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A psychometric evaluation of the english version of the dimensions of attitudes toward science instrument with a U.S. population of elementary educators

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HIGHLIGHTS

- A science attitude measurement instrument was translated and validated for U.S. use.
- The validated instrument can be used for cross-cultural comparisons.
- A measurement instrument is provided for use with pre-service/in-service elementary educators.
- Analysis of the sample population showed positive attitudes toward science.
- The instrument could be of use to administrators, practitioners, and researchers.

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ABSTRACT

The purpose of this study was to review the development and evolution of the Dimensions of Attitudes toward Science Instrument (DAS), translate the DAS into English, and examine its psychometric properties with a U.S. sample of pre-service and in-service elementary educators. After translation and expert review, the DAS was administered to a sample of 300 U.S. in-service and pre-service teachers. Confirmatory factor analysis and fit indices values supported a seven-factor theoretical model. The entire DAS was found to have good internal consistency. This study confirmed the DAS is a valid instrument for a U.S., English-speaking elementary education teacher population.

1. Introduction

Research examining the affective domain in science education is significant as science achievement is associated with attitudinal and emotional responses (Kazempour, 2014). The need for attitudinal research in science education is well documented, and examination of educators' attitudes toward science is necessary (Blalock et al., 2008; Maier, Greenfield, & Bulotsky-Shearer, 2013). Educators' attitudes toward science significantly influence the success of teaching and learning in the science classroom (Kazempour, 2014; Maier et al., 2013). As such, science educators' attitudes are purportedly the most influential factor in providing quality science education (Jones & Leagon, 2014). As Kazempour (2014) explains, teachers' attitudes toward science and toward science teaching, in combination with their instructional practices, greatly influence students' achievement in science, attitudes toward science, interest in pursuing advanced science education and careers, and students' levels of scientific literacy.

Since the quantitative measurement of science attitudes to inform education was encouraged in the 1930s (Noll, 1935), numerous instruments have been developed and subsequently examined, to varying degrees, for validity and reliability (e.g. Lederman, 1992; Munby, 1983). Many instruments have focused on assessing students' attitudes toward science and their intention to pursue science careers (Blalock et al., 2008). Fewer instruments have been developed to measure teachers' science attitudes and beliefs (see Jones & Leagon, 2014), and reviews of teacher-focused

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instruments have demonstrated limitations in the quality of psychometric properties and rigorous validation (Blalock et al., 2008; Tytler, 2014; van Aalderen-Smeets & Walma van der Molen, 2013). One potentially promising existing instrument is the Dimensions of Attitudes toward Science Instrument (DAS; van Aalderen-Smeets & Walma van der Molen, 2013). The DAS is an instrument that was previously created to measure elementary educators' attitudes toward teaching science; it was written in Dutch and initially validated with a population of pre-service and in-service elementary educators from the Netherlands (van Aalderen-Smeets & Walma van der Molen, 2013). Korur, Vargas, and Serrano (2016) later translated the DAS into Spanish and Turkish and found the DAS to have adequate internal reliability and good construct validity with a population of in-service and pre-service teachers from Spain and Turkey.

Given the instrument's emerging methodological strength and good psychometric properties for a variety of international populations, the purpose of this study is to review the development of the DAS, translate the DAS into English, examine its face and content validity for use with a U.S. population, and collect new data from a U.S. elementary educator sample to evaluate its psychometric properties. Having a validated instrument to measure U.S. elementary educators' professional attitude toward teaching science will help meet the call for research in the science education literature for an increased understanding of teacher attitudes and perceptions, primarily at the elementary level (Blalock et al., 2008). This understanding is vital to the development of effective pre-service teacher training and in-service teacher professional development (Jones & Leagon, 2014; Kazempour, 2014). Further translation and validation of the DAS in English will allow comparisons of teacher attitudes across cultures, providing a big picture perspective that could potentially inform understanding of the relationship between teacher attitudes and student performance cross-culturally on assessments such as the Trends in International Mathematics and Science Study (TIMSS) and Program for International Student Assessment (PISA) (Korur et al., 2016).

