The Effects of an Automatic Speech Analysis System on Enhancing EFL Learners' Oral Reading Fluency

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Abstract

The purpose of the study was to investigate the effects of an ASAS (Automatic Speech Analysis System) on EFL learners' oral reading fluency from the perspectives of WCPM (words read correctly per minute), MFS (multidimensional fluency scale), and accuracy rate. A three by two between-subject design was conducted. Three classes of English-majored college students in central Taiwan were conveniently sampled and participated in the training. From each class, eight learners of low oral reading fluency and another eight of high oral reading fluency were chosen for data analysis. Learners in Class 1 enhanced their oral reading fluency with an audio player, Class 2 with a system-paced ASAS, and Class 3 with a learner-paced ASAS. Pretest and posttest were conducted before and after the training. During the 8-week training period, each student was required to read half of an article by repeating after the model speaker for thirty minutes each week. Two-way ANOVA simple main effect was conducted to analyze the data. Four conclusions were made. First, the training either with an audio player or with an ASAS enhanced learners' WCPM more than their MFS scores. Second, students of low oral reading fluency benefited more by practicing with the ASAS. Third, training either with an audio player or an ASAS didn't seem to help learners of high oral reading fluency much. Fourth, learners' enhancement of WCPM came mainly from the improvement of reading speed rather than accuracy rate.

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Keywords: automatic speech analysis system, oral reading fluency, multidimensional fluency, oral reading accuracy rate

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1. Introduction

1.1. Background and Motivation of the Study

One of the crucial components to the development of English reading ability is oral reading fluency which has been neglected in the curriculum of any English programs in Taiwan. In fact, sufficient oral reading fluency is essential to good reading comprehension and enjoyable reading experience (Zon,, 2002; Orosco, et al., 2008). When students read fluently, they make less effort on decoding and article chunking and therefore they may pay more attention to reading, comprehension (LaBerge & Samules, 1974). Clearly, students will understand better what they read when they are able to pay more attention to comprehension. Moreover, students’ knowledge of word meaning with its intonation, expression, phrasing and pausing determines their interpretation of the text (Rasinski, 2003).

Despite its importance to skilled reading, oral reading fluency has often been left out in the classroom (Allington, 1983; Zon, 2002; Bashir and Hook, 2009; National Institute of Child Health and Human Development, n.d.). In order to develop oral reading fluency, one of the approaches, guided repeated oral reading, is suggested. That is, teachers should encourage students to read passages orally with systematic and explicit guidance and feedback. Nonetheless, it is a common phenomenon that EFL learners in Taiwan usually do not read aloud when they read an English passage or article. One important reason to this negligence is test-oriented instruction prevalent in Taiwan. Another reason is the limited instructional materials and insufficient time for building students' oral reading fluency.

In this study, students were required to read aloud by using an ASAS (Automatic Speech Analysis System) and were expected to promote their oral reading fluency (Samuels, 1979; Chiu, Liou & Yeh, 2007; Schwienhorst (2008). Now, many speech analysis coursewares, such us PASTE, GoldenWave Digital Audio Editor, Voice Paramas, have become more and more reliable in promoting students’ English oral ability. Among these, MyET (My English Tutor) (http://www.myet.com/), a language learning and web-based software, is developed as an individual tutor by professional speech recognition researchers in Taiwan. It is categorized as an ASAS in helping language learners improve speaking skills. MyET offers acoustic analyses of learners’ English oral performance according to pitch, timing, pronunciation and emphasis. Learners listen to native speakers’ demonstration in this system, and then imitate the model through microphone recording. Next, learners are provided immediately scores and feedbacks by the system. Furthermore, MyET analyzes the voice problems on segments and suprasegments through graphic displays of pitch profile for each learner. Because of the function of MyET, this study attempts to use it to motivate and model students’ practice of reading aloud and to investigate its effect on students’ oral reading fluency as the result of each practice.

1.2. Purpose of the Study and Research Questions

This study tried to investigate the effect of an ASAS on EFL college students' oral reading fluency from three perspectives: WCPM (Words read Correctly Per Minute), multidimensional fluency, and oral reading accuracy rate.

Based on the above purposes, four research questions are hereby proposed.

