Assessing Informal Reasoning in Culturally Diverse Students

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Since the onset of the 20th century, Western nations have been researching and developing methods to predict the academic success of students in the formalized educational system (Benjamin, 2009; Wasserman, 2012). Current methods utilize standardized intelligence tests (Deary, Strand, Smith, & Fernandes, 2007; Kaufman, 2009; Laundra, & Sutton, 2008; Zavala & Mims, 1983). Although Wasserman (2012) states that there is no agreed upon definition of the term 'intelligence', perhaps the best definition, to date, is found in Merriam-Webster's Online Dictionary (2019) which defines intelligence as one's "ability to reason, apply knowledge, think abstractly, and process information." Central to the term intelligence are both general intelligence and/or fluid reasoning (Ferrer, O'Hare, & Bunge, 2009; Kanazawa, 2010; Maccow, 2015; Perkins, Farady, & Bushy, 1991).

Formal Reasoning

General Intelligence and/or fluid reasoning are widely accepted as the foundation of human cognition and achievement (Ferrer, et al., 2009; Maccow, 2015). They are defined as one's ability to think abstractly and conceptually, problem solve deductively and inductively, and solve novel problems (Ferrer et al., 2009; Maccow, 2015). Nearly identical in definition to fluid reasoning, is formal reasoning, which is defined as reasoning that employs abstract thinking, deductive and inductive problem solving, and mathematical novel/symbolic logic (Johnson & Blair, 1991; Perkins et al., 1991). It follows that fluid reasoning is a representation of one's formal reasoning abilities. Since research indicates that formal reasoning abilities support the formal learning environments of public schools (Marshall & DeCapua, 2013; Miller-Jones, 1989, 1991; Voss, Perkins, & Segal, 1991), those who formally reason well are more likely to achieve higher levels of academic success in current school systems.

Informal Reasoning

Informal reasoning, in contrast to formal/fluid reasoning, is defined as being contextualized and concrete in nature, more inductive than deductive, and of practical application in *real world* problem solving (Johnson & Blair, 1991; Marshall & DeCapua, 2013; Miller-Jones, 1991; Salmon, 1991). Students who reason informally may experience difficulty in the current highly formalized academic setting which is founded on formalized methods of pupil instruction and assessment of student intelligence and achievement (Ferrer et al., 2009; Marshall & DeCapua, 2013; Miller-Jones, 1989, 1991; Voss et al., 1991).

Thus far, the correlation between informal reasoning and academics remains primarily anecdotal, due primarily to the lack of existing research on the topic (Johnson & Blaire, 1991). Research regarding reasoning has prioritized the formal model, as it is easier to quantify, measure, and is more revered in academia (Johnson & Blair, 1991). Additionally, the majority of existing studies of informal reasoning (Chng, Wild, Hollomann, & Otterpohl, 2014; Sadler, 2004; Teig & Scherer, 2016; Widodo, Saptarani, Randi, & Rochintaniawati, 2017; Zeiffler, Garfield, Delmas, &

Reading, 2008) relate to argumentative logic (Sadler, 2004) rather than measurable problem solving in a psychometric form.

Since the definition of informal reasoning varies depending on its context (Johnson & Blair, 1991), for the purpose of this article, informal reasoning is defined as a form of reasoning reliant on concrete, contextual, and practical thinking and problem solving, not bound by the rules of mathematical logic and/or abstract thinking.

Reasoning and Cultural

According to Schein (1992), culture can be defined as shared assumptions and knowledge to solve problems of one group, passed from one generation to another. According to Cole (2005), Flynn (2016), Greenfield (1998) and Miller-Jones (1989, 1991), culture correlates to how humans cognitively process and formulate formal and informal reasoning abilities. Variables, such as socio-economic status and accessibility to certain resources that directly impact culture, directly and indirectly shape how one will reason (Downer & Pianta, 2006; Peisner-Feinberg, Burchinal, Clifford, Culkin, Howes, Kagen, & Yazejian, 2001). A resulting factor of the impact of culture and socio-economic status on one's reasoning abilities is that some individuals may fare better than others on fluid/formal reasoning-based assessment tools (Flynn, 2016; Greenfield, 1998). Flynn (2016) further adds that these tools could be considered *barometers* of how formally a group reasons as opposed to a measure of their true, innate reasoning abilities. Past and current research related to problem solving and reasoning, across different cultures, supports the theory that some do better than others when faced with formal reasoning-based tasks and assessments (Cole, 2005; Hvitfeldt, 1986; Marshall, 1998; Miller-Jones, 1989, 1991; Romstad & Xiong, 2017; Serpell, 2017; Werth, Kathuria, & Serpell, 1998).

