

Factor Modeling used in Validation Research

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Keywords: Factor studies, validation research, writing assessment.

Abstract: In order to demonstrate the usefulness of factor modeling studies, this paper presents a brief account of relevant research conducted for validation purpose. The paper first reviews the early studies conducted to testify theories about language ability, then examines the more recent efforts made to validate language construct in specific testing situations. Suggestions for future studies were made with regard to how to apply factor modeling in specific research contexts.

1. Introduction

Over decades, factor modeling has been an effective method for collecting validity evidence in language testing research (Oller Jr, 1979; Kunnan, 1994; Chapelle, 1999). This quantitative method could demonstrate the relationship between test performance and the construct to be measured, providing crucial evidence for construct representativeness. The investigation of the fitness of the empirical test performance to a psychometric model hypothesized based on a given construct theory helps clarify the dimensionality of the construct in focus (Gu, 2011).

This study presents a brief review of validity research using factor analysis to demonstrate the usefulness of the quantitative methodology. After examining how factor analysis was introduced to construct studies, the researcher focused on its application in writing assessment. Suggestions for future studies were made with regard to how to apply factor modeling in specific research contexts.

2. Factor analysis in language model validation

Bentler (1978) proposed using modeling approach in construct validation study. He argued that a causal-modeling approach can shed light on the entire nomological network of the relationship among a given construct, other constructs and the manifest variables. Foci in construct modeling studies included investigation on the “components”, “traits” and “factors” of language proficiency.

Taking the perspective of a language test developer, Oller (1979) is the first to apply factor analyses to validate theories about language proficiency. To address one crucial question as whether “language ability can be divided up into separately testable components” (ibid., p. 243), hypothetical models were proposed in line with three competing theories regarding the nature of language proficiency. The divisibility hypothesis assumed that tests of different components could not be accounted for by a unique variance (Spearman, 1904; Spolsky, 1968). The indivisibility hypothesis was based on structuralism (Lado, 1961; Carroll, 1965), claiming that all tests shared the same variance. A third hypothesis, as a weak form of the unitary hypothesis, stated that performance on a particular test was explainable by both a shared variance and a unique variance.

Bachman and Palmer (1982) posited communicative competence comprised three distinct traits, linguistic competence, pragmatic competence, and sociolinguistic competence. They applied confirmatory factor analysis (CFA) to investigate language use data of four assessment tasks, interview, writing, multiple-choice, and self-rating. The results showed the higher-order general factor model fit the data excellently, rejecting the completely unitary model and the completely divisibility model. They hence concluded that communicative competence could be explained by two sub-competences: one was a first-order trait factor for grammatical and pragmatic competence, and the other was the sociolinguistic competence as one independent trait.

Bachman and Palmer (1982) examined the tested three language ability models in four different

language assessment tasks. The writing sample test they used contained a variety of tasks, ranging from short answer items to extended composition writing. The writing tasks were scored with reference to three main traits: grammatical competence associated with range and accuracy; pragmatic competence related to vocabulary, cohesion and organization; and sociolinguistic competence with reference to the distinction of formulaic, register substantive, nativeness, and cultural reference. Factor analysis results showed that writing had two sub-constructs: one was the grammatical and pragmatic competence, the other the sociolinguistic competence, and both loaded onto a higher-order general factor.

On the basis of the human-information processing theory (Gagné et al., 1993), Purpura (1997; 1998) looked into the relationship between cognitive and metacognitive strategy use and how they were related to L2 language performance. Structural equation modeling (SEM) discovered that cognitive strategy use was a multidimensional construct composed of three factors, comprehending, memory and retrieval, and the metacognitive strategy was a unidimensional construct consisting of the assessment factor, which encompassed planning, monitoring and evaluating strategies. Purpura (1999) found cognitive strategy mediated the effect of metacognitive strategy on test performance. He thus suggested that Bachman and Palmer's strategic competence model (1996) should be expanded to include cognitive strategies.

Song (2005) inspected the relationships between ESL learners' strategy use and their language test performance on the Michigan English Language Assessment Battery (MELAB). Exploratory factor analyses identified six cognitive strategy use factors and three metacognitive strategy use factors. The subsequent regression analyses showed mixed results about the influence of strategy use on test scores: some of the metacognitive and cognitive strategies had a significant, positive effect on language performance, and some had significant, negative impact, whereas others had no significant impacts at all.