1. Is an ASAS more efficient than an audio player in improving EFL learners’ oral reading fluency in terms of WCPM?
2. Is an ASAS more efficient than an audio player in improving EFL learners’ oral reading fluency in terms of multidimensional fluency?
3. Is EFL learners' oral reading accuracy rate enhanced with the use of an ASAS?
2. Literature Review

2.1. Oral Reading Fluency

Laberge and Samuels (1974) and Carver (1997) had agreed that efficient oral reading could be defined as "that level of reading competence at which textual material can be effortlessly, smoothly, and automatically understood" (Schreiber, 1980, p.177). Moreover, Meyer and Felton (1999) defined fluency in a similar definition as "the ability to read connected text rapidly, smoothly, effortlessly, and automatically with little conscious attention to the mechanics of reading such as deciding" (p.284). Hudson, Mercer and Lane (2000) argued that oral reading fluency involved "accurate reading at a minimal rate with appropriate prosodic features and deep understanding" (p16).

Oral reading fluency could be determined or counted by reading correct words per minute. Hence, the scores mirror small, approximately equal interval units (L.S. Fuchs & Fuchs, 1999). Basically, fluent reading had been featured as the accurate and swift expressing of a passage, associated with adequate reading comprehension (Levy, Ablleo & Lysynchuk, 1997). "Oral reading fluency is the ability to read accurately, quickly, effortlessly, and with appropriate expression and meaning" (Rasinski, 2003, p.31). Oral reading fluency was indexed by the speed and accurate recognition of isolated words in order to predict reading ability and comprehension (Martin-Chang S. & Levy B.2006). Wolf and Katzir-Cohen (2001) also defined reading fluency as "a level of accuracy and rate where decoding was relatively effortless; where oral reading was smooth and accurate with correct prosody; and where attention can be allocated to comprehension" (p.219). To be specifically, reading fluency meant a level of correctness and pace at which decoding was effortless and at which oral reading was stable and accurate with right prosody. Basically, fluent reading could be seen as a feature of accurate and speedy understanding of a text and could be conjoined with reading comprehension (Levy, Ablleo & Lysynchuk, 1997).

2.2. Computer-Assisted Modeling and Oral Reading Fluency

The computer has been seen as an effective tool to assist students to improve oral reading fluency. Computer could provide a model of fluent reading and learners follow the model. Carver & Hoffman (1981) said that computer-assisted programs could help learners improve oral reading fluency. Computer-assisted language learning is related to behavioristic and cognitive styles in teaching such as drill-and-practice and tutorial software (Wyatt, 1984; Juel, 1996; Thaler, Ehner, Wimmer and Landerl, 2004; Kartal, 2006). Specifically, August (2003) stated that the use of technology could help EFL literary education. The National Reading Panel (NRP) stated that the applied speech recognition technology in reading curriculum is a field in need of advanced research (NRP, 2000).

According to Poulsen, Hastings and Allbritton’s study (2007), a Reading Tutor which uses automated speech recognition to "listen" to children read aloud, providing both spoken and graphical feedback., had significant evidence to enhance of EFL students’ oral reading fluency. This technology analyzes children’s oral reading, record their location within the context of a passage and offer feedback to children immediately and in response to difficulties they face during the oral reading task. The measurement of fluency includes two parts: total words per minutes in reading and correct words per minute. Furthermore, researchers also measured sight word recognition measure as indication of fluency. The result showed that participants’ fluency and sight word recognition were improved under the LISTEN system. In other words, a Reading Tutor had significant evidence to enhance of EFL students’ oral reading fluency.

3. Methodology
3.1. Design of the Study

A three by two between-subject design was conducted. Two independent variables are included in the study: 1. training method including reading aloud with an audio player, reading aloud with a system-paced ASAS and read aloud with a learner-paced ASAS and 2. learners’ original oral reading fluency, categorized as learners of low oral reading fluency (LORF) and high oral reading fluency (HORF). There were 8 participants in each cell. All participants took the pretest and the posttest before and after the training. Their words read correctly per minute (WCPM), multidimensional fluency scores (MFS), and accuracy rate (words read correctly / words read per minute) are dependent variables.

3.2. Participants

Three classes of English-majored college students in central Taiwan were conveniently sampled. Learners in Class 1 received the training with an audio player, Class 2 with a system-paced ASAS, and Class 3 with a learner-paced ASAS. From each class, eight learners of low oral reading fluency and another eight of high oral reading fluency were chosen for data analysis. Among them, 24 were male and 24 female. They aged from 18 to 21 and had learned English for more than 6 years.

3.3. Instruments

Sixteen multimedia computers with an ASAS were used in this study. Each participant in Class 2 and Class 3 had his/her own username and password for logging into the ASAS. When learners finished reading each sentence, the scores of pronunciation, pitch, timing and emphasis were given on the right part of the screen. The model’s and the learner's spectral wave was compared on the bottom of the screen. Four articles were from the Studio Classroom magazine – advanced level (2006), one of the most popular magazines for English learning in Taiwan. They were put in the ASAS for ORF practice. All contexts were related to the topic of technology. Each article was divided into two parts, one part as one lesson in the ASAS. Their readability ranges from 5 to college grade level, calculated by Flesch-Kincaid and SMOG formulas. Some sentences from the four articles were selected to be the contents of the pretest and posttest.