2. Conceptual framework

2.1. Measuring attitudes toward science

Recently, increased attention has been focused on teachers' attitudes and beliefs toward science and teaching science as vital to improved science teaching, and ultimately, student science achievement and science career intention (Fulmer, 2013; Kazempour, 2014; Korur et al., 2016). As Jones and Carter (2007) stated,

> Our definitions of ourselves as science teachers (and learners) is bound to our belief systems, epistemologies, prior experiences, motivation, knowledge, and skills. These factors are all linked to each other with reciprocal influence and are embedded in the larger sociocultural environment. Only through further research that can take a systems view of attitudes and beliefs can we truly understand how attitudes and beliefs shape instructional practice and use this knowledge to achieve reform (p. 1096).

Thus, the core of educational change centers on the beliefs that teachers hold regarding science and regarding teaching science (Haney, Lumpe, & Czerniak, 2002). However, few recent studies have actually examined teacher beliefs toward science in the U.S. context, especially with an instrument that could potentially yield cross-cultural comparisons.

One study examined the influence of teachers' science content knowledge, attitudes, and understanding on students' science conceptions (Fulmer, 2013). In a year-long study that utilized a mixed-methods design, Fulmer (2013) demonstrated that teachers' science content knowledge, attitudes, and understanding of science can influence students' conceptions and, thus, the importance of elementary science teachers' science attitudes in their teaching practices. Importantly, the study highlighted the need to more fully examine the effect of teachers' content knowledge, attitudes, and understanding of science on students' science learning as "teachers' attitudes or instructional approach can serve as mediators of the relationship between teachers' conceptions and their students' learning" (Fulmer, 2013, p. 1232).

Given the understanding of the importance of science education in the elementary grades in influencing students' future decisions to engage in scientific careers (Cvencek, Meltzoff, & Greenwald, 2011; Forbes & Schmader, 2010; Morgan, Isaac, & Sansone, 2001), as well as in building scientific understanding, an increased understanding of the significance of elementary science education has occurred (Roth, 2014). There is a growing need to examine elementary teachers' attitudes in regards to science and science teaching (Kazempour, 2014). In order to do so, valid and reliable measurement instruments are essential and, importantly, translation of existing instruments for use in a variety of populations is needed.

Importantly, attitude is difficult to measure and has been done so primarily through self-report measures (Blalock et al., 2008). Attitude, and more specifically attitude toward science, is also challenging to define. However, the consensus among researchers is the idea that attitudes toward science is not a unitary concept and needs to be defined as a multidimensional construct (Jones & Leagon, 2014; Kane, Sandretto, & Heath, 2002; Osborne, Simon, & Collins, 2003). Thus, when attitudinal science measures are constructed, they need to consider the dimensionality attitudes toward science, carefully use the literature to identify the many dimensions, and then undertake the analysis of the dimensions using a factor analysis.

As such, the DAS was initially developed following a comprehensive theoretical framework proposed by van Aalderen-Smeets, Walma van der Molen, and Asma (2012). van Aalderen-Smeets et al. (2012) conducted an extensive review of the existing literature regarding concepts of attitude in order to more fully understand and structure the construct of elementary teachers' attitudes toward science. Additionally, the authors examined the components of attitude following general psychological attitude theories and, ultimately, constructed a tripartite model. Thus, van Aalderen-Smeets et al. (2012) purported that attitudes toward teaching science consists of the three dimensions of cognitive, affective, and perceived control and seven factors (perceived relevance, gender stereotypes, perceived difficulty, enjoyment, anxiety, self-efficacy, and context) within these three dimensions. The cognitive dimension consists of: (a) perceived relevance, which refers to the importance and relevance a teacher assigns to teaching science; (b) perceived difficulty, which is a teacher's perception of how difficult it is to teach science, and (c) gender beliefs, which refers to a teacher's beliefs about the ability that boys and girls have related to science. The affective dimension includes enjoyment and anxiety. Enjoyment is defined as the positive feelings a teacher has about science and about teaching science. Alternatively, anxiety is defined as the apprehension that teachers experience about science and science teaching. The perceived control dimension is inclusive of self-efficacy and context dependency. Self-efficacy is the belief of a teacher's capability to succeed in science and to teach science (Bandura, 1977; van Aalderen-Smeets & Walma van der Molen, 2013). Finally, context dependency represents the context in which a teacher develops an attitude toward science and the beliefs that the teacher holds about the context (van Aalderen-Smeets et al.,