and 5 being very real, how real is this photograph? | .08 | **.77** | .60 |
| RQ11 | On a scale of 1 to 5, 1 being very unreal and 5 being very real, how real is this photograph? | .35 | **.36** | .25 |

*Note:* Boldface indicates highest factor loading *Summary of Items and Factor Loadings for Equamax Orthogonal Two-Factor Solution for the PRQ (n=39)*

**Table 8**

*PRQ Pilot Test EFA: Factor Correlation Matrix*

| | Transformed | Constant |
|---|---|---|
| Transformed | 1.000 | -0.021 |
| Constant | -0.021 | 1.000 |

The factor loadings in the pattern matrix demonstrate that, for the most part, each item loaded strongly onto one factor and not the other. The exceptions to this rule are item RQ11, which loaded at a level above .30 on both factors, and RQ1 and RQ4, which did not load strongly on either factor. Ideally in an EFA, items should load onto one factor above the cut-off point of .30 and not load onto any other factors above that level (Brown, 2009). According to that standard, any item that loads at a level above .30 on more than one factor is problematic, as is any item that fails to load on any factor with a value above .30. Despite these anomalies, the statistics in Tables 7 and 8 indicate that, in this case, an equamax rotation presents a relatively simple structure to this factor analysis.

Additionally, the factor correlation matrix in Table 8 shows that the correlation between these two factors falls well below the level (.32), which would indicate a significant overlap of variance among these factors (Brown, 2009). Instead, Table 7 indicates that these factors were not significantly correlated, and the rotation solution for this EFA should be orthogonal. Among orthogonal rotations, the equamax rotation was selected because its results offered the simplest solution in statistical as well as ontological terms.

The items in the PRQ contain photos that have been altered in five different ways. Three of the photos have two or more images that were combined in some way. Three of the photos had the contours of the main image noticeably distorted. Three of the photos had the colors enhanced or altered. Three of the photos had lines and shapes essentially drawn on top of the main image, and three of the photos had not been noticeably changed in any way. The two-factor solution suggested by the pattern matrix in Table 7 separated the photos that have had images combined or have had their contours altered (Items 2, 5, 7, 9, 11, 12, 13, 14, and 15) from the photos that have had only their colors changed or are essentially unaltered (Items 3, 6, 10, and 11).

There were two types of exceptions to that rule. The first type was those items that did not load significantly on either factor. These items are RQ1, which had combined images, and RQ4, a color photo in which the colors were intensified. Since these items did not load well on either factor, they were assigned to a factor based on the pattern established by the factor loadings of all the other items as shown in Table 7. So, for subsequent Cronbach's alpha and CFAs, RQ1 was placed into factor 1 (*transformed*), and RQ4 was placed with factor 2 (*constant*). The other type of exception was RQ8, which technically had only its colors changed. However, the colors were altered so dramatically that the photo looked almost like a drawing. This radical change in the appearance of the photo apparently made participants consider it similar to the photos that had combined images or altered contours.

Because the items in the PRQ loaded onto factors in a way that made sense statistically as well as ontologically and photographically, no changes were made to this instrument as a result of the pilot stage analyses.

## Photographic Knowledge Questionnaire

Following the joint questionnaire's PRQ section, the same 39 participants completed the PKQ section. A unique part of the PKQ for the pilot stage was the accompanying Response Process Survey embedded within it. The purpose of this survey was to assess participants' thought processes as they answered the questions that made up the PKQ to help establish the instrument's face validity.

### *Response Process Survey*

The Response Process Survey questions were embedded into the PKQ by placing a response process question immediately after each PKQ question in the same way the expert survey was embedded in the PKQ and PRQ during the preparatory stage. For example, the first question in section G (G1) of the PKQ asks, *If I wanted to learn more about how to print photos, which of these would be the best option?* This question was immediately followed by this response process question: *Was the last question clear and understandable?* The participants could select one of these four answers: *(4) Extremely clear, (3) Somewhat clear, (2) Somewhat unclear,* or *(1) Extremely unclear.* Again, the purpose of asking these response process questions was to help determine participant thought processes as they answered the PKQ questions. This was done to establish the response process or face validity of the PKQ instrument.

The statistical result of these response process questions is a face validity index or FVI. The response process questions associated with the PKQ were given an I-FVI (item face validity index) score. This score was based on the proportion of participants who gave that questionnaire item a clarity and comprehensibility score of 3 or 4 (3 =

*somewhat clear* or 4 = *extremely clear*). The statistic is obtained by giving a "1" to an item for each participant who rates it a 3 or 4 and a "0" for each participant who gave it a 1 or 2 (0 = *extremely unclear* or 1 = *somewhat unclear*). All those 1's and 0's were added up and divided by the number of participants in the study. For Response Process Surveys that are administered online, like the one included in this study, it is recommended that each item receive a rating of .80 or above (Yusoff, 2019). The scores for each of the items on the PKQ are shown in Table 9.

**Table 9**

*PKQ I-EVI Scores by Item*

| Section | Item | I-EVI Score | Section | Item | I-EVI Score |
|---|---|---|---|---|---|
| A | 1 | .84 | | | |
| B | 1 | .89 | E | 1 | .76 |
| | 2 | .82 | | 2 | .76 |
| | 3 | .71 | | 3 | .82 |
| | 4 | 76 | | 4 | .76 |
| | 5 | .74 | | 5 | .79 |
| C | 1 | .76 | F | 1 | .74 |
| | 2 | .87 | | 2 | .71 |
| | 3 | .89 | | 3 | .76 |
| | 4 | .84 | | 4 | .82 |
| | 5 | .87 | | 5 | .84 |
| D | 1 | .82 | G | 1 | .82 |
| | 2 | .76 | | 2 | .76 |
| | 3 | .76 | | 3 | .84 |
| | 4 | .89 | | 4 | .92 |
| | 5 | .79 | | 5 | .82 |
| PKQ S-FVI | | .80 | | | |

Most of the items in the PKQ did achieve an I-FVI number above .80, and those below the .80 threshold were less than a tenth of a point below it. The lowest rating that any item received was .71. The S-FVI, which is the FVI score for the overall PKQ, was

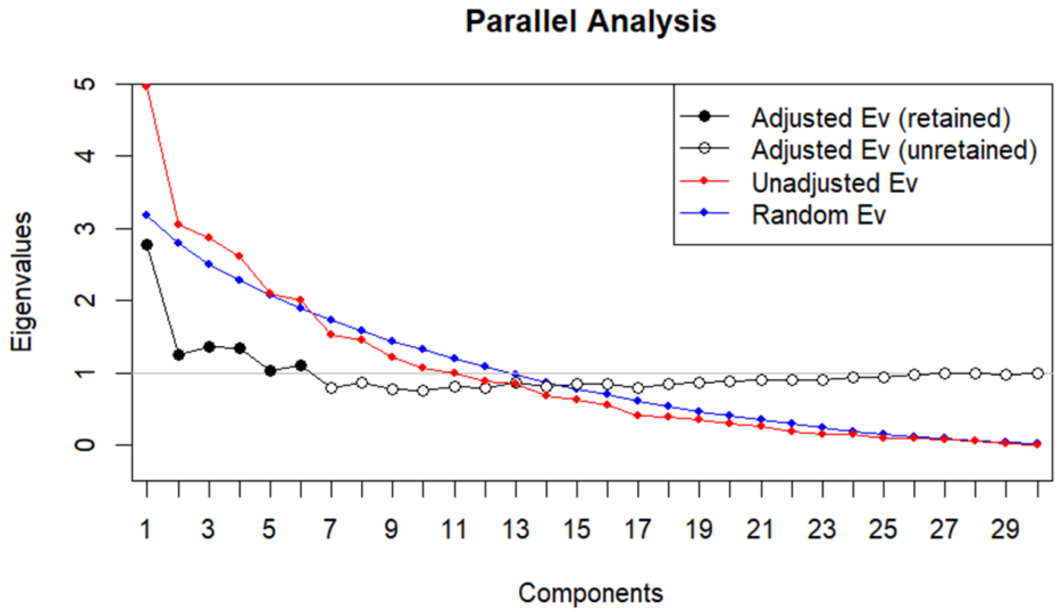
.80, right at the lower limit for an acceptable score. Although some of the I-FVI scores were below the .80 threshold, there did not appear to be any pattern of low scores occurring consistently in any one section or consistently across any set of like item numbers (all the number fours, for example, B4, C4, D4, etc.). Such a pattern of low scores might have indicated a group of related items that all needed to be changed. However, as noted, no such pattern was evident, so it was unclear how those items that scored just below the .80 I-FVI threshold might be rewritten to make them score higher. As a result, it was decided to move ahead without altering any of the questionnaire items.

### *PKQ Pilot Test EFA*

After the Response Process Survey was scored, an EFA was performed using the participants' answers on the PKQ. This EFA-generated scree plot is seen in Figure 2, which indicates that a six-factor model would best describe the PKQ pilot test stage data. However, when a factor analysis was attempted with six factors, the resulting key statistics were, overall, weaker than those same statistics from an analysis with five factors. A five-factor solution also worked better conceptually than a six-factor solution as it aligns more closely with the epistemic dimensions model on which the PKQ was designed. Going forward, a five-factor solution was used in place of the six-factor solution suggested by the scree plot.

**Figure 2**

*Scree Plot of PKQ Pilot Test*




The key statistics resulting from the EFA performed on participants' responses to the PKQ in this pilot stage are shown in Tables 10 and 11. As with the tables describing the PRQ results, Table 10 contains the Eigenvalues, Cumulative Variance, and Cronbach's alpha for each factor, while Table 11 contains Bartlett's Sphericity, KMO, and a composite of the questionnaire's Cronbach's alpha rating.

**Table 10**

*PKQ Pilot Test EFA: Eigenvalues, Cumulative Variance and Cronbach's Alpha*

| Factors | Eigenvalue | % of variance | Cumulative % | Cronbach's alpha |
|---|---|---|---|---|
| Justification | 2.80 | .10 | .10 | .78 |
| Certainty | 1.27 | .10 | .19 | .71 |
| Source | 1.36 | .09 | .28 | .71 |
| Connectivity | 1.34 | .08 | .36 | .74 |
| Simplicity | 1.11 | .07 | .43 | .48 |

Some of the key statistics summarized in the previous tables met the minimum suggested levels mentioned earlier in this chapter, with some of them being more than adequate. Bartlett's Test of Sphericity, for example, indicated the correlations in the data from the pilot test PKQ warranted a factor analysis. Other statistics, like the cumulative variance or Kaiser-Meyer-Olkin factor adequacy level, however, were quite low. However, this may have been due to the sample size of the pilot test. As a result, it was determined that the field test, with a larger population, may strengthen these statistics.