3.4. Procedure of Data Collection

The pretest, training, and posttest were conducted over 10 weeks. In the first week, each participant read one article, which was one of the article used in the training, aloud to be recorded as the pretest data. From the second to the ninth week, participants were required to read four articles aloud, half an article in one week for 30 minutes, with an audio player (Class 1), the system-paced ASAS (Class 2), or the learner-paced ASAS (Class 3). In the tenth week, the posttest was done. Each participant read the same article as in the pretest aloud and their voice was recorded for later analysis.

3.5. Data Analysis Method

Three scoring included 3 parts: words read per minute (WPM), words read correctly in a minute (WCPM) and multidimensional fluency score (MFS). The standard of determining words read correctly (Table 1) was adopted from Blevins’ article (2001). Participants’ multidimensional fluency score was given on a multiple reading scale, adopted from Rasinski and Zutell’s study (1996). There are four items:
accuracy, phrasing, smoothness and pace, with 1 to 4 points for each item. Two raters scored participants WCPM and MFS for acceptable inter-rater reliability above .85 (Cohen & Manion, 1994, p.139-140).

Table 1. Standard of Word Read Correctly or Incorrectly

<table>
<thead>
<tr>
<th>Words read correctly</th>
<th>Words read incorrectly</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Pronounce correctly</td>
<td>● Mispronunciation</td>
</tr>
<tr>
<td>● Self-correction within 3 seconds</td>
<td>● Substitution</td>
</tr>
<tr>
<td>● Read repeatedly</td>
<td>● Omission</td>
</tr>
<tr>
<td></td>
<td>● Don’t read within 3 seconds</td>
</tr>
</tbody>
</table>

Two-way ANOVA simple main effect was conducted to compare pretest and posttest scores for the effectiveness of the ASAS and the influence of original oral reading fluency on the enhancement of WCPM, MFS, and accuracy rate.

4. Results and Discussion

Two raters were responsible for scoring students' oral reading fluency with the standard of WCPM and MFS, as described above. Both raters were graduate students in a graduate institute of applied foreign languages and one of them is an English teacher at a junior high school in central Taiwan. The inter-rater reliability, indicated by Pearson Correlation Coefficient, is .99 for WCPM and .89 for MFS.

4.1. Analysis of WCPM

In terms of WCPM, Class 1, Class 2, or Class 3 all made significant progress with the training. As hypothesized, in enhancing oral reading fluency the ASAS helped learners more than the audio player, especially for those learners of low oral reading fluency (LORF).

![Figure 1. Comparison between Pretest and Posttest of WCPM](image)

The three different training methods help students significantly improve their WCPM after the training. For those learners of LORF, Table 2 shows that they benefited more from the use of the ASAS. (Comparison between Pretest & Posttest within Class 1: F=5.43, p=.030; within Class 2: F=17.07, p=.000;
within Class 3: \( F=23.41, p=.000 \). Figure 1 further shows that learners in Class 2 and Class 3 made more progress than those in Class 1 (Class 3: 87-68=19 > Class 2: 71-55=16 > Class 1: 67-58=9).

Table 2. Two-way ANOVA Simple Main Effect of WCPM

<table>
<thead>
<tr>
<th>ORF</th>
<th>Source of Variation</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>Within Cells</td>
<td>1269.95</td>
<td>21</td>
<td>60.47</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>Comparison between Pretest &amp; Posttest</td>
<td>328.52</td>
<td>1</td>
<td>328.52</td>
<td>5.43</td>
<td>.030</td>
</tr>
<tr>
<td>Low</td>
<td>within Class 1</td>
<td>328.52</td>
<td>1</td>
<td>328.52</td>
<td>5.43</td>
<td>.030</td>
</tr>
<tr>
<td>Low</td>
<td>within Class 2</td>
<td>1032.02</td>
<td>1</td>
<td>1032.02</td>
<td>17.07</td>
<td>.000</td>
</tr>
<tr>
<td>Low</td>
<td>within Class 3</td>
<td>1415.64</td>
<td>1</td>
<td>1415.64</td>
<td>23.41</td>
<td>.000</td>
</tr>
<tr>
<td>High</td>
<td>Within Cells</td>
<td>668.59</td>
<td>21</td>
<td>31.84</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>Comparison between Pretest &amp; Posttest</td>
<td>356.27</td>
<td>1</td>
<td>356.27</td>
<td>11.19</td>
<td>.003</td>
</tr>
<tr>
<td>High</td>
<td>within Class 1</td>
<td>356.27</td>
<td>1</td>
<td>356.27</td>
<td>11.19</td>
<td>.003</td>
</tr>
<tr>
<td>High</td>
<td>within Class 2</td>
<td>656.64</td>
<td>1</td>
<td>656.64</td>
<td>20.62</td>
<td>.000</td>
</tr>
<tr>
<td>High</td>
<td>within Class 3</td>
<td>306.25</td>
<td>1</td>
<td>306.25</td>
<td>9.62</td>
<td>.005</td>
</tr>
</tbody>
</table>

