Recently, the Test of English as a Foreign Language (TOEFL) changed by including a writing section that gives the examinee an option between computer and handwritten formats to compose their responses. Unfortunately, this may introduce several potential sources of error that might reduce the reliability and validity of the scores. The seriousness of these sources of error was studied by examining the quality of the ratings and the distribution of construct-irrelevant variance. Participants were 152,951 TOEFL examinees who participated in regular TOEFL administrations. Results indicate that raters have slightly better agreement for word-processed essays than handwritten essays. The generalizability analyses suggest that this is caused by the interaction of examinees x items x readers confounded with undifferentiated error. (Author/SLD)
The Impact of Composition Medium on Essay Raters in Foreign Language Testing

Jonathan R. Manalo
Edward W. Wolfe
Michigan State University
Abstract

Recently, the Test of English as a Foreign Language changed by including a writing section that gives the examinee an option between computer and handwritten formats to compose their responses. Unfortunately, this may introduce several potential sources of error that might reduce the reliability and validity of the scores. We attempted to identify the seriousness of this by examining the quality of the ratings and the distribution of construct-irrelevant variance. Results indicated raters have slightly better agreement for word-processed essays than handwritten essays. The generalizability analyses suggest this is caused by the interaction of examinees × items × readers confounded with undifferentiated error.
The Impact of Composition Medium on Essay Raters in Foreign Language Testing

Currently, the Test of English as a Foreign Language (TOEFL) requires examinees to complete a computer-based multiple-choice section as well as a writing section administered by either computer or pencil and paper. However, by administering the writing section in both media, the potential for construct-irrelevant variance to negatively impact the scores becomes a greater concern. That is, there is a higher likelihood that the composition medium may influence the reliability of the scores and the accuracy of the inferences that are based on those scores. A potential reason for this error may be differential rater perceptions. Raters may perceive an essay composed in one medium to be qualitatively different from an essay composed in another medium. For example, Powers, Fowles, Farnum, and Ramsey (1994) found that when an essay composed in handwriting is subsequently transcribed to a typewritten format, raters prefer to read the handwritten essays. Similarly, raters may have higher expectations for the computer-based essays (Arnold, Legas, Obler, Pacheco, Russell, & Umbdenstock, 1990). Other researchers have found that raters potentially perceived differences in the apparent length, ease of reading, and surface correctness of handwritten and word-processed essays (Bridwell, Sirc, & Brooke, 1985; Hawisher, 1987; Levin, Riel, Rowe, & Boruta, 1985). Fortunately, raters can be trained to compensate for their perceptual differences (Powers et al., 1994). Hence, a specific rater’s judgements can be made to be consistent across the different formats.

Research Questions

Research, however, has yet to provide evidence of this for foreign language examinees. Our purpose is to determine the degree rater judgements are affected by computer-based and handwriting composition mediums for a foreign language examination, specifically, the TOEFL.
Our research question is: "To what degree are rater judgements affected by computer-based and handwriting composition mediums for the TOEFL?"

Method

Examinees

Participants were 152,951 TOEFL examinees (males = 53.5%, females = 46.5%) from 223 countries that participated in a regular administration between 1/24/98 and 2/9/99 of the computer-based TOEFL test. Most of the examinees indicated taking the test for admittance into undergraduate (39%) or graduate studies (45%). The others indicated non-academic reasons (16%). Each examinee was administered a computer-based multiple-choice section, while being offered the choice of word processor (51.5%) or handwriting (48.5%) for the single prompt of the writing section.

TOEFL

The TOEFL test consists of four sections: (a) listening, (b) structure, (c) reading, and (d) writing. As stated previously, the examinee is administered the computer format for the multiple-choice sections listening, structure, and reading, while for the writing section, the examinee is given the choice between paper and pencil or a word processor. Our analyses focused only on the responses to the writing section.

The writing section measures the examinee’s proficiency in writing English. A single prompt requires examinees to compose a response that accomplishes the following: (a) generate, organize, and develop ideas; and (b) support those ideas using examples or evidence. Examinees are given 30 minutes to respond to the prompt. Operationally, the writing section is scored on a scale ranging from 1 to 6 by two trained and independent readers (i.e., trained in interpreting the
response to TOEFL standards, to score across multiple topics, and to use the software which essays are distributed to the readers and scores are recorded; and independent from knowing the score assigned by the other reader). The average of the two scores (i.e., writing composite score) is assigned to the essay unless there is a discrepancy between the two readers. In that case, a third independent reader rates the essay, and the score is resolved (ETS, 1999).