**Table 11**

*PKQ Pilot Test EFA: Other Key Exploratory Factor Analysis Statistics*

| **Key EFA Statistic(s)** | **Pilot Test Statistics** |
|---|---|
| Bartlett's Test of Sphericity | p < 2.22 e-16 |
| Kaiser-Meyer-Olkin Factor Adequacy | 0.21 |
| Cronbach's Alpha (Composite) | 0.78 |

*Note:* e-16 indicates 2.22 x 10-16 or 0.000000000000000222

The way in which the items in the PKQ loaded onto the five factors mentioned earlier in this chapter is shown in Table 12. Like the pattern matrix in the PRQ pilot test stage section, Table 12 shows how each item loaded onto each of the five factors. This was done to show the factors onto which each item loaded most strongly and to demonstrate the relative simplicity of the solution offered by this EFA. It also shows the names chosen for each of the factors. These names are derived from the Hofer and Pintrich model of personal epistemology, the conceptual foundation on which the PKQ was designed. This model consists of four dimensions: *source, simplicity, justification*, and *certainty*.

**Table 12**

*Results From a Factor Analysis of the Photographic Knowledge Questionnaire (PKQ)*

| | Item | Factor Loading 1 | 2 | 3 | 4 | 5 | Communality |
|---|---|---|---|---|---|---|---|
| B1 | If I wanted to learn more about the rule of thirds, which of these would be the best option? | **.50** | -.14 | -.74 | -.27 | .08 | .68 |
| C1 | If you wanted to learn how to use a tripod, which of these would be the best option? | **.34** | .12 | -.04 | -.01 | .13 | .18 |
| D1 | If you wanted to learn about ISO, which of these would be the best option? | **.55** | -.14 | -.14 | .13 | -.09 | .33 |
| E1 | If I wanted to learn more about repetition, which of these would be the best option? | **.83** | -.09 | -.11 | -.06 | .01 | .66 |
| F1 | If I wanted to learn more about aperture, which of these would be the best option? | **.78** | -.17 | -.05 | -.01 | .00 | .57 |
| G1 | If I wanted to learn more about how to print photos, which of these would be the best option? | **.34** | .32 | .07 | -.03 | .13 | .33 |
| B2 | Which of these options would be the best way to demonstrate that I've learned about the rule of thirds? | .12 | **.36** | -.53 | -.14 | -.17 | .43 |
| C2 | Which of these options would be the best way to demonstrate that I've learned how to use a tripod? | .25 | **.46** | -.35 | -.03 | .15 | .48 |
| D2 | Which of these options would be the best way to demonstrate that I've learned about ISO? | .16 | **.23** | -.13 | .16 | -.17 | .16 |
| E2 | Which of these options would be the best way to demonstrate that I've learned about repetition? | -.13 | **.44** | -.17 | -.07 | .10 | .23 |
| F2 | Which of these options would be the best way to demonstrate that I've learned about aperture? | -.25? | **.69** | -.07 | .17 | .11 | .57 |
| G2 | Which of these options would be the best way to demonstrate that I've learned how to print photos? | .08 | **.57** | .09 | .13 | .07 | .43 |
| B3 | Is it easy or difficult to understand the rule of thirds? | -.18 | .25 | **.35** | -.15 | -.03 | .22 |

| | Item | Factor Loading 1 | 2 | 3 | 4 | 5 | Communality |
|---|---|---|---|---|---|---|---|
| C3 | Is it easy or difficult to understand how to use a tripod? | .09 | .06 | **.20** | -.48 | -.03 | .30 |
| D3 | Is it easy or difficult to understand ISO? | -.16 | **.64** | .00 | -.02 | -.15 | .37 |
| E3 | How easy or difficult is repetition to understand? | -.03 | **.41** | .04 | .04 | -.03 | .19 |
| F3 | Is it easy or difficult to understand aperture? | .08 | **.66** | .19 | -.12 | -.16 | .47 |
| G3 | Is it easy or difficult to understand how to print photos? | .15 | .15 | **.41** | -.39 | .07 | .42 |
| B4 | How connected is the rule of thirds to the other concepts and skills in photography? | .00 | .07 | .03 | **.86** | -.05 | .74 |
| C4 | How connected or disconnected is using a tripod to the other concepts and skills in photography? | -.04 | .02 | -.23 | .20 | **.67** | .57 |
| D4 | How connected or disconnected is ISO to the other concepts and skills in photography? | .04 | .09 | .14 | **.65** | .12 | .51 |
| E4 | How connected is repetition to the other concepts and skills in photography? | .13 | .01 | .22 | **.63** | -.14 | .41 |
| F4 | How connected is aperture to the other concepts and skills in photography? | -.25 | .21 | -.31 | .18 | **.52** | .52 |
| G4 | How connected is printing photos to the other concepts and skills in photography? | -.08 | .30 | .16 | -.06 | **.69** | .70 |
| B5 | How likely is the rule of thirds to change at some point in the future? | -.05 | -.14 | .09 | -.01 | **.61** | .37 |
| C5 | How likely is the use of tripods to change at some point in the future? | .13 | .04 | .32 | **.41** | .37 | .52 |
| D5 | How likely is ISO to change at some point in the future? | .37 | -.01 | **.52** | .19 | .07 | .49 |
| E5 | How likely is repetition to change at some point in the future? | -.12 | -.16 | .27 | -.11 | **.46** | .32 |
| G5 | How likely is printing photos to change at some point in the future? | .25 | -.11 | -.14 | -.11 | **.67** | .49 |

*Note: N=39*. The rotation method was an oblique, promax rotation. Boldface indicates highest factor loading

Analysis of the factor matrix in Table 12, along with the earlier scree plot, indicates the items that were conceptually expected to align within a single simplicity factor instead loaded into two distinct factors. Questions 3 and 4 in each section of the PKQ were meant to address the dimension of *simplicity* within the dimensions of epistemic belief model. Those questions attempted to measure participants' personal epistemology regarding how simple or complex knowledge of photography is, as well as how interrelated that knowledge is. For example, item F3 reads, *Is it easy or difficult to understand aperture*? while Item F4 reads, *How connected is aperture to the other concepts and skills in photography?* The third item within each section of the PKQ is worded similarly to Item F3 in the example above and the fourth item within each section is worded similarly to item F4. Theoretically, both sets of items (#3 and #4 in each section) should load strongly onto a single, *simplicity* factor. However, most of the #3 items loaded together in one factor and most of the #4 items loaded together in a separate factor. As a result, it was decided to divide the s*implicity* factor into two factors, a *simplicity* factor for the #3 items from each section, and a *connectivity* factor for the # 4 items, as those items addressed how connected the photographic concepts and skills were perceived to be.

Unlike the PRQ EFA in this stage, the results in Table 12 were produced by using an oblique, promax rotation. Table 12 and Table 13, which is a factor correlation matrix, suggested that an orthogonal rotation solution would work with this data because the factors did not have significant correlations between them and because the items, for the most part, loaded strongly on only one factor each. However, a promax rotation was selected in this case because it provided a simpler solution in terms of how the items loaded onto the five factors used in this analysis. It was also selected because it was the option that allowed PKQ items to load onto factors in a sequence that most closely matched the Hofer and Pintrich model and because it allowed each factor to be loaded with a minimum of four items.

Table 13

*PKQ Pilot Test EFA: Factor Correlation Matrix*

| | Certainty | Source | Justification | Simplicity | Connectivity |
|---|---|---|---|---|---|
| Certainty | 1.000 | 0.272 | 0.205 | 0.159 | 0.145 |
| Source | 0.272 | 1.000 | 0.216 | 0.224 | 0.022 |
| Justification | 0.205 | 0.216 | 1.000 | 0.078 | 0.060 |
| Simplicity | 0.159 | 0.224 | 0.078 | 1.000 | -0.161 |
| Connectivity | 0.145 | 0.022 | 0.060 | -0.161 | 1.000 |

Table 12 is organized to show which factors each of the items in the questionnaire should have loaded onto most strongly, with all the #1 items together and all the #2 items together, and so forth. However, the items did not always load together in that way. Some of the items loaded more strongly with factors that were not associated with that item's question type. For example, D3 should have loaded strongly on the *simplicity* factor. Instead, it loaded strongly on the *justification* factor (.64). Also, some of the items that should have aligned strongly with the *connectivity* factor (for example, C4, F4 & G4) aligned more strongly with the c*ertainty* factor. This type of misalignment was the exception rather than the rule throughout all the questionnaire items, but it was a common problem across four of the five factors suggested by the EFA. In short, this factor matrix indicates a model in which all items did not fit neatly into their predetermined factors.

Despite this misalignment of some of the PKQ items, the decision was made to move onto the field test stage, with the changes noted previously, as most of the items loaded together in keeping with the instrument's design. Additionally, since there was no clear pattern of misaligned variables occurring in one common section or one common factor, it was unclear how the instrument might be changed to load all the items onto the conceptually correct factors.

## Field Test Stage

The Field Test stage used only confirmatory factor analyses performed on both the PKQ and PRQ. In each case, the factor structure suggested by the respective EFAs conducted in the pilot stage was used as the starting point for the CFAs conducted in this stage. In keeping with the procedures outlined in the Methods chapter, there were no Response Process Surveys embedded into either of the instruments in this stage as the instruments' face validity had already been established.

### Confirmatory Factor Analysis

A CFA seeks to confirm that a preconceived set of factors exists and determine the degree to which those factors are present in a given dataset. Typically, in a study using factor analyses, an EFA is conducted first to reveal the factors latent in the data; then a CFA is conducted on a different dataset derived from the same instrument to demonstrate the degree to which those factors are present. The key statistical measures produced by a CFA are a chi-square test for goodness of fit, a comparative fit index (CFI), a Tucker-Lewis Index (TLI), a root mean square error of approximation (RMSEA) and a standardized root mean square residual (SRMR) (Reichenheim, & Bastos, (2021). 2021, Wang 2022). Each of these key statistics, along with their recommended levels of acceptability, are included in Table 14.

**Table 14**

*Confirmatory Factor Analysis: Key Statistics*

| Key CFA Statistic(s) | Ideal Level(s) |
|---|---|
| Chi-Square Test for Goodness of Fit (*p* value) | ≥ 0.05 |
| Comparative Fit Index (CFI) | ≥ 0.90 |
| Tucker-Lewis Index (TLI) | ≥ 0.90 |
| Root Mean Square Error/Approximation (RMSEA ) | ≤ 0.05 |
| Standardized Root Mean Square Residual (SRMR ) | 0 = perfect, < 0.08 = good fit. |

## Field Test Sample Group

To begin this stage, Centiment was again tasked with recruiting the predetermined number of participants (minimum 100). Exactly 106 participants completed the PRQ and PKQ. Participants took the same combined questionnaires administered in the pilot test stage minus the Response Process Survey, which had been previously connected to the PKQ. The results were downloaded, and two CFAs were conducted, one with the PRQ results and one with the PKQ results.