Phakiti (2003) asked test takers to complete a research questionnaire after a reading test to closely model the relationship between the strategy use and reading test performance. The exploratory factor analysis (EFA) revealed that both metacognitive and cognitive strategies load onto a single metacognitive competence factor. Phakiti (2008) used SEM to specify the interrelationships among Thai English learners' reading performance and their reported use of three types of strategy use: metacognitive strategies, the more task-specific cognitive strategies, and test-taking strategies. The metacognitive strategy use variable was found to be the overarching factor affecting cognitive strategy use factors covering learning strategies, test-taking strategies and test-wisness strategies. Cognitive strategies had a direct impact on task performance and mediated the impact of metacognitive strategies on the task performance.

3. Factor analysis studies in writing assessment

While indispensable for examining test performance, testing tasks are simultaneously obscure or even alters the use of language ability under observation (Bachman, 1990). Consequently, it is important to explore the particular construct being measured by a specific test, as demonstrated by the writing assessment studies presented below.

Yang (2009) employed SEM to explore the relationship between writing strategies (rhetorical strategies, self-regulatory strategies and test-taking strategies) and L2 writing performance based on questionnaire study. SEM results demonstrated that the self-regulatory strategy use had a direct impact on the rhetorical and test-wisness strategy use and indirectly influenced test performance. Rhetorical strategy use was found to have a direct positive impact on writing performance, while test-wisness strategy exerted a negative influence. The retrospective interview revealed that the high-performance group tended to use more selecting and organizing strategies when reading, while low-performance group's use of selecting and connecting signified their weakness in listening comprehension.

Bae and Bachman (2010) investigated writing traits in two elementary language tasks in English and Korean. Content, grammar, spelling and text length were established a priori as the writing construct components. CFA results indicated that the higher-order factor model to be a statistically

parsimonious model. The task methods were found to exert a weak and inconsistent effect on writing tasks in two languages.

In light of a three-strand writing cognition construct framework (expressive language and literacy skills as Strand I, composing strategies as Strand II, and critical thinking for writing as Strand III) proposed by Deane et al. (2008), Deane et al. (2011) conducted a factor analysis study on the construct composites measured by the E-rater. EFA on the Attali/Powers (2008) data set identified ten dimensions for the writing construct. After editing out three problematic factors, a second EFA on the remaining factors were performed. A three-factor structure comprising word choice, fluency, and convention was confirmed by the CFA. Researchers suggested that the identified language use factors measured the first two strands of the competency model, as the academic orientation factor was associated with Strand I and elaboration and sentence complexity factors were related to Strand II. Thereby, the researchers concluded that automated scoring can be used to measure these parts of the said competency model.

Sawaki et al. (2013) examined the writing construct in the TOEFL iBT test and its relationship with other tasks within the test. This integrated task required writers to produce writing based on a listening and a reading material. Hence, the factor analysis not only included writing variables in terms of analytical ratings produced by automated and human rating, but also the reading and listening variables measured by previous sections. Three factor models were tested on the nine sub-constructs produced by the EFA. The higher-order factor model was considered superior to the correlated three factor model and unitary trait model, based on theoretical and statistical considerations. The examination of the relationships among the writing, reading and listening variables indicated that the comprehension higher-order model chosen as the final model. The research findings showed the writing construct have three correlated but distinct sub-constructs and comprehension functioned as a common dimension underlying listening, reading and writing, accounting for the content aspect of integrated writing.

4. Conclusion

This paper demonstrated that factor modeling is an effective method to validate language theory and specify the construct components of writing tasks. The development from the early form of EFA to the combination of EFA and CFA, then to the SEM reflected not only growing complexity in statistical means, but also the depth of understanding and consensus among scholars regarding what constitutes language ability. For instance, now it is generally accepted that language ability is an over-arching factor impacting on all the construct composites.

In the context of writing assessment, factor analysis is especially useful for disentangling the implicit connection among score reported and the analytical rating items, linguistic index, and relevant testing tasks. More studies employing this method are expected to shed more light on the underlying construct of writing.

Acknowledgements

This research was financially supported by the Philosophy and Social Sciences of Guangzhou City Planning Project (2018GZGJ110) and the Innovative Research Team Project of Guangdong Mechanical & Electrical Polytechnic.

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