

# A Framework for Applying Language Testing Methods to Support Systems of Second Language Use

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## 論文の内容の要旨

### A Framework for Applying Language Testing Methods to Support Systems of Second Language Use

(言語テスト手法を第二言語使用の支援システムに適用するためのフレームワーク)

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(本文)

(Body) The combination of globalization and widespread use of text communication over the Internet has led to the growing use of computers for reading and writing texts written in a second language – especially English. Practical application systems for providing automatic support to second language users in reading and writing have been proposed in various fields, including natural language processing (NLP).

Moreover, the methodologies used to test second language knowledge have become quite sophisticated over the past several decades in the field of language testing. There is still no framework, however, that enables collaboration between these two fields despite the progress made in each field in recent years. This lack of collaboration means that second language knowledge is not obtainable in practical support systems although it is essential for personalizing support. Personalization of support for second language users is important since their language abilities can greatly vary. Moreover, the mathematical models used for language testing are difficult to apply to practical application systems.

This thesis presents a novel unified framework for practical application systems that enables language testing methods and support systems to be used together. Within

language testing, we focus on vocabulary testing because vocabulary knowledge is essential and is used for measuring higher levels of second language knowledge such as reading and writing ability. To determine to which application systems vocabulary testing methods are easily applicable, this thesis categorizes existing application systems supporting second language users by using a proposed three-handshake model. With this model, we can see that reading support is one of the applications to which vocabulary testing can most easily be applied.

We then identified the properties that language testing models should have to be used in practical application systems. The desired properties are *interpretable parameters using language testing models*, *globally optimal parameter estimation*, *out-of-sample setting*, and *noisy stimuli (word) detection*. Previous models for vocabulary testing, namely the item response theory models, do not have all the desired properties. For example, those with noisy word detection are non-convex, and thus lack the first property. We cannot apply language testing models to practical support systems as-is because such models require more robust parameter estimation. To tackle this problem, we developed a novel mathematical framework for deriving convex models with noisy word detection. The derived models have all the desired properties.

Finally, we tested the proposed framework by creating a reading support system that automatically detects words unfamiliar to users and highlights those words. We also created the first dataset covering a large body of English as a second language user's vocabulary knowledge.

The contributions of this thesis are 1) the proposal of a unified framework that enables language testing to be applied to application systems, 2) the proposal of a mathematical model that satisfies all the desired properties, 3) the demonstration of the proposed framework for reading support, and 4) the creation of the dataset.