Before taking the PKQ and PRQ, the field test group answered a section of demographic questions. Their responses showed that this group was also diverse: 59 identified as female, 43 as male, 2 as non-binary, and 2 preferred not to answer. Regarding race, 52 answered they were White, 31 were Black, 13 were Asian, 4 were Hawaiian, and 2 were American Indian, with 4 identifying as “Other” or preferring not to answer. This was a slightly older group than the pilot test sample, with 4 high school freshmen, 17 sophomores, 33 juniors and 52 seniors. Again, this information is not pivotal to this study, but it does show that the Field Test sample group represented many different demographic groups.

### *PRQ Field Test CFA*

The two-factor model suggested by the EFA conducted during the pilot test stage was used as the starting point for the CFA conducted in this stage. The key statistical results for the Field Test CFA are shown in Table 15.

**Table 15**

*PRQ Field Test CFA: Key Statistics*

| Key CFA Statistic(s) | Field Test Statistics |
|---|---|
| Chi-Square Test for Goodness of Fit (*p* value) | 0.14 |
| Comparative Fit Index (CFI) | 0.94 |
| Tucker-Lewis Index (TLI) | 0.92 |
| Root Mean Square Error/Approximation (RMSEA) | 0.04 |
| Standardized Root Mean Square Residual (SRMR) | 0.07 |

In general, these statistics demonstrated a good fit between the two-factor model (those factors being *transformed* and *constant*) and the PRQ instrument. All the levels of the key statistics in Table 15 met the minimum suggested levels. Additionally, these key statistics were better than the key statistics from the pilot test EFA, which was to be expected with a larger sample size and suggested an accurate reading of the PRQ's reliability and validity. It also showed that the poor KMO score in the pilot test EFA had no negative impact on the CFA results from the field test stage.

As noted in the pilot test section, there were two items that did not load strongly onto either of the two factors used in this CFA. Those were items RQ1 and RQ4. It is a common practice in such situations to remove items that do not load at an acceptable level from the data before conducting a CFA. That was attempted with the field test data, which was, of course, different from the pilot test data, where items RQ1 and RQ4 loaded at subpar levels. The resulting CFA (minus items RQ1 and RQ4) yielded weaker results in each of the key statistical categories than the statistics given in Table 15 for the whole dataset. Consequently, the results for the whole dataset, including items RQ1 and RQ4, are reported as part of this study.

### *PKQ Field Test CFA*

The results from the pilot stage EFA conducted on the PKQ results suggested a 5-factor model would best fit the data and should be subject to an oblique, promax rotation. However, as noted in the pilot test section, this approach would group together some items that were not intended to be epistemologically aligned. As a result, in this stage, two separate CFAs were conducted using the field test dataset. The first CFA was organized so that each item aligned with the factor onto which they loaded most strongly in the EFA results. Going forward, this will be called the *organic* model. In this model, most of the items loaded as expected, with all the question #1's loading together for example. There were some exceptions, however. For example, C3 loaded with the #4 items (B4, D4, E4, etc.) and G4 loaded with the #5 items.

It was expected that the first questions in each section (B1, C1, D1, etc.) would load together because all those questions were designed to address a common dimension of personal epistemology: *source*. Similarly, the second questions in each section (B2, C2, D2, etc.) were all designed to address another common dimension, *justification*, and the third questions (B3, C3, D3, etc.) were all designed to address s*implicity.* This same organization is true for the fourth and fifth questions in each section as well. The unexpected way in which the items loaded together on common factors seemed, at this point, to make statistical sense but presented a problem for the conceptual framework on which the PKQ, specifically, and this study, in general, was conceived. For this reason, a second CFA analysis was performed in this stage using an arrangement of items strictly in keeping with the Hofer and Pintrich model (dimensions of epistemic belief). This model will be referred to as the p*rescribed model* as it is arranged with the first question in each section grouped together in one factor (B1, C1, D1, E1, F1 & G1) and the second question in each section grouped together in the next factor following the sequence described previously. As there are five questions in each section, this model also involves five factors. The key statistical results of these two CFA's (*organic* and *prescribed*) are compared in Table 16.

**Table 16**

*PKQ Field Test - Key CFA Statistics*

| Key CFA Statistic(s) | Organic Model | Prescribed Model |
|---|---|---|
| Chi-Square Test for Goodness of Fit (*p* value) | 0.00 | 0.00 |
| Comparative Fit Index (CFI) | 0.67 | 0.74 |
| Tucker-Lewis Index (TLI) | 0.62 | 0.70 |
| Root Mean Square Error/Approximation (RMSEA) | 0.07 | 0.06 |
| Standardized Root Mean Square Residual (SRMR) | 0.09 | 0.08 |

Interestingly, the *prescribed* model slightly outperformed the *organic* model in each of the key statistical categories except for the chi-square *p* value, where they were the same. Still, none of the key statistical categories for either model of the PKQ reached the levels recommended for these various statistical measurements. Particularly problematic is the chi-square p-value for each CFA, which is essentially zero in every case. For the model to be considered a good fit, the p-value should be above 0.05.

## Research Questions

The purpose of the statistical analyses performed was to produce valid and reliable instruments to measure high school students' ontological beliefs regarding photographic reality and their epistemological beliefs regarding photographic knowledge.

### Research Question 1

Research Question 1 asked, *to what extent is an instrument designed to measure high school students' ontological beliefs regarding photographic reality valid and reliable?*

This research question was answered using the data from the field test administration of the Photographic Reality Questionnaire. As demonstrated in Table 15, the key statistics from the CFA performed in the field test stage indicate that this instrument was reliable as it met the recommended statistical levels in each of the statistical categories. Particularly strong is the chi-square *p* value, which indicates the strength of the fit between the proposed model and the data collected. This statistic is also important because it forms the basis for some of the other key statistics shown in Table

15 that, as mentioned, also indicate the strength of the model and the data derived from the PRQ. Taken together, these key statistics seem to indicate this instrument has satisfactory construct validity.

The reliability of the PRQ was demonstrated as part of the EFA conducted in the pilot test stage. The results of Cronbach's alpha analysis are shown in Tables 5 and 6. The Cronbach's alpha level for the PRQ overall (.69) is not quite at the recommended minimum level (.70), and the level of the items aligned together in the *constant* factor was even lower (.52). These levels would seem to give cause to question the reliability of the PRQ. Since these levels came from the pilot test stage, which involved only 39 participants, using a larger sample size might increase those numbers. That proved to be the case when a Cronbach's alpha coefficient was performed on the dataset from the field test. That dataset produced Cronbach's alphas of .71 for the instrument, .74 for the *transformed* factor, and .57 for the *constant* factor. While the c*onstant* factor was still low, it was better than the coefficient for that factor from the pilot test stage, as were the other coefficients. Most importantly, the composite Cronbach's alpha is .71, which puts it into the acceptable range.

## Research Question 2

Research Question 2 asked, *to what extent is an instrument designed to measure high school students' epistemological beliefs regarding photographic knowledge valid and reliable*?

Research question 2 was addressed through the factor analyses conducted on the data from the pilot test and field test administration of the PKQ. As was mentioned earlier, the EFA performed in the pilot test stage revealed an alignment of items with factors that were not in keeping with the model on which the PKQ was designed. However, aligning the items onto factors based strictly on the dimensions, which formed the foundation for the PKQ (the *prescribed* model), resulted in some slightly stronger statistical outcomes than did aligning the items as suggested by the pilot test EFA (the *organic* model). Even so, the key statistical levels from the CFAs conducted using the *prescribed* and *organic* models were not that different, and neither model generated statistics that consistently met the recommended minimum levels for the key CFA statistics (Table 16 shows how those two different models compare.). This seems to suggest that, in its current state, the PKQ might not have sufficiently strong construct validity.

On the other hand, the reliability of the PKQ appears to be relatively strong. The overall Cronbach's alpha of this instrument is 0.78, safely above the 0.70 minimum acceptable level for that test. The items assigned to the various factors also achieved acceptable Cronbach's alpha levels except for the *simplicity* factor, which achieved only 0.48. Still, the reliability of the PKQ would have to be considered satisfactory based on the instrument's overall Cronbach's alpha level.

## Chapter IV Summary

Overall, the three test stages (preparatory, pilot test and field test) went as anticipated. No changes to either of the two test instruments or any of the items in those instruments were deemed necessary. The key statistical results for the EFAs and CFAs conducted in the pilot test and field test stages, respectively, did not always meet the suggested levels to be considered satisfactory. For both the PRQ and PKQ, in the pilot test stage, the key EFA statistics were a mixed bag. For both instruments, the Eigenvalues and Bartlett's test of sphericity were consistently strong, while the cumulative variance for each instrument was below the recommended standards, and the Kaiser-Meyer-Olkin factor adequacy was uneven, with the score on the PKQ being quite poor.

The CFA results, however, were different depending on the instrument. The key statistics resulting from the CFA conducted on the PRQ were quite strong, meeting essentially all the recommended levels. Conversely, the PKQ key statistics from the field test stage were poor. Still, these PKQ key statistics were generally better than some other similar studies of personal epistemology that were considered successful (Cazan, 2013; Koksal & Ertekin, 2016). The five-factor model derived from the PKQ's pilot test EFA coincided more accurately with the actual data collected when the simplicity dimension was divided into two factors, one for each of the different types of *simplicity* questions contained in each of the six sections of the PKQ. The EFA results did not indicate that the Hofer and Pintrich (or *prescribed*) model would be a viable solution but using it as the model for one of the CFAs performed in the field test stage resulted in stronger key statistics than using the model which the EFA results indicated (the o*rganic* model).

It should be noted here that the statistical strength of many of the key EFA and CFA statistics was stronger for the PRQ than they were for the PKQ, especially for the field test CFA, indicating that the underlying factorial model for the PRQ is perhaps stronger than the model underlying the PKQ. That is interesting because the PKQ was constructed on the established Hofer and Pintrich model (the dimensions of *source, justification, certainty,* and s*implicity*). The PRQ, on the other hand, was not built on any existing model of personal ontological beliefs as no such model is known to exist independent of a model of personal epistemology (Hofer & Pintrich 1997, Schraw 2013). The reasons for this surprisingly strong, unplanned model of photographic/ontological factors will be discussed further in Chapter V.

# CHAPTER V

# DISCUSSION

## Chapter Overview

This study was an attempt to establish the validity and reliability of two research instruments: one designed to measure the personal ontological beliefs of high-school-age students and the other designed to measure their personal epistemological beliefs. This chapter contains a synopsis of the study, a review of the findings, the conclusions based on those findings, and recommendations for future research in personal epistemological and ontological beliefs.

## Summary of Findings

In this section, the statistical evidence regarding the validity and reliability of the two instruments designed to assess the research questions for this study will be discussed: the Photographic Reality Questionnaire (PRQ) and the Photographic Knowledge Questionnaire (PKQ).

### Research Question One

To what extent is an instrument designed to measure high school students' ontological beliefs regarding photographic reality valid and reliable?

***Validity***

This section discusses the findings of this study relative to the validity of the PRQ, as it was the instrument designed to address the first research question.