Analysis

Quality of the Ratings. The analysis of the quality of the ratings was accomplished by examining scores assigned to handwritten and word-processed essays separately using several reliability indices. The first index, the Pearson product moment correlation (r), was computed using the scores assigned by the two randomly selected readers for each examinee's essay. The second index, or group of indices, is the proportion of perfect, adjacent, and outside-of-adjacent agreement between the two reader scores. These were determined by the absolute differences between the two scores that were equal to 0, 1, and 2 or more points on the 6-point TOEFL rating scale, respectively. The third index is Cohen's coefficient kappa (κ)

\[ \kappa = \frac{P_o - P_e}{1 - P_e} \]

This coefficient indicates the degree to which readers agree beyond the level expected by chance, where \( P_o \) is the observed proportion of ratings in perfect agreement and \( P_e \) is the expected proportion of ratings in perfect agreement based on the marginal distributions of ratings assigned by the two readers.

Generalizability Analyses. The generalizability analyses examines the scores assigned to handwritten and word-processed essays separately to determine the extent ratings are influenced by construct-irrelevant variance. Here, we used a \((e : i) \times r\) design, where examinees (e) are
nested within items (i) and crossed with readers (r). Variance components and dependability coefficients (\( \phi \)) were estimated between the two modes of composition and then compared. The \( \phi \) coefficients were calculated using

\[
\phi = \frac{\sigma^2_{(e_i)}}{\sigma^2_{(e_i)r} + \frac{\sigma^2_i}{n_i} + \frac{\sigma^2_{(e_i)r,e}}{n_i n_r}}
\]

where \( \sigma^2 \) is the variance component for a facet of the measurement design (i.e., a main effect for examinees, \( e \), items, \( i \), or raters, \( r \), or some interaction of these sources of variance), and \( n \) is the number of elements of that facet across which observed scores are recorded.

Unfortunately, because the sample size was very large (152,951), estimating variance components for all the data in a single estimation 'run' was limited by the software capabilities of Proc Varcomp in SAS (1998). However, by dividing the data in each medium into five mutually exclusive data sets, estimation of the variance components was possible. That is, we averaged the variance components (weighted by the sample size of the respective data set) of the five mutually exclusive data sets for each medium. The \( \phi \) coefficients were estimated using these weighted averages.

Results

Quality of the Ratings

The indices of rating quality are shown in Table 1. Specifically, for each composition medium, we show the following indices: (a) the Pearson product moment correlation \( r \), (b) Cohen's coefficient kappa \( \kappa \), and (c) the percent of perfect, adjacent, and outside-of-adjacent agreement. The table reveals that, in general, the differences in the quality of the ratings, although only modest, are in favor of the word-processed essay scores. That is, it was generally
easier for readers to agree on scores for the word-processed essays than for the handwritten essays. This was true regardless of the index we considered. Specifically, \( r \) is .67 for readers of handwritten essays and .74 for readers of word-processed essays. \( \kappa \) is .30 for readers of handwriting essays and .35 for readers of word-processed essays. The agreement indices are roughly equal, but slightly in favor of readers of computer based essays. Specifically, the degree of perfect agreement (a difference of zero) is 50% for readers of handwritten essays and 51% for word-processed essays. The degree of adjacent agreement (an absolute difference of one) is 45% for handwritten essays and 44% for word-processed essays. The degree of outside agreement (an absolute difference of two or more) is 6% for readers of handwritten essays and 5% for readers of word-processed essays.

**Generalizability Analyses**

The generalizability analyses results are shown in Table 2. The analysis reveals that the scores for word-processed essays are more reliable than scores for handwritten essays. Specifically, the \( \phi \) coefficient is .79 for handwriting and .85 for word processing. The variance components reveal that the variance that is accounted for by the two mediums is equal or approximately equal between each mode for the item, reader, and item \( \times \) reader facets. It also suggests that the differences in random error across modes can be attributed to the undifferentiated error. In other words, there is more variance attributed to true variance (i.e., examinees) in word processing (73%) than in handwriting (65%), while there is less variance attributed to undifferentiated error variance in word-processing (23%) than handwriting (30%).

**Discussion**

To summarize, our findings revealed the following: (1) \( r, \kappa \), the degree of perfect agreement, and the \( \phi \) coefficient were lower when raters evaluated handwritten essays than when
they evaluated word-processed essays; (2) the degree of non-perfect agreement (adjacent and outside) was lower for readers of word-processed essays than for readers of handwritten essays; and (3) more variance is attributed to true variance for word processors than handwritten essays, while more error variance is attributed to undifferentiated error variance for handwritten essays than word-processed essays.