Regarding learners of high oral reading fluency (HORF), Table 2 indicates that all three classes made significant progress from the pretest to the posttest (Comparison between Pretest & Posttest within Class 1: \( F=11.19, p=.003 \); within Class 2: \( F=20.62, p=.000 \); within Class 3: \( F=9.62, p=.005 \)). Learners in Class 2, practicing with the system-paced ASAS, made the most progress (in Figure 1, Class 2: 112-99=13 > Class 1: 109-100=9 > Class 3: 106-98=8). The effects of the ASAS seem not very consistent for the HORF learners.

4.2. Analysis of Multidimensional Fluency

In investigating learners' multidimensional fluency scores (MFS), Table 3 shows that LORF learners made significant progress with the use of the ASAS (Class 2: \( F=9.64, p=.005 \); Class 3: \( F=8.10, p=.010 \)), but not with the use of the audio player (Class 1: \( F=.19, p=.671 \)). Figure 2 indicates the progress that LORF learners made from the pretest to the posttest (Class 2: 8.00-5.75=2.25 > Class 3: 10.63-8.56=2.07 > Class 1: 6.38-6.69=-0.31). The ASAS is helpful in enhancing LORF learners' multidimensional fluency.
On the other hand, for HORF learners, no matter what tool the learners used, all the learners did not make progress from the pretest to the posttest (in Table 3, Comparison between Pretest & Posttest within Class 1: $F=.21, p=.654$; within Class 2: $F=.12, p=.737$; within Class 3: $F=.46, p=.503$). Furthermore, Figure 2 displays that differences between the pretest and posttest are very small and even negative for Class 2 (Class 1: 12.75-12.50=0.25; Class 2: 13.44-13.63=-0.19, Class 3; 13.50-13.13=0.37).

Table 3. Two-way ANOVA Simple Main Effect of Multidimensional Fluency

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within Cells</td>
<td>44.09</td>
<td>21</td>
<td>2.10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comparison between Pretest &amp; Posttest</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>within Class 1</td>
<td>.39</td>
<td>1</td>
<td>.39</td>
<td>.19</td>
<td>.671</td>
</tr>
<tr>
<td>within Class 2</td>
<td>20.25</td>
<td>1</td>
<td>20.25</td>
<td>9.64</td>
<td>.005</td>
</tr>
<tr>
<td>within Class 3</td>
<td>17.02</td>
<td>1</td>
<td>17.02</td>
<td>8.10</td>
<td>.010</td>
</tr>
<tr>
<td>High</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>within Class 1</td>
<td>.25</td>
<td>1</td>
<td>.25</td>
<td>.21</td>
<td>.654</td>
</tr>
<tr>
<td>within Class 2</td>
<td>.14</td>
<td>1</td>
<td>.14</td>
<td>.12</td>
<td>.737</td>
</tr>
<tr>
<td>within Class 3</td>
<td>.56</td>
<td>1</td>
<td>.56</td>
<td>.46</td>
<td>.503</td>
</tr>
</tbody>
</table>

The above finding, answering part of research question 1, indicates that an ASAS is more efficient than an audio player in improving EFL learners’ oral reading fluency in terms of WCMP, but only LORF learners benefit from practicing with the ASAS in terms of multidimensional fluency. In fact, WCMP only involves accuracy and speed, but MFS includes other two parts: phrasing and smoothness. This is understandable in that the ASAS does not provide training on phrasing and smoothness. The results comply with Li’s (2002) argument that students of low oral reading fluency interact effectively with an ASAS.