**Face Validity.** The face validity for the PRQ was measured mainly through the comments made by a panel of experts regarding each item in this instrument. Those specific comments were largely undisclosed during Chapter IV, as none of them suggested any pertinent changes to the items in the PRQ. In fact, the comments section following each of the items on the version of the PRQ given to the panel of experts was most often left blank. At the same time, some comments were made that were not feasible or did not meet the purposes of the PRQ. Consequently, those comments were set aside. All credible indications were that the PRQ has an adequate level of face validity.

**Content Validity.** The ratings given by the panel of experts regarding how essential or non-essential each item was on the PRQ formed the basis for the instrument's content validity. According to the content validity ratio (CVR), the procedure used to rate these items (Taherdoost, 2016), a 1 represents a perfect score, with a score of .62 being the minimum allowed for an item to be considered acceptable. Of the 15 items in the PRQ, 13 of them were given a perfect CVR score of 1 and two of them were given a score of .67. Consequently, the PRQ can be considered to have satisfactory content validity. The ratings given to each of the PRQ items are shown in Table 2 in Chapter IV, and a more detailed explanation of the content validity ratio is also included in that chapter.

**Construct Validity.** This type of validity is established through the key statistics that resulted from the EFA performed during the pilot test stage and the CFA performed during the field test stage. Most of these key statistics met the minimum levels of acceptability with some of them being significantly above the minimum level. Good examples of the latter case are Bartlett's Test of Sphericity ($p = 0.00006$), the chi-square p value (0.14) and the root mean square error of approximation (0.04). In some cases, these key statistics were not consistent with the other statistics with which they should have been more closely aligned. For example, Bartlett's Test of Sphericity and the Kaiser-Meyer-Olkin are both measures of a given dataset's potential for viable results through factor analysis. In the case of the PRQ, the result from Bartlett's Test was quite good; whereas, the result from the KMO was merely adequate.

A more concerning case of inconsistency is the relationship between the cumulative variance of the factors indicated by the EFA and the strength of the eigenvalues connected to those two factors (2.15 and 1.34). The cumulative variance is really the only key statistic that is in the sub-standard range (0.37). Perhaps this statistic is low because of the three items (or variables) that didn't load cleanly onto either factor in the EFA conducted during the pilot test stage (RQ1, RQ4 and RQ11). Variables included in a factor to which they don't statistically belong can adversely affect the cumulative variance in an Exploratory Factor Analysis (EFA) (Morse, 2022). The group of problematic items only includes three, but there are only 15 items in the questionnaire and the cumulative variance is only 13 points below the 0.50 minimum acceptable level. Perhaps if those items were removed from the EFA, which is a somewhat common practice in exploratory factor analyses (Morse, 2022), the cumulative variance would be satisfactory. Another plausible reason for the low cumulative variance level is the small number of factors selected for the EFA. As described in Chapter IV, when an EFA utilizing a four-factor solution was conducted on the pilot test stage dataset, the cumulative variance rose to an acceptable level. Ultimately, a four-factor solution was not adopted because the resulting factor loadings were not sufficiently strong, and the arrangement of factors did not make sense ontologically or photographically.

Despite the low cumulative variance, the PRQ appears to have adequate content validity because all the other key statistics are either just above the minimum level of acceptability or well above that level. It should be noted that the cumulative variance was produced by the EFA performed during the pilot test stage and that the key statistics from the CFA in the subsequent field test stage all met the minimum levels of acceptability. So, it appears that this sub-par EFA statistic was likely also related to population size in addition to the issues related to cumulative variance discussed previously.

**Criterion Validity.** The design of this study did not address this type of validity and instead left it as an issue for future research, as noted at the end of Chapter II. This type of validity could have been addressed by a statistical regression involving participants' PRQ scores and their grades in a photography class and/or their level of photo editing experience. It also might have been established by comparing participant results on this questionnaire to the results of an established questionnaire concerned with the same content. However, no such similar questionnaire exists. While this type of validity was not addressed in this study, it is mentioned here because it will be considered in the recommendations for future research section.

### ***Reliability***

The reliability of the PRQ was addressed through the Cronbach's alpha coefficient. The alpha statistics for this instrument were generally close to the minimum level of acceptability on both sides of that line. In the pilot test stage, the overall Cronbach's alpha level for the PRQ was 0.69, just below the established minimum level of .70. The alpha level for each of the two factors separately was .72 for the *transformed* factor and .52 for the *constant* factor.

However, these levels were higher in the Cronbach's alpha analysis conducted in the field test stage. In that analysis, the overall alpha level was .71, and the alpha levels for each of the factors separately were .74 for the *transformed* factor and .57 for the *constant* factor. Given that better results came from an analysis of the instrument given to a larger sample group, these results should be considered more accurate as larger samples are considered to generate more accurate results than those generated by smaller samples. As such, the PRQ can be considered to meet the acceptable level of reliability.

### ***Summary of the PRQ's Validity and Reliability***

Based on the indicators mentioned in the previous paragraphs, the results of this study show the PRQ is a valid and reliable instrument for measuring the personal ontological beliefs of high school age students relative to a series of photographs. Admittedly, this is not a widely useful questionnaire; neither is the format used to design it. It is only applicable in photography and only in judging photographic reality. However, this instrument may provide a model for other content areas and, more generally, these findings have implications for future research involving models of personal ontological beliefs.

## Research Questions Two

To what extent is an instrument designed to measure high school students' epistemological beliefs regarding photographic knowledge valid and reliable?

### *Validity*

**Face Validity.** Like the PRQ, the face validity of the PKQ was established by the results of the survey given to the panel of experts. As was the case with the PRQ, most of the experts made no comments regarding the formatting or wording of any of the questions and, as was demonstrated in Chapter IV, most of the comments that were made did not concern things that should have been or could have been changed about the questionnaire's items or the questionnaire's overall construction and appearance. Unlike the PRQ, however, the PKQ also had a Response Process Survey that was built into the pilot test stage version of the questionnaire. As was explained in both Chapters III and IV, the purpose of this survey was to record students' response process to the items in the questionnaire as they completed it, as a way of determining if the items were written clearly and if participants felt they knew how they were supposed to answer the questions. This survey generated a face validity index (FVI) score between 1 and 0 for each item in the questionnaire, with an I-FVI (item-level) score of .80 or higher considered acceptable. The results of the survey indicated that 16 of the 31 items in the PKQ had an I-FVI score over .80. Of the 15 items that did not reach the benchmark level of .80, 11 scored above .75, with two items tying for the lowest score of .71. So, although many of the items scored below the level considered to be acceptable, they did not score much below that level. Also, the instrument as a whole received an S-FVI (scale-level) score of .80, just within the acceptable range.

Consequently, between the results of this Response Process Survey and the results of the survey given to the panel experts, the PKQ was considered to have acceptable but not conclusive face validity. The results of the Response Process Survey given with the PKQ in the pilot test stage are shown in Table 9 of Chapter IV.

**Content Validity.** As was the case with the PRQ, the content validity of the PKQ was assessed through the use of a survey given to the panel of experts in which they were asked how essential they felt each of the questionnaire's items was. Again, the items received a score between 1 and 0, with .62 being the minimum score considered acceptable (Taherdoost, 2016). In the case of the PKQ, each of the items received a score above that minimum threshold, with 22 of the 31 items receiving a perfect score of 1. Of the remaining items, four items tied with the lowest score of .67, which is still above the established minimum. The PKQ was, therefore, considered to have an acceptable level of content validity.

**Construct Validity.** The construct validity of the PKQ was established through the key statistics derived from the EFA conducted in the pilot test stage and the CFA conducted in the field test stage. As a reminder, because of the way in which the items from this instrument loaded together on various factors in the EFA, it was decided to conduct two parallel CFAs during the field test stage. The item groupings or models for these parallel CFA's were entitled the *organic* model and the *prescribed* model. For a more detailed explanation of this process, see the pilot test section of Chapter IV.

The key statistics for the PKQ from the pilot test and field test stages proved to be a mélange of satisfactory and unsatisfactory scores that made a conclusive decision regarding the construct validity of this instrument problematic. A couple of the key statistics generated by this questionnaire were above or well above the level considered acceptable. One example would be the Bartlett's Test of Sphericity ($p < 2.22e\text{-}16$). However, many of the other key indicators of the PKQ's construct validity were not particularly good. Some were just below the minimum acceptable level, like the standardized root mean square residual (0.092 for the *organic* model and 0.082 for the *prescribed* model), which should be below 0.08 to indicate a "good fit." Others are well below the acceptable minimum. For example, the Kaiser-Meyer-Olkin factor adequacy score for this questionnaire was 0.21, where it should be above 0.50. Also problematic is the chi-square *p* value, which, unlike other p values, should be above 0.05 and instead measure 0.000 for both the *organic* and *prescribed* models. Looking at these statistics together makes it difficult to claim that the PKQ has a satisfactory level of construct validity.

**Criterion Validity.** As was the case with the PRQ, this study did not involve analyses that would establish the PKQ's criterion validity. By design, this study is focused more on the face, content, and construct validity, leaving criterion validity for potential future research.

***Reliability***

The reliability of the PKQ was generally found to be at an acceptable level. The Cronbach's alpha coefficients for each of the five factors used in the pilot stage EFA were above the minimum acceptable level of .70 except for the s*implicity* factor, which measured at .48, well below the acceptable minimum level. However, the overall Cronbach's alpha coefficient for this instrument was .78. The PKQ can then be considered to have, generally, an acceptable level of reliability.

***Summary of the PKQ's Validity and Reliability***

Based on the statistical findings, the PKQ needs revision and further testing to become a valid instrument. As noted earlier, it did have a few key statistics that indicate it is a valid instrument, but there are other key statistics that place its validity in doubt. Furthermore, the way the items in this questionnaire loaded together on different factors in the pilot test EFA was not consistent with the conceptual framework on which the instrument is based. Because of this unexpected combination of items indicated by the EFA, two versions or models of factor loadings were used in the field test CFA: an *organic* model based on the factor loadings from the EFA, and a *prescribed* model based on the way the items were supposed to be aligned based on this study's conceptual framework. Generally, the key CFA statistics from the *prescribed* model were better than those same statistics from the *organic* model. For example, the comparative fit index, which should measure above 0.90 to be considered acceptable, measured at 0.67 for the *organic* model and 0.74 for the *prescribed* model. This is consistent with most of the key statistics, where, in most cases, the level achieved by the p*rescribed* model is better than the level achieved by the *organic* model. Even so, the levels from both models were usually below the acceptable minimum for those key statistics, again indicating that the validity of this instrument is questionable.

## Conclusions

### Personal Ontology

It is clear that this study produced more conclusive results regarding personal ontologies than it did about personal epistemologies. Much of this conclusion is based on the relative strength of the statistics produced by the PRQ compared to those statistics produced by the PKQ. Also, the factor loadings indicated by the pilot test EFA of the PRQ aligned the items of that questionnaire in a way that made statistical and ontological sense. That is, the items containing photos that had not been noticeably altered in any way other than color loaded together and those items containing photos that had been altered in ways that involved contours or imagery all loaded together. This seems to indicate that the instrument could consistently gauge participants' perceptions of these photographs' type and perhaps level of alteration.