Although these differences are small, specifically, the reliability differences are no greater than .07, and the degree of agreement (or non-agreement) does not differ by more than 7%, these findings are consistent with other research (e.g., Bridgeman & Cooper, 1998). Given the high stakes of large-scale examinations, these small but consistent findings take on greater meaning. Our findings suggest that having different writing formats in large-scale examinations, at least in the case of the TOEFL, may introduce construct-irrelevant variance into the rater’s judgements. Our generalizability analyses suggests that this is possibly the result of the interaction of examinees × items × readers in conjunction with the undifferentiated error variance. In other words, the cause of the poorer agreement among scores for handwritten essays may lie in the non-uniformity of these essays (i.e., differences in handwriting quality, etc.)—a conclusion that was also drawn by Bridgeman and Cooper (1998). Therefore, our findings suggest that the scores for handwritten essays will have decreased reliability, and consequently, the inferences that are based on those scores may have decreased validity. Hence, the fairness of using such scores to make decisions about these individuals is questionable.

There are three general limitations to our study. First, the results of the reliability analyses are not as convincing or informative as they could be if a better design or more appropriate analytic method was employed. For example, our design did not allow us to examine sources of error that would have been informative, such as the examinee × rater interaction.
Here, this was confounded with undifferentiated error. Second, examinee ability confounds any difference between media (i.e., selection is a threat to internal validity). It may well be that the observed differences are due to differences in the variance of the two populations. Third, computer hardware and software limitations prevented us from performing the cleanest and most sophisticated analyses that we could have performed. For example, we may have been able to more directly estimate the variance components for the generalizability study and to use better methods for combining variance component estimates (i.e., weighting each variance component by its estimation variance rather than by its sample size) from the subsets of data that we analyzed separately if we were to have used Proc Mixed in SAS rather than Proc Varcomp. Future research could perform more complete and more sophisticated generalizability analyses of these data.
References


Table 1

Indices of Rating Quality for Readers of Handwriting and Word-Processing Composition

Mediums of the TOEFL

<table>
<thead>
<tr>
<th>Composition Medium</th>
<th>Handwriting</th>
<th>Word Processing</th>
</tr>
</thead>
<tbody>
<tr>
<td>r</td>
<td>.67</td>
<td>.74</td>
</tr>
<tr>
<td>κ</td>
<td>.30</td>
<td>.35</td>
</tr>
<tr>
<td>% Perfect</td>
<td>50%</td>
<td>51%</td>
</tr>
<tr>
<td>% Adjacent</td>
<td>45%</td>
<td>44%</td>
</tr>
<tr>
<td>% Outside</td>
<td>6%</td>
<td>5%</td>
</tr>
</tbody>
</table>

Note. r = Pearson correlation coefficient. κ = Cohen's coefficient kappa. % Perfect, % Adjacent, and % Outside are the proportion of absolute differences between the two reader scores that were equal to 0, 1, and 2 or more points on the 6-point TOEFL rating scale, respectively. Sample size is 152,951.
Table 2

Generalizability Analyses for Readers of Handwriting and Word-Processing Composition

Mediums of the TOEFL

<table>
<thead>
<tr>
<th>Composition Medium</th>
<th>Handwriting</th>
<th>Word Processing</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\phi$</td>
<td>.79</td>
<td>.85</td>
</tr>
</tbody>
</table>

Variance Component

<table>
<thead>
<tr>
<th></th>
<th>Handwriting</th>
<th>Word Processing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examinee</td>
<td>65%</td>
<td>73%</td>
</tr>
<tr>
<td>Item</td>
<td>0.3%</td>
<td>0.3%</td>
</tr>
<tr>
<td>Reader</td>
<td>1.7%</td>
<td>1.6%</td>
</tr>
<tr>
<td>Item $\times$ Reader</td>
<td>2.5%</td>
<td>1.7%</td>
</tr>
<tr>
<td>Undifferentiated</td>
<td>30%</td>
<td>23%</td>
</tr>
</tbody>
</table>

*Note.* $\phi$ is the dependability coefficient. Sample size is 152,951.
Acknowledgements