Several different studies, directly and indirectly related to the analysis of problem solving and reasoning amongst groups, indicate that formalized tasks and concepts are more challenging to some groups compared with more utilitarian and less formal tasks and concepts (Cole, 2005; Diamond, 1997; Hvitfeldt, 1986; Luria, 1973; Romstad & Xiong, 2017). These formalized concepts and tasks included abstract reasoning tasks, categorical thinking and reasoning, and general word association tasks (Cole, 2005; Marshall, 1998, 2013; Miller-Jones, 1989, 1991). Overall, much of the research suggests that formal reasoning is less innate than once believed and that the more exposure a group has to formal reasoning, the more dominant that reasoning is; however, the fact that formal reasoning can be learned suggests that culture plays a significant role in its development.

Research on two specific cultural groups, urban African-American children by Miller-Jones (1989, 1991) and Hmong-American students by Hvitfeldt (1986), Marshall (1998), Marshall & DeCapua (2013), and Romstad and Xiong (2017) indicates that students who exhibit more dominant informal reasoning abilities than formal reasoning abilities demonstrate more difficulties in their formalized academic environments. Authors of the studies also concluded that helping the two groups formalize their ways of thinking through classroom strategies and supports would likely produce higher academic results.

The Romstad and Xiong Study

Romstad and Xiong (2017) analyzed 200 score sets from two studies done on Hmong-American students in the Twin Cities, Minnesota from 2012 to 2017. The assessment tools used were the Kaufman Assessment Battery for Children – Second Edition (KABC-II) and the Wechsler Intelligence Scales for Children – Fifth Edition (WISC-V). Overall, performance across all three indices on the KABC-II, including the Fluid Crystallized Index (FCI), the Mental Processing Index (MPI), and the Nonverbal Index (NVI), was found to be one standard deviation below the mean. For the KABC-II, 154 students were assessed between the ages of 5 and 18 years. For the WISC-V, 46 students were assessed between the ages of 7 and 14. Performance on the KABC-II yielded average FCI scores of 83, average MPI scores of 85, and average NVI scores of 86. The younger students in the study performed the lowest, with average scores all in the below average range across the FCI, MPI, and NVI indices. Overall performance on the WISC-V yielded lower results with a Full-Scale IQ mean of 78 and a Nonverbal IQ mean of 84, equivalent to the KABC-II NVI mean score.

Most important in this study was not the composite scores but the subtest scores obtained by the sample. Subtests that were less formal yielded scores that were much closer to the standardized sample's performance. Subtests that were more formal in nature yielded scores that were lower than the standardized samples performance. The results of this study suggest that the KABC-II and WISC-V yielded lower overall scores, due in part to the higher formal loading of some subtests compared to others. The results also suggest that in order for groups similar to those sampled to achieve more balanced scores, tools specific to measuring informal reasoning may be necessary.

A Clear and Present Need

Assessing a student with current standardized tests carries the risk of assigning ineffective special education remedies for a student who is an *informal reasoner*. A student who has dominant informal reasoning tendencies *has* the potential to develop formal reasoning and improve academic achievement if that subject is identified early in the education process. To date, there is no method to quantify informal reasoning abilities through use of psychometric tests; therefore, there is no standardized method of identifying an *informal reasoner*. Neither are there commonly applied intervention methods designed to develop formal reasoning abilities and improve academic achievement. Lacking both testing and intervention methods specific to students with dominant informal reasoning is a concerning void.

New Research

Current research by Carl Romstad, of Designs for Learning, and Milton Dehn, of Schoolhouse Educational Services, has provided new information regarding the analysis and quantification of informal reasoning through an innovative measure of informal reasoning. The instrument is unique in that it measures one's abilities to problem solve in contextual, inductive, and practical ways. Additionally, examinees are not required to apply in-depth abstract and conceptual thinking.

The subtests designed and used in the scale require examinees to analyze and replicate designs they observe, demonstrate efficiency in navigation, demonstrate quantitative reasoning,

and analyze sets of pictures to find what is missing, solve a presented problem, or create an object.

In its initial piloting phase, the scale produced equivalent scores across Caucasian and Non-Caucasian students. Specifically, when scores were compared between racial/ethnic groups (Caucasian vs Asian, Latino, and African American), the scores were not significantly different. Furthermore, when socio-economic status (SES) was analyzed, those of lower SES performed the same as those of higher SES, and in some cases, better. Overall, the new measure of informal reasoning has, to date, demonstrated cultural, ethnic, and socio-economic fairness for examinees. Equality on these three levels is a rarity in the field of intellectual assessment.

Conclusion

For more than a century, intelligence tests have been the primary method of measuring a subject's reasoning abilities and assessing his or her potential for academic success. Central to these tests is the measure and interpretation of *formal reasoning* (Ferrer, et al., 2009; Flynn, 2016; Greenfield, 1998; Maccow, 2015). Far less research exists on *informal reasoning,* though it has been observed across populations and its existence acknowledged by academics (Johnson & Blair, 1991).

Current research indicates that a standardized measure of informal reasoning is plausible. The piloting of the new measure yielded equivalent results across ethnic/racial and SES groups. Future research on informal reasoning and development of the new scale has the potential to help practitioners measure innate reasoning abilities with a more *culturally-fair* test.

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