Beyond a discussion of the apparent strength of the PRQ, the results produced by this instrument also suggest that personal ontological beliefs can be measured and studied separately from personal epistemological beliefs. Granted, the PRQ is a simple questionnaire that asks the same basic question about the reality of 15 photographs. It is hardly a design that could be replicated in other disciplines. Still, it did produce consistently better results than the PKQ, which, like many similar instruments, was designed to measure participants' personal epistemological beliefs. This seems to suggest that personal ontologies can be measured using methods like those that have been used to measure personal epistemologies for the past five decades. How such research might be organized and conducted will be discussed in the Recommendations of Future Research section of this chapter.

### Weakness of the Photographic Knowledge Questionnaire

While the PRQ results were fairly strong statistically, the PKQ results were not. The instrument did have an acceptable reliability score, demonstrating internal consistency, however, the instrument validity analysis, or accuracy, was poor. As shown in the last section, the key statistics resulting from the PKQ often failed to reach the recommended minimum level needed to consider it valid. Consequently, one would have to conclude that this study did not produce any evidence as to the efficacy of domain-specific personal epistemology questionnaires. The PKQ was unique in that its questions were designed to ask specific questions about specific skills and concepts used in photography. The thinking was that this design would produce stronger results than previous personal epistemology questionnaires because the questioning would be clearer to participants. The results of the Response Process Survey, which was a measure of the instrument's face validity, showed the overall instrument and most of the individual items in the PKQ scored above the minimum I-FVI threshold of .80, but not all did. So, the participants' perceptions of the questionnaire's items were that not all of them were completely clear or comprehensible. That, coupled with the results of the PKQ EFA and CFA, leads to the conclusion that this study fails to demonstrate conclusively that a self-reporting questionnaire containing very domain-specific items can accurately measure personal epistemic beliefs regarding photography. In practical terms, this suggests the instrument is producing consistent scores, but these scores did not accurately reflect the underlying concept being measured. This discrepancy between reliability and validity suggests that the instrument needs further refinement to assess the intended epistemological construct more accurately.

## The Conceptual Framework

Additionally, the inconsistent results from the PKQ also cast doubt as to the viability of the combined Hofer and Pintrich/Schraw models, which were the basis for the conceptual framework of this study. To be clear, the PKQ was only built around the Hofer and Pintrich model of personal epistemological dimensions. The combination of that model with the Schraw model of epistemic positions or world views, which was proposed in Chapter II, was something this study did not actually tackle in a statistical sense. However, if one part of the proposed combination is theoretically inconclusive, it would be difficult to consider the combined model viable based on this study. This inconclusiveness may exist because both the Hofer and Pintrich model and the Schraw model were designed to describe general epistemic beliefs, making their combination unsuitable for gauging domain-specific epistemic beliefs.

## Specific Questioning

While the key statistics resulting from the PKQ did not consistently reach acceptable levels, they were still better than the key statistics from other similar studies of personal epistemology, which were considered by their authors to be successful (Cazan 2013; Koksal & Ertekin, 2016). Still, the purpose of this study was to develop an improved instrument that addresses the issues leading to poor results in previous studies. Specifically, the design of the PKQ, the very specific nature of its questioning and the similarity and connectivity of items across the different sections of the questionnaire were supposed to extract more consistent answers from participants due to their lack of confusion. So, even though the results from the PKQ were better than the results from some previous studies, they were not good enough to claim that the instrument is convincingly valid, that it was built on a strong conceptual framework or model or that it's very specific, domain-centric question design was particularly effective.

**Practical Application**

In Chapter II, two ideological approaches for applying the conceptual framework behind this study to classroom instruction were proposed. It is generally acknowledged by researchers of personal epistemology that individuals with more sophisticated, nuanced personal epistemologies tend to learn better and have better academic success than individuals with more basic, concrete personal epistemic beliefs. Both ideological approaches would attempt to move students from a set of simpler, *realist* epistemic beliefs to a more *contextualist* or *relativist* set of beliefs. Where they differ is in how to accomplish this advancement. One approach would be attempting to directly change students' personal epistemic beliefs in order to help them develop their knowledge base. This could be accomplished through instructional methods like teaching cognitive processing strategies or critical thinking skills. The other approach would be to increase students' knowledge and experience base to help them move from one stage to the next. This could be accomplished through constructivist teaching methods that help students make their own connections between what they know and what they are learning, as well as making connections across courses and disciplines.

Another consequence of the relatively poor showing of the PKQ in terms of its key statistics is that it is impossible to draw any conclusions as to which of these approaches might be more effective. Had the PKQ's results been better, the conclusion could be that it is a valid instrument and the model it was built on (Hofer and Pintrich, 1997) might appear to be an effective one. If that had been the case, the PKQ might have been used to determine which teaching strategies effectively advance students' epistemological beliefs regarding photography and, consequently, which of the ideological approaches mentioned previously might be most effective. As things stand, however, it would be difficult to imagine successfully using the PKQ in any of those ways.

## Limitations and Delimitation of the Study

In Chapter I, the limitations and delimitations of this study regarding its design and methodology were discussed. In this section, the possible impact of these limitations and delimitations is discussed.

A miscalculation on the part of the researcher was the decision not to include an assessment of the instruments' criterion validity in the study's methodology. As this study was designed, it was decided that its focus should be the validity and reliability of the PKQ and PRQ. It was further decided that demonstrating how participants' scores on these instruments might vary based on their level of previous, formal photography experience or how their scores might be predictive of their photography class grades or test scores would be left for subsequent research, as was stated in the Delimitations section of Chapter I. Perhaps not including a method for measuring the research instruments' criterion validity was a mistake. This type of validity could have been gauged through linear regressions involving participants' PRQ and PKQ scores with their self-reported experience in photography and photography classes and/or their photography class grades.

Participants' experiences with photography and photography classes were data that was gathered through the brief demographic survey, which participants answered prior to taking the PRQ and PKQ questionnaires in both the pilot test and field test stages. Gathering participants' photography class grades for use in linear regressions would have been more difficult; perhaps a self-reporting set of questions regarding participants' grades would have worked. Either way, it seems that some measure of criterion validity might have been added to this study, which could have added another level of certainty, one way or the other, to the existing statistical results that were, in some instances, inconclusive.

Another issue of delimitation mentioned in Chapter I is that of sample size. The sample sizes used in both the pilot test stage and the field test stage were in keeping with the number of participants recommended by experts in establishing instrument validity and reliability (Pernegar et al., 2014; Ruel et al., 2016). However, it should be noted that the statistics generated in the field test stage, which had a larger sample size, were generally better than the statistics from the pilot test stage. It seems possible that if the sample sizes for both stages had been larger, the statistical results might have been more significant and, as is usually the case with larger sample sizes, more accurate.

Consideration might also have been made for the factor analyses that were conducted in this study. Studies involving factor analyses typically have larger sample sizes than studies that use other methods to establish an instrument's validity. The sample size of a study, which utilizes a factor analysis, is often determined by the ratio of participants to the number of variables (or, sometimes, the number of factors) in those analyses. Using such a method can result in sample sizes of 300 to 1000 or more (Arrindel & van der Ende, 1985: Comrey & Lee, 1992; Hatcher & O'Rourke 2013). Sample groups of that size would have been outside the budget for this study. Still, using the relatively small sample size of around 100 in the field test, although it was the size recommended, might have been a factor in the resulting findings related to the instruments' validity and reliability.

## Recommendations for Future Research

### Future Research Involving the PRQ

The most compelling findings from this study involve the statistical strength of the PRQ as a research instrument. The strength of the PRQ combined with the relative weakness of the PKQ suggests that participants' ontological beliefs were measured independently of their epistemological beliefs. If this is the case, perhaps a theoretical model of personal ontological beliefs, separate from those of personal epistemology, is warranted. Such a model could be developed using methods similar to those used to develop models of personal epistemology. Often, those models are created based on a conglomeration of existing personal epistemology research studies. The authors will pick out pieces of evidence to back up the theoretical foundation on which their model is based and present their reasoning behind how the model is organized. This method is not possible for developing a model of personal ontology at this point because a body of such research does not exist.

Perhaps the best example to follow in creating a model of personal ontology would be the methodology employed by Perry in creating his original model of epistemic positions (Perry 1970). His original research, as described briefly in Chapter II, was a longitudinal, qualitative study in which he conducted yearly interviews with a group of undergraduate students. The students' answers revealed to Perry the common, underlying, epistemic beliefs they held about their own learning experiences. From these interviews, Perry developed his original theory of epistemological positions or stages through which people progress due to experience and maturation. This method could be followed as a way of creating a theoretical model of personal ontologies. The research might start with a longitudinal study which follows a group of participants through their high school and/or college years. Participants would be interviewed at regular intervals, perhaps once or twice a year from their freshman to senior years. The students would be asked open-ended questions about their perceptions of the reality around them and how those perceptions impact their educational experiences. For example, they might be asked a domain-specific question like, *What makes this photograph real (or unreal)* or a general question like, *What is the difference between a person and a computer or Are you on the same level as your teacher(s)?* From there, the student answers would be analyzed to look for common responses and to see if patterns emerge based on age, experience, or other common demographics. This would take some time to accomplish, but it may be worth the effort. Researchers have consistently found that personal epistemic beliefs impact student learning and achievement; perhaps personal ontological beliefs will be found to have a similar impact.

This potential impact of ontological beliefs on academic achievement also suggests the potential for a smaller but still important piece of research that was mentioned in the limitations section of this chapter and also at the end of both Chapter II, that being the correlation between PRQ results and participants' level of photo experience and their photography course grades. As was stated in that prior section, this would be a way of establishing the criterion validity of the PRQ. It will also help demonstrate if photography students with more experience and/or those who have higher grades and test scores have a more nuanced perception of the reality of the photographs in that instrument than those students with lower grades and/or less photography experience. That would be a key step in connecting more sophisticated ontological beliefs with higher academic achievement, as has been done in studies of personal epistemology.

Another potential topic for research along the lines of personal ontologies is the impact that learning to edit and manipulate photographs has on an individual's ontological beliefs regarding what is and is not real. As discussed in Chapter II, scholarly research has been done on the impact of a person's ontological beliefs on the ways in which they edit photographs. However, there appears to be no research on the impact that the practice of editing photographs has on an individual's perception of what is and is not real. Unlike the type of research suggested previously, this type of study would be relatively simple. It would involve two groups of photography students, one group that has had a series of lessons on how to edit photographs, specifically, how to change colors, how to add and subtract images, how to alter contours, etc. The other group would be made up of photography students who have had no photo editing instruction. At the end of the unit, both groups would take the PRQ, a valid and reliable instrument for measuring personal ontological beliefs regarding photography, and the results should show whether those students who have had formal photo editing instruction tend to have different, more sophisticated perceptions of which photographs they consider to be real and which they do not. The purpose of this type of study would be to show that students' ontological beliefs can be changed, possibly advanced, as a result of classroom instruction. The capacity to alter student's ontological beliefs would be more impactful if it could also be shown that students with more advanced ontological beliefs also experience greater academic success, which is the subject of the research proposed earlier.