4.3. Analysis of Accuracy Rate

Figure 3 Comparison between Pretest and Posttest of Accuracy Rate
Although the ORF training brought about certain effects on the enhancement of EFL learners’ oral reading fluency from the perspectives of WCPM and MFS, when accuracy rate, the percentage of WCPM over WPM, is concerned, learners' accuracy rate was not improved regardless of what tool those learners used (Table 4). For those LORF learners, only learners in Class 2 made significant progress on their accuracy rate (Comparison between Pretest and Posttest Class 1: F=.10, p=.759; within Class 2: F=6.66, p=.017; Class 3: F=1.88, p=.185). Figure 3 shows that LORF learners in Class 1 improved by 0% (86%-86%), Class 2 by 4% (92%-88%) and Class 3 by 2% (93%-91%).

On the other hand, according to Table 4 HORF learners' accuracy rate was not enhanced either by using the audio player or the ASAS (Comparison between Pretest & Posttest within Class 1: F=1.72, p=.204; within Class 2: F=.83, p=.373; within Class 3: F=.05, p=.832). Figure 3 shows that these learners made less than 3% of progress in reading words correctly (Class 1: 96%-93%=3%; Class 2: 95%-94% =1%; Class 3: 95%-95%=0%).

### Table 4. Two-way ANOVA Simple Main Effect of Accuracy Rate

<table>
<thead>
<tr>
<th>ORF</th>
<th>Source of Variation</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Within Cells</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Comparison between Pretest &amp; Posttest</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>within Class 1</td>
<td>6.5</td>
<td>1</td>
<td>.65</td>
<td>.10</td>
<td>.759</td>
</tr>
<tr>
<td></td>
<td>within Class 2</td>
<td>44.82</td>
<td>1</td>
<td>44.82</td>
<td>6.66</td>
<td>.017</td>
</tr>
<tr>
<td></td>
<td>within Class 3</td>
<td>12.64</td>
<td>1</td>
<td>12.64</td>
<td>1.88</td>
<td>.185</td>
</tr>
<tr>
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<td></td>
</tr>
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<td></td>
<td>Within Cells</td>
<td>242.58</td>
<td>21</td>
<td>11.55</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Comparison between Pretest &amp; Posttest</td>
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<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>High</td>
<td>within Class 1</td>
<td>19.85</td>
<td>1</td>
<td>19.85</td>
<td>1.72</td>
<td>.204</td>
</tr>
<tr>
<td></td>
<td>within Class 2</td>
<td>9.58</td>
<td>1</td>
<td>9.58</td>
<td>.83</td>
<td>.373</td>
</tr>
<tr>
<td></td>
<td>within Class 3</td>
<td>5.3</td>
<td>1</td>
<td>5.3</td>
<td>.05</td>
<td>.832</td>
</tr>
</tbody>
</table>

The above results imply that learners' oral reading speed is enhanced after the oral reading training, but the number of words read correctly is in fact not higher. That is, it is easier for learners to model the reading speed, but pronunciation of individual words may need other methods, such as the teacher's or peer's guidance and feedback.

### 4.4. Conclusions

From above results of data analysis, four conclusions are made here. First, training of ORF with an audio player or an ASAS enhances students' WCPM more than their MFS scores. WCPM only involves accuracy and speed (pace); whereas, the MFS includes other two parts: phrasing and smoothness. Instructor's individual or detailed explanation and corrective feedback may be necessary for students to improve phrasing and smoothness.

Second, students of LORF benefit more by practicing with the ASAS. This is especially true when students practiced their oral reading with the learner-paced ASAS. In this mode, they were able to repeat those sentences which they felt more difficult or unfamiliar. Therefore, they could read these sentences more fluently after the repeated practice. The finding corresponds to Taguchi, Takayasu-Mass and Gorsuch’s research (2004) in arguing that assisted repeated reading could potentially help weak EFL learners’ fluency. Begeny and Martens (2006) also argued that students who had the low oral reading fluency benefited from repeated reading.
Third, training either with an audio player or an ASAS doesn't seem to help students of HORF much. Since those students have already reached a certain level of reading fluency, individual instructor's or more specific guidance, such as linking of sounds, stopping, omission of sounds, and etc. may be more helpful.

Fourth, learners' enhancement of WCPM comes mainly from the improvement of reading speed rather than accuracy rate. Tijms (2007) pointed out that an ASAS made prominent development of reading speed, especially for the reading fluency of individuals with low proficient level. Many studies found that repeated reading improves students' reading fluency (Meyer & Felton, 1999; National Institute, 2000; Therreien, 2004). However, either an audio or an ASAS has limitation on improving learners' accuracy rate (Hintikka, Landerl & Aro, 2008; Klicpera and Schabmann, 1993). One-way modeling in an audio player or an ASAS could not give individual feedback for students to learn correct pronunciation. The enhancement of accuracy needs more interactive and individual instruction or feedback.

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References


