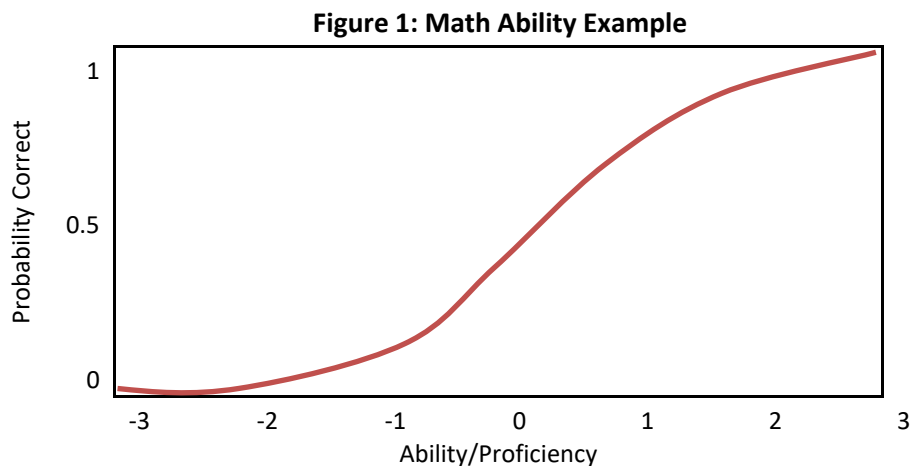


What is IRT?

Item Response Theory (IRT) describes the application of statistical models to data, such as the Motor Carrier Management Information System (MCMIS), as a basis for measuring abilities, attitudes, or other variables such as the safety culture of a motor carrier. IRT models are designed to observe each “response option” to an “item” as a function of the latent trait being measured by the assessment.¹ For example, in standardized testing, schools use IRT models to assess an individual’s proficiency in a subject area based on two components of the questions: 1) each question’s level of difficulty and 2) each question’s ability to distinguish between different levels of proficiency.²

If one desired to determine the math ability of various students, they could theoretically utilize an IRT where the model specifies the probability of a correct response to a question as a function of the students’ ability as shown in Figure 1. In Figure 1, the horizontal axis represents the level of ability, which is quantified according to a standard scale that ranges from -3 to 3, such that a value of zero reflects a moderate level of ability. The vertical axis represents the probability of a correct answer to a math question, and the S-shaped curve represents the probability of a correct response at each level of ability. The same concept is true for the IRT model developed by the National Academy of Sciences (NAS) Panel as demonstrated in Figure 2.



The IRT model proposed by the NAS Panel would observe the prevalence of violations as a function of a carrier’s latent safety culture by developing a mathematized hypothesis. FMCSA would develop the hypothesis by obtaining estimates of relevant parameters, such as the seven Behavioral Analysis and Safety Improvement Categories (BASICS), and then testing them to ascertain their relationship with safety. This allows the mathematized hypothesis to be empirically tested, which would enable FMCSA to improve the reliability of the assessment moving forward.³

¹ <https://soe.uncg.edu/partners/office-of-assessment-evaluation-and-research-services/item-response-theory/>

² “FMCSA Correlation Study Public Meeting: Data Quality and Sources: IRT Modeling,” FMCSA (Aug 2018)

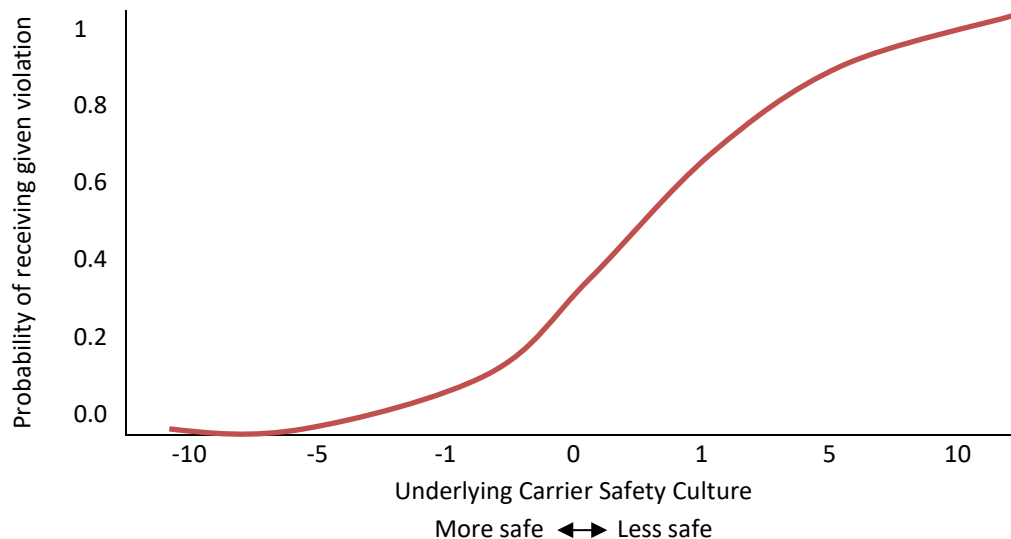
³ http://psychology.wikia.com/wiki/Item_response_theory

Issues

In order for the IRT model to assess safety performance appropriately, the measures included in the construct *must* have a *credible* relationship with a carrier’s underlying safety culture. The key idea then relates to the notion that the safety culture of the carrier *causes* them to incur multiple violations.⁴ The NAS Panel believed that “violations provide indicators of carrier safety under the *assumption* that safety impacts *crashes* [emphasis added].⁵” However, the probability of receiving a violation can be reliant upon a number of confounding factors, such as where a carrier operates, as states tend to both enforce and interpret the Federal Motor Carrier Safety Regulations differently.⁶ While the IRT model might be able to correct for these differences, FMCSA will need to improve and update their data collection.

Moreover, as the Government Accountability Office (GAO) has found, not all violations have a direct relationship to crashes. Violations are not always an accurate indicator of a motor carrier’s safety culture. Regardless of the NAS’s recommendations, the underlying problems of the Compliance, Safety, and Accountability (CSA) program and the Safety Measurement System (SMS) remain. Namely, the *belief* that compliance is equal to safety.

Figure 2: The Relationship between Carrier Safety and the Probability of Receiving Given Violations



⁴ National Academies of Sciences, Engineering, and Medicine, *Improving Motor Carrier Safety Measurement*, The National Academies Press, (2017) pg. 70

⁵ *Ibid.*, pg. 69

⁶ *Idiosyncratic Practices of State Enforcement Agencies by Region*, OOIDA Foundation (2016)

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