**Future Research Involving the PKQ**

The weak results from the PKQ analyses indicate that changes would need to be made to make it a viable instrument. There are three elements of this study relating to the PKQ that could be altered in an attempt to make it a more valid and reliable questionnaire: (1) the theoretical model on which the PKQ is based, (2) the methodology used to assess the PKQ's validity, and (3) the wording of the items which constitute the PKQ.

Of those three options, a change in the underlying model on which the PKQ was based would be the most dramatic. This would likely require all the items to be rewritten to match the new model, and it could possibly require at least modest changes in the methodology used to validate the new version of this instrument. Additionally, a new model would have to be chosen or developed. Any model selected would need to better explain how individuals develop and hold personal epistemological beliefs regarding how knowledge is created or acquired, what justifies knowledge, and how bodies of knowledge are interconnected. Developing a new and better model would require a different conceptual approach and more research. As was suggested earlier in connection with the development of a model of personal ontology, perhaps a new model could be developed imitating Perry's original method of conducting a longitudinal study involving periodic interviews and open-ended questions. Developing a theoretical model in this way might be done using a grounded theory approach, beginning with no preconceived ideas and following where the data leads through a systematic analysis. The downside would be the amount of time required and the potential for researcher bias to work its way into the findings. In the end, given the results of this study as they concern the PKQ and previous studies done with the Hofer and Pintrich model, this approach may yield more solid findings.

Another possibility is to use a different methodology while still employing the same conceptual model that currently underpins the PKQ. This would likely mean a mixed-methods type methodology as the PKQ is a multiple-choice questionnaire, and choosing a strictly qualitative methodology would basically mean using an altogether different instrument. In a mixed methods methodology, the PKQ could be used in a form roughly equivalent to its current state coupled with a system of one-on-one or group interviews with participants. Those interviews might be best after participants have taken the PKQ and might consist of questions about why participants answered as they did, what they thought the questions were asking them and so forth. This approach may provide insight into item development, resulting in greater validity. This approach may also be a way to resolve possible issues with PKQ as an instrument without requiring an underlying conceptual change.

The third option for attempting to improve the PKQ's validity would be to identify items that students struggled with and examine these for possible rewording. Before accepting this alternative, something to consider is that the panel of experts polled at the beginning of this study indicated that the questions in the PKQ were "essential" and had a satisfactory level of content validity. On the other hand, the Response Process Survey indicated that the participants felt 15 of its 31 items in the PKQ might have some clarity issues as far as how they were written. So, rewriting some of the items on the PKQ could improve its validity, and this option might be considered in connection with the previous option involving a change in methodology. If interviews were conducted in concert with an administration of the PKQ, it might become evident which items need to be revised or abandoned.

Finally, in Chapter IV, it was noted that the PKQ was written at a grade level of 10.6, which is slightly above the target grade level of somewhere between the $9^{th}$ and $10^{th}$ grades. Perhaps if it were written at a lower grade level, it would also be easier to understand, and its results would be more conclusive. So, while simply rewriting the test will not necessarily make the PKQ a stronger instrument, it is a possibility and perhaps a good place to start, given the investment of time and other resources necessary to attempt the other recommendations made in this section.

## Recommendations for both Instruments

Due to this study's focus on instrument validation, the researcher decided that the study's methodology would include analyses of each instrument's face validity, content validity, and construct validity. It was decided that attempts to determine the instruments' predictive or criterion validity would be left for future research. The rationale for this decision was that it was first important to know that the instruments measured what they were designed to measure before attempting to determine if participants' scores on the instruments could be correlated with participants' grades or test scores. Due to this decision, the methods of this study include analyses to determine both instruments' face and content validity and a series of factor analyses to determine their construct validity. These methods did not include any analyses, such as linear regressions, that could be used to measure the instruments' criterion validity.

The PRQ is ready, at this point, for an analysis of its criterion validity using a linear regression comparing participants' photography class grades and/or test scores with their PRQ scores. If such a regression showed a significant correlation between PRQ scores and grades and/or test scores, it would help establish the instrument's criterion validity. The PKQ is not ready for such an analysis in its current state as it has not been demonstrated to have adequate construct validity. Once steps have been undertaken which result in a satisfactory increase in the PKQ's CFA key statistics, and that instrument is shown to have a sufficient level of construct validity, then a linear regression could be performed with the goal of establishing its criterion validity

## Recommendations for Practice

Since the PRQ results were the most conclusive, recommendations from this study would have to involve student's personal ontological beliefs. Fortunately, that could be easily done in photography. Specifically, these recommendations involve challenging student's ontological perceptions of photographic reality, what makes a photograph real and what might alter that reality. This could be accomplished through projects in which students manipulate photographs to create a reality that they envision (at least in part) prior to the creation of that reality.

One example might be a "What If" project in which students think up a way to complete this sentence: W*hat if* . . . ... For example, *what if clouds were muffins*? The student would then find or create some photos of muffins, then in Photoshop or similar photo editing software, cut the images out of the background they are in and paste them into a sky background. The finishing details would involve making the light logic work between the muffins and the existing background, whatever the things were under the sky, and so forth.

Another possible, similar project is HDR (High Dynamic Range) photographs. This project would involve creating HDR photographs manually, rather than simply completing the process within the camera. HDR photographs are usually done by placing a camera on a tripod and taking an initial, well exposed photograph of the desired setting. One way to proceed after this initial photograph is for the photographer to take the same photo with the exposure set one stop darker (or underexposed), and then another photo with the exposure set two stops darker than the original. The process is repeated with an additional photo being taken one stop lighter (or overexposed) than the original, and the final photo being two stops lighter than the original. These five photos are then superimposed over each other in Photoshop or a similar photo editing software and combined in such a way that the resulting image has the highlights of the most overexposed photo and the shadows of the most underexposed photo, with all the intermediate values coming from the photos that fall between those extremes. The value in this type of project is that students can see how photos can create images that are extra-real, where one can see more detail than is present is a singular, more traditional photographic image.

These possible examples of the types of projects that could be used to help photography students understand how photographs can be manipulated to represent three-dimensional reality in two dimensions according to the desires of the photographer and the idea that something can look real, “like a photograph”, is misleading. Hopefully, the end result of photo projects such as these would be to help precipitate a change or advancement in student personal ontological beliefs.

## Summary

Based on the data collected during the preparatory, pilot and field test stages of this study, the PRQ appears to be a reliable and valid research instrument. This suggests that successful research into personal ontology is a viable possibility including a preliminary model of how personal ontological beliefs might fit together and how they might change or advance with an individual's maturation and experience. Some other suggested topics of research were proposed as well as some teaching methods which might help students advance their ontological beliefs regarding photography.

Conversely, the data from the preparatory, pilot and field test stages is inconclusive about the reliability and validity of the PKQ. The data resulting from these stages, in particular the key statistics necessary to establish construct validity, failed to demonstrate that the PKQ was a valid instrument. Consequently, all the suggestions in this chapter regarding the PKQ involved attempts to make it into a more valid instrument for measuring personal epistemic beliefs about photography. Whether such an alteration could be successfully undertaken is not known at this point. Ideally, the PKQ should function as a valid and reliable instrument to measure individuals' personal epistemological beliefs in the same way the PRQ has been shown to measure personal ontological beliefs.

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# APPENDICES

# Appendix A.
# Photographic Reality and Photographic Knowledge Questionnaires

**Photographic Reality Questionnaire**

**Directions**

Rate the following 15 photos based on how "real" they appear to you. (Real = Having objective, independent existence; not artificial, fake, or deceptive.)

**Your answers should be based on your opinion. There are no established right or wrong answers.**

RQ1 **-On a scale of 1 to 5, 1 being very unreal and 5 being very real, how real is this photograph?**

- 1 = Very Unreal
- 2 = Somewhat Unreal
- 3 = Neutral
- 4 = Somewhat Real
- 5 = Very Real

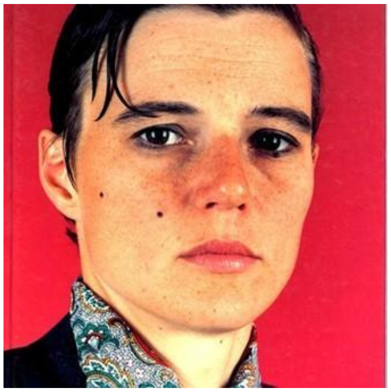
RQ2 **- On a scale of 1 to 5, 1 being very unreal and 5 being very real, how real is this photograph?**

- 1 = Very Unreal
- 2 = Somewhat Unreal
- 3 = Neutral
- 4 = Somewhat Real
- 5 = Very Real

RQ3 - **On a scale of 1 to 5, 1 being very unreal and 5 being very real, how real is this photograph?**

- 1 = Very Unreal
- 2 = Somewhat Unreal
- 3 = Neutral
- 4 = Somewhat Real
- 5 = Very Real

RQ4 - **On a scale of 1 to 5, 1 being very unreal and 5 being very real, how real is this photograph?**



- 1 = Very Unreal
- 2 = Somewhat Unreal
- 3 = Neutral
- 4 = Somewhat Real
- 5 = Very Real

RQ5 - **On a scale of 1 to 5, 1 being very unreal and 5 being very real, how real is this photograph?**

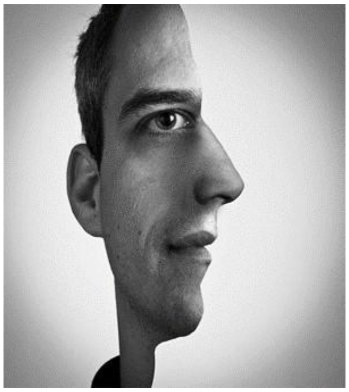
- 1 = Very Unreal
- 2 = Somewhat Unreal
- 3 = Neutral
- 4 = Somewhat Real
- 5 = Very Real

RQ6 - **On a scale of 1 to 5, 1 being very unreal and 5 being very real, how real is this photograph?**

- 1 = Very Unreal
- 2 = Somewhat Unreal
- 3 = Neutral
- 4 = Somewhat Real
- 5 = Very Real

RQ7 - **On a scale of 1 to 5, 1 being very unreal and 5 being very real, how real is this photograph?**

- 1 = Very Unreal
- 2 = Somewhat Unreal
- 3 = Neutral
- 4 = Somewhat Real
- 5 = Very Real



RQ8 - **On a scale of 1 to 5, 1 being very unreal and 5 being very real, how real is this photograph?**

- 1 = Very Unreal
- 2 = Somewhat Unreal
- 3 = Neutral
- 4 = Somewhat Real
- 5 = Very Real

RQ9 - **On a scale of 1 to 5, 1 being very unreal and 5 being very real, how real is this photograph?**

- 1 = Very Unreal
- 2 = Somewhat Unreal
- 3 = Neutral
- 4 = Somewhat Real
- 5 = Very Real