This project greatly benefited from the input of our colleagues. Specifically, Claudia Gentile provided input into the design and data collection for this study. Pat Carey, Robbie Kantor, Yong-Won Lee, Philip Oltman, and Ken Sheppard each provided guidance in obtaining and interpreting the data. In addition, James Algina, Robert Brennan, Chris Chiu, and David Miller gave us advice during various stages of data analysis. We also thank the TOEFL program for providing us with the funds to carry out this work.
REPRODUCTION RELEASE

I. DOCUMENT IDENTIFICATION:

Title: THE IMPACT OF COMPETITION MEDIUM ON ESSAY HABITS IN FOREIGN LANGUAGE TESTING

Author(s): JONATHAN L. MANALO & EDWARD W. WOLFE

Corporate Source: AERA 2000 IN NEW ORLEANS

II. REPRODUCTION RELEASE:

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in the monthly abstract journal of the ERIC system, Resources in Education (RIE), are usually made available to users in microfiche, reproduced paper copy, and electronic media, and sold through the ERIC Document Reproduction Service (EDRS). Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.

If permission is granted to reproduce and disseminate the identified document, please CHECK ONE of the following three options and sign at the bottom of the page.

The sample sticker shown below will be affixed to all Level 1 documents

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

Level 1

☑

Check here for Level 1 release, permitting reproduction and dissemination in microfiche or other ERIC archival media (e.g., electronic) and paper copy.

The sample sticker shown below will be affixed to all Level 2A documents

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE, AND IN ELECTRONIC MEDIA FOR ERIC COLLECTION SUBSCRIBERS ONLY, HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

Level 2A

☐

Check here for Level 2A release, permitting reproduction and dissemination in microfiche and in electronic media for ERIC archival collection subscribers only.

The sample sticker shown below will be affixed to all Level 2B documents

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

Level 2B

☐

Check here for Level 2B release, permitting reproduction and dissemination in microfiche only.

Documents will be processed as indicated provided reproduction quality permits.

If permission to reproduce is granted, but no box is checked, documents will be processed at Level 1.

I hereby grant to the Educational Resources Information Center (ERIC) nonexclusive permission to reproduce and disseminate this document as indicated above. Reproduction from the ERIC microfiche or electronic media by persons other than ERIC employees and its system contractors requires permission from the copyright holder. Exception is made for non-profit reproduction by libraries and other service agencies to satisfy information needs of educators in response to discrete inquiries.

Signature: __________________________

Printed Name/Position/Title: JONATHAN L. MANALO, RESEARCH ASSISTANT

Organization/Address: 401 CLARKSON HALL, MICHIGAN STATE UNIVERSITY, EAST LANSING, MI 48824

Telephone: 517-355-8459

E-Mail Address: MANALOJ@M.S.U.EDU

Date: 5/13/99

(over)
March 2000

Dear AERA Presenter,

Congratulations on being a presenter at AERA. The ERIC Clearinghouse on Assessment and Evaluation would like you to contribute to ERIC by providing us with a written copy of your presentation. Submitting your paper to ERIC ensures a wider audience by making it available to members of the education community who could not attend your session or this year's conference.

Abstracts of papers accepted by ERIC appear in Resources in Education (RIE) and are announced to over 5,000 organizations. The inclusion of your work makes it readily available to other researchers, provides a permanent archive, and enhances the quality of RIE. Abstracts of your contribution will be accessible through the printed, electronic, and internet versions of RIE. The paper will be available full-text, on demand through the ERIC Document Reproduction Service and through the microfiche collections housed at libraries around the world.

We are gathering all the papers from the AERA Conference. We will route your paper to the appropriate clearinghouse and you will be notified if your paper meets ERIC's criteria. Documents are reviewed for contribution to education, timeliness, relevance, methodology, effectiveness of presentation, and reproduction quality. You can track our processing of your paper at http://ericae.net.

To disseminate your work through ERIC, you need to sign the reproduction release form on the back of this letter and include it with two copies of your paper. You can drop off the copies of your paper and reproduction release form at the ERIC booth (223) or mail to our attention at the address below. If you have not submitted your 1999 Conference paper please send today or drop it off at the booth with a Reproduction Release Form. Please feel free to copy the form for future or additional submissions.

Mail to: AERA 2000/ERIC Acquisitions
        The University of Maryland
        1129 Shriver Lab
        College Park, MD 20742

Sincerely,

Lawrence M. Rudner, Ph.D.
Director, ERIC/AE

ERIC/AE is a project of the Department of Measurement, Statistics and Evaluation at the College of Education, University of Maryland.