RQ10 - **On a scale of 1 to 5, 1 being very unreal and 5 being very real, how real is this photograph?**

- 1 = Very Unreal
- 2 = Somewhat Unreal
- 3 = Neutral
- 4 = Somewhat Real
- 5 = Very Real

RQ11 - **On a scale of 1 to 5, 1 being very unreal and 5 being very real, how real is this photograph?**

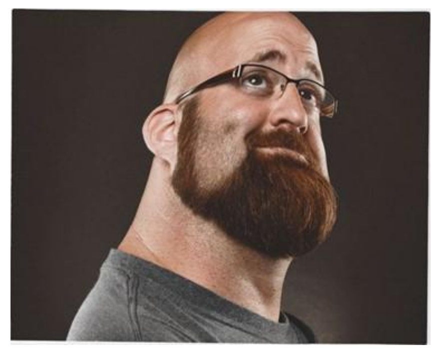
- 1 = Very Unreal
- 2 = Somewhat Unreal
- 3 = Neutral
- 4 = Somewhat Real
- 5 = Very Real

RQ12 - **On a scale of 1 to 5, 1 being very unreal and 5 being very real, how real is this photograph?**

- 1 = Very Unreal
- 2 = Somewhat Unreal
- 3 = Neutral
- 4 = Somewhat Real
- 5 = Very Real

RQ13 - **On a scale of 1 to 5, 1 being very unreal and 5 being very real, how real is this photograph?**

- 1 = Very Unreal
- 2 = Somewhat Unreal
- 3 = Neutral
- 4 = Somewhat Real
- 5 = Very Real



RQ14 - **On a scale of 1 to 5, 1 being very unreal and 5 being very real, how real is this photograph?**

- 1 = Very Unreal
- 2 = Somewhat Unreal
- 3 = Neutral
- 4 = Somewhat Real
- 5 = Very Real

RQ15 - **On a scale of 1 to 5, 1 being very unreal and 5 being very real, how real is this photograph?**

- 1 = Very Unreal
- 2 = Somewhat Unreal
- 3 = Neutral
- 4 = Somewhat Real
- 5 = Very Real

**Photo Knowledge Questionnaire Directions**

The following questions are about how the concepts and skills involved in photography are learned. Please answer them based on your own experience as honestly and thoughtfully as possible.

**Your answers should be based on your opinion. There are no established right or wrong answers.**

A1 **On a scale of 1 to 5, how familiar are you with these photographic concepts and skills**

| | Not familiar at all | Slightly familiar | Moderately familiar | Very familiar | Extremely familiar |
|---|---|---|---|---|---|
| Rule of Thirds | ○ | ○ | ○ | ○ | ○ |
| How to use a tripod | ○ | ○ | ○ | ○ | ○ |
| ISO | ○ | ○ | ○ | ○ | ○ |
| Repetition | ○ | ○ | ○ | ○ | ○ |
| Aperture | ○ | ○ | ○ | ○ | ○ |
| How to print a photo | ○ | ○ | ○ | ○ | ○ |

B1 **If I wanted to learn more about the rule of thirds, which of these would be the best option?**

- From a photography teacher
- From another student
- From an online tutorial about the rule of thirds
- From an instructional video about the rule of thirds
- By using the rule of thirds in my own photos

B2 **Which of these options would be the best way to demonstrate that I've learned about the rule of thirds?**

- I could answer multiple choice questions about the rule of thirds on a test
- I could answer a short answer or essay question about the rule of thirds on a test
- I could use the rule of thirds to complete a school project
- I could use the rule of thirds to take photos for myself
- I could explain the rule of thirds to another person

B3 **Is it easy or difficult to understand the rule of thirds?**

- Extremely easy
- Somewhat easy
- Neither easy nor difficult
- Somewhat difficult
- Extremely difficult

B4 **How connected is the rule of thirds to the other concepts and skills in photography?**

- Very disconnected
- Somewhat disconnected
- Not especially connected or disconnected
- Somewhat connected
- Very connected

B5 **How likely is the rule of thirds to change at some point in the future?**

- Extremely unlikely
- Somewhat unlikely
- Neither likely nor unlikely
- Somewhat likely
- Extremely likely

C1 **If you wanted to learn how to use a tripod, which of these would be the best option?**

- From a photography teacher
- From another student
- From an online tutorial about using tripods
- From an instructional video about using tripods
- By using a tripod to take my own photos

C2 **Which of these options would be the best way to demonstrate that I've learned how to use a tripod?**

- I could answer multiple choice questions about how to use a tripod on a test
- I could answer a short answer or essay question about how to use a tripod on a test
- I could use a tripod to complete a school project
- I could use a tripod to take photos for myself
- I could explain how to use a tripod to another person

C3 **Is it easy or difficult to understand how to use a tripod?**

- Extremely easy
- Somewhat easy
- Neither easy nor difficult
- Somewhat difficult
- Extremely difficult

C4 **How connected or disconnected is using a tripod to the other concepts and skills in photography?**

- Very disconnected
- Somewhat disconnected
- Neither connected or disconnected
- Somewhat connected
- Very connected

C5 **How likely is the use of tripods to change at some point in the future?**

- Extremely unlikely
- Somewhat unlikely
- Neither likely nor unlikely
- Somewhat likely
- Extremely likely

D1 **If you wanted to learn about ISO, which of these would be the best option?**

- From a photography teacher
- From another student
- From an online tutorial about ISO
- From an instructional video about ISO
- By using ISO in my own photos

D2 **Which of these options would be the best way to demonstrate that I've learned about ISO?**

- I could answer multiple choice questions about ISO on a test
- I could answer a short answer or essay question about ISO on a test
- I could use ISO to complete a school project
- I could use ISO to take photos for myself
- I could explain ISO to another person

D3 **Is it easy or difficult to understand ISO?**

- Extremely easy
- Somewhat easy
- Neither easy nor difficult
- Somewhat difficult
- Extremely difficult

D4 **How connected or disconnected is ISO to the other concepts and skills in photography?**

- Very disconnected
- Somewhat disconnected
- Neither connected or disconnected
- Somewhat connected
- Very connected

D5 **How likely is ISO to change at some point in the future?**

- Extremely unlikely
- Somewhat unlikely
- Neither likely nor unlikely
- Somewhat likely
- Extremely likely

E1 **If I wanted to learn more about repetition, which of these would be the best option?**

- From a photography teacher
- From another student
- From an online tutorial about repetition
- From an instructional video about repetition
- By using repetition in my own photos

E2 **Which of these options would be the best way to demonstrate that I've learned about repetition?**

- I could answer multiple choice questions about repetition on a test
- I could answer a short answer or essay question about repetition on a test
- I could use repetition to complete a school project
- I could use repetition to take photos for myself
- I could explain repetition to another person

E3 **How easy or difficult is repetition to understand?**

- Extremely easy
- Somewhat easy
- Neither easy nor difficult
- Somewhat difficult
- Extremely difficult

E4 **How connected is repetition to the other concepts and skills in photography?**

- Very disconnected
- Somewhat disconnected
- Neither connected or disconnected
- Somewhat connected
- Very connected

E5 **How likely is repetition to change at some point in the future?**

- Extremely unlikely
- Somewhat unlikely
- Neither likely nor unlikely
- Somewhat likely
- Extremely likely

F1 **If I wanted to learn more about aperture, which of these would be the best option?**

- From a photography teacher
- From another student
- From an online tutorial about aperture
- From an instructional video about aperture
- By using aperture in my own photos

F2 **Which of these options would be the best way to demonstrate that I've learned about aperture?**

- I could answer multiple choice questions about aperture on a test
- I could answer a short answer or essay question about aperture on a test
- I could use aperture to complete a school project
- I could use aperture to take photos for myself
- I could explain aperture to another person

F3 **Is it easy or difficult to understand aperture?**

- Extremely easy
- Somewhat easy
- Neither easy nor difficult
- Somewhat difficult
- Extremely difficult

F4 **How connected is aperture to the other concepts and skills in photography?**

- Very disconnected
- Somewhat disconnected
- Neither connected or disconnected
- Somewhat connected
- Very connected

F5 **How likely is aperture to change at some point in the future?**

- Extremely unlikely
- Somewhat unlikely
- Neither likely nor unlikely
- Somewhat likely
- Extremely likely

G1 **If I wanted to learn more about how to print photos, which of these would be the best option?**

- From a photography teacher
- From another student
- From an online tutorial about printing photos
- From an instructional video about printing photos
- By printing my own photos

G2 **Which of these options would be the best way to demonstrate that I've learned how to print photos?**

- I could answer multiple choice questions about printing photos on a test
- I could answer a short answer or essay question about printing photos on a test
- I could print photos to complete a school project
- I could print photos for myself
- I could explain how to print photos to another person

G3 **Is it easy or difficult to understand how to print photos?**

- Extremely easy
- Somewhat easy
- Neither easy nor difficult
- Somewhat difficult
- Extremely difficult

G4 **How connected is printing photos to the other concepts and skills in photography?**

- Very disconnected
- Somewhat disconnected
- Neither connected nor disconnected
- Somewhat connected
- Very connected

G5 **How likely is printing photos to change at some point in the future?**

- Extremely unlikely
- Somewhat unlikely
- Neither likely nor unlikely
- Somewhat likely
- Extremely likely

# Appendix B.
# Sample of the Expert Survey

**Sample of the PKQ Expert Survey (Including questionnaire items from section B of the PKQ)**

Thank you for agreeing to review this questionnaire. The purpose of the questionnaire is to determine what photography students believe regarding where knowledge in photography comes from, how it is acquired and demonstrated and how likely it is to change in the future. You are asked to decide which of the questions in this questionnaire are essential to achieving that purpose and which are not.

You have been invited to review this questionnaire because you have expertise in the field of personal epistemology/ontology or as a photography instructor. If you are an expert in teaching photography, please consider whether the topics addressed in the questions below represent relevant topics in a high school photography course. If you are an expert in personal epistemology/ontology, please consider whether the questions will effectively induce students to reveal their personal epistemological or ontological beliefs regarding photography.

The questions in italics are the questions that make up the questionnaire to be presented to students. You should answer those questions but the important questions for you to answer are the questions in bold type. In these questions, you will be asked how essential the preceding question was. As you consider how essential each question is, remember to look at it based on your specific charge mentioned above.

Thanks so much for your help!

*(Directions to Students)*

***Photographic Knowledge Questionnaire***

*The following questions are about how concepts and skills are learned in photography. Please answer them based on your own experience as honestly and thoughtfully as possible. Your answers should be based on your opinion. There are no established right or wrong answers.*

*Thanks for your help!*

***B1 If I wanted to learn more about the rule of thirds, which of these would be the best option?***

*From a photography teacher*
*From another student*
*From an online tutorial about the rule of thirds*
*From an instructional video about the rule of thirds*
*By using the rule of thirds in my own photos*

EQ-B1.1 How essential is question B1?

- Essential
- Useful but not Essential
- Not Essential

EQ-B1.2 Do you have any comments about question B1?

***B2 Which of these options would be the best way to demonstrate that I've learned about the rule of thirds?***

*I could answer multiple choice questions about the rule of thirds on a test*
*I could answer a short answer or essay question about the rule of thirds on a test*
*I could use the rule of thirds to complete a school project*
*I could use the rule of thirds to take photos for myself*
*I could explain the rule of thirds to another person*

EQ-B2.1 How essential is question B2?

Essential
Useful but not Essential
Not Essential

EQ-B2.2 Do you have any comments about question B2?

***B3 Is it easy or difficult to understand the rule of thirds?***

*Extremely easy*
*Somewhat easy*
*Neither easy nor difficult*
*Somewhat difficult*
*Extremely difficult*

EQ-B3.1 How essential is question B3?

- Essential
- Useful but not Essential
- Not Essential

EQ-B3.2 Do you have any comments about question B3?

***B4 How connected is the rule of thirds to the other concepts and skills in photography?***

*Very disconnected*
*Somewhat disconnected*
*Not especially connected or disconnected*
*Somewhat connected*
*Very connected*

EQ-B4.1 How essential is question B4?

- Essential
- Useful but not Essential
- Not Essential

EQ-B4.2 Do you have any comments about question B4?

***B5 How likely is the rule of thirds to change at some point in the future?***

*Extremely unlikely*
*Somewhat unlikely*
*Neither likely nor unlikely*
*Somewhat likely*
*Extremely likely*

EQ-B5.1 How essential is question B5?

- Essential
- Useful but not Essential
- Not Essential

EQ-B5.2 Do you have any comments about question B5?

**Appendix C.**
**Sample of the Response Process Survey**

**Sample of the Response Process Survey (Including questionnaire items from section B of the PKQ)**

*B1 If I wanted to learn more about the rule of thirds, which of these would be the best option?*

*From a photography teacher*
*From another student*
*From an online tutorial about the rule of thirds*
*From an instructional video about the rule of thirds*
*By using the rule of thirds in my own photos*

**RP-B1 Was the last question clear and understandable?**

- **Extremely unclear**
- **Somewhat unclear**
- **Somewhat clear**
- **Extremely clear**

*B2 Which of these options would be the best way to demonstrate that I've learned about the rule of thirds?*

*I could answer multiple choice questions about the rule of thirds on a test*
*I could answer a short answer or essay question about the rule of thirds on a test*
*I could use the rule of thirds to complete a school project*
*I could use the rule of thirds to take photos for myself*
*I could explain the rule of thirds to another person*

**RP-B2 Was the last question clear and understandable?**

- **Extremely unclear**
- **Somewhat unclear**
- **Somewhat clear**
- **Extremely clear**

*B3 Is it easy or difficult to understand the rule of thirds?*

*Extremely easy*
*Somewhat easy*
*Neither easy nor difficult*
*Somewhat difficult*
*Extremely difficult*

**RP-B3 Was the last question clear and understandable?**

- **Extremely unclear**
- **Somewhat unclear**
- **Somewhat clear**
- **Extremely clear**

*B4 How connected is the rule of thirds to the other concepts and skills in photography?*

*Very disconnected*
*Somewhat disconnected*
*Not especially connected or disconnected*
*Somewhat connected*
*Very connected*

**RP-B4 Was the last question clear and understandable?**

- **Extremely unclear**
- **Somewhat unclear**
- **Somewhat clear**
- **Extremely clear**

*B5 How likely is the rule of thirds to change at some point in the future?*

*Extremely unlikely*
*Somewhat unlikely*
*Neither likely nor unlikely*
*Somewhat likely*
*Extremely likely*

**RP-B5 Was the last question clear and understandable?**

- **Extremely unclear**
- **Somewhat unclear**
- **Somewhat clear**
- **Extremely clear**

# Appendix D.
# Letter of Information and Demographic Information Questions

**Letter of Information**

This is a research study about how high school students believe they can best learn about photography. You may or may not have much experience taking or editing photos and you may or may not have ever had a photography course. Experience with photography is not necessary for you to participate in this research project. We are only interested in how you believe you learn subjects like photography. We are not going to ask questions to find out how much you really know about photography. This is not a test, so there are no right or wrong answers to any of these questions. So, your answers should be based on your personal beliefs about how you learn things and how you can demonstrate what you know.

This questionnaire also contains questions about the clarity and understandability of the survey itself. In these questions, we are asking you to tell us how easy or difficult the questions about learning photography are to read and understand. Altogether, the questionnaire should take about 30 to 45 minutes to complete. We appreciate your willingness to participate and your commitment to answer each question truthfully and attentively.

When researchers do things like have students take questionnaires or collect students' background information, some unexpected things could happen. For example, someone not connected to the study might accidentally see your questionnaire answers, or they might see your background information. We will do everything we can to prevent those things from happening, but there is still a chance, so we want you to know that first.
Not everyone who is a part of research studies receives something good from it. In this study, nothing directly good will happen to you, but you will help us learn more about people like you. Also, we will tell other people about what we learned from doing this study with you and the 130 or so other people who are in the study, but we won't tell anyone your name or that you were in the study.

If this sounds like something you would like to do, please click on "I agree to be part of this study." You do not have to be in this study if you do not want to be. If you decide to stop after you begin, that's okay, too.

If you have any questions about this study, you can contact Dr. Debra Spielmaker at 435-213-5562 or debra.spielmaker@usu.edu. If you have any concerns about this study, please contact Utah State University's Human Research Protection Office at (435) 797-0567 or irb@usu.edu.

If you would like to be in this study, please click “I agree to be part of this study” and you will be able to begin the questionnaire.

Thanks again for your time and consideration.

- ☐ I agree to be part of this study
- ☐ I do not agree to be part of this study

**Demographic Information Questions**

Age: How old are you?

- ☐ 15
- ☐ 16
- ☐ 17
- ☐ 18

Grade: What grade are you in?

- ☐ 9th
- ☐ 10th
- ☐ 11th
- ☐ 12th

Race Choose one or more races that you consider yourself to be

- ☐ White or Caucasian
- ☐ Black or African American
- ☐ American Indian/Native American or Alaska Native
- ☐ Asian
- ☐ Native Hawaiian or Other Pacific Islander
- ☐ Other
- ☐ Prefer not to say

Gender How do you describe yourself?

- ☐ Male
- ☐ Female
- ☐ Non-binary / third gender
- ☐ Prefer to self-describe ______________________
- ☐ Prefer not to say

PE1 Have you ever had a photography class? (Select all that apply)

- ☐ Yes, in High School
- ☐ Yes, in Middle School
- ☐ Yes, in Elementary School
- ☐ Yes, outside of a school setting
- ☐ No

PE2 Have you ever been in a photography club? (Select all that apply)

- ☐ Yes, in school
- ☐ Yes, outside of school
- ☐ No

PE3 What device(s) do you use to take photos (Select all that apply)

- ☐ A cell phone
- ☐ A digital camera
- ☐ A film camera
- ☐ I don't take photographs regularly

PE4 What device(s) to you use to edit photos (Select all that apply)

- ☐ A cell phone
- ☐ A tablet or laptop computer
- ☐ A desktop computer
- ☐ I don't regularly edit photos

Q104 To show that you are paying attention, please select "All of the above."

- ☐ Fun
- ☐ Exciting
- ☐ Strong
- ☐ Attractive
- ☐ Happy
- ☐ All of the above

# Appendix E.
# Curriculum Vitae

**Earl Stanford Maeser Jr.**
(801).707.5304 | stanmaeser@gmail.com
691N 2670W Lehi, Ut 84043

## PROFESSIONAL SUMMARY

A seasoned educator looking for a new, challenging opportunity. Possesses strong classroom management skills, a broad understanding of educational philosophy and the ability to teach using a range of approaches. Experienced with challenging teaching situations, managing programs and extracurricular activities

## EDUCATION

**Doctor of Philosophy In Career and Technical Education** **August 2024**
Utah State University, Logan, Utah

- Dissertation - *Instrument Development For Determining High School Students' Epistemological and Ontological Beliefs Regarding Photography*

**Master of Education in Secondary Education** **August 1999**
Utah State University, Logan, Utah

- Thesis – *Using Computers to Teach Visual Arts*

**Bachelor of Fine Arts, Painting and Drawing Emphasis** **June 1991**
University of Utah, Salt Lake City, Utah

## WORK EXPERIENCE

**Visual Art/CTE Teacher** **2009 - 2022**
Cottonwood High School, Murray, Utah

- Taught the stage crew class and advised the student stage tech association. Worked with administrators and performing arts teachers to facilitate all school productions and assemblies.
- Served as Stage Manager for outside groups and productions which rented Cottonwood's 3500 seat auditorium, including organizations like Deseret Book, the Sterling Scholar Awards and the Angel Tree Concert.
- Acted as teacher and station manager for the student television class/production, KOLT TV. Directed students in writing, directing, producing and appearing in the school's daily announcement show, KOLT News.
- Streamed home sporting events such as football, basketball, volleyball and swimming as well as graduation ceremonies and other important school related events.
- Managed facilities and materials for the above-mentioned classes and groups as well as those related to the Commercial Photography program.

**Visual Art/CTE Teacher** **2000 – 2009**

Granite High School, South Salt Lake, Utah

- Organizing faculty member of the school's Academy of Information Technology. Served as the instructor for the Computer Technology, Commercial Art and Multimedia courses.
- Created and acted as the advisor for a traditional film Photography Club as an afterschool program.
- Taught Ceramics I & II and managed the facilities including materials, tools, chemicals and kilns for those classes.
- Acted as the Student Government advisor for three years. Organized, promoted and executed activities such as service projects, fundraisers, dances and assemblies.

**Visual Art Teacher** **1991 - 2000**

Brockbank Junior High School, Magna, Utah

- Served as a member of the Site-Based Steering Committee, (a group of faculty members empowered to make decisions regarding the school's curricular and behavior management systems), from 1993 to 1996 and again from 1999 to 2000
- Acted as the assistant girls' basketball coach and head coach for a total of six years with our teams advancing to the district playoffs three of those years
- Managed the school stage and was the stage crew club advisor for six years, helping with school theatrical, dance and musical productions
- Organized and managed one of the first Junior High School computer labs in Granite School District oriented towards art related software including Adobe Photoshop and Avid Cinema

## RELEVANT SKILLS

- Problem Solving
- Attention to Detail
- Leadership
- Photo & Video Software Proficiency
- Artistically and Technically Minded

## ENDORSEMENTS/CERTIFICATIONS

- Visual Art
- Commercial Art CTE
- Intro to Information Technology
- Computer Technology
- Commercial Digital Photography
- TV Broadcasting

**AWARDS/RECOGNITIONS**

- Educator of the Year, Brockbank Jr. High, 2000
- Teacher of the Year, Granite High School, 2007
- Outstanding Technical Direction in a Musical, 2013, 2014, 2016