A Validity Study of the Evaluation Tool of Children’s Handwriting–Cursive

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OBJECTIVES. This study examined concurrent validity of the Evaluation Tool of Children's Handwriting–Cursive (ETCH-C) by comparing ETCH-C total legibility percentage scores with handwriting grades from teachers. The study also identified the legibility percentage score discriminating between satisfactory and unsatisfactory handwriting.

METHOD. The participants were 101 fourth graders who completed two handwriting instruments. Three teachers sorted the Cursive Practice and Review work sheets into A, B, C, and unsatisfactory groups to establish handwriting grade. The study compared ETCH-C total legibility percentage scores with teacher grading, using personal judgment of handwriting on the Cursive Practice and Review work sheet.

RESULTS. Mean legibility percentage scores increased significantly as handwriting grade increased. The concurrent validity coefficients were .61 for ETCH-C total words and .65 for ETCH-C total letters and handwriting grade. ETCH-C legibility percentage scores discriminating satisfactory from unsatisfactory handwriting ranged from 73% to 82% on ROC (receiver operating characteristic) curves.

CONCLUSION. Results support the concurrent validity of the ETCH-C with handwriting grades. A 75% word legibility percentage score discriminated satisfactory and unsatisfactory handwriting.


Students having difficulty performing the occupational task of handwriting often are referred to occupational therapists for evaluation (Chu, 1997; Jewell, 1999; Vreeland, 2000). Occupational therapists assess the students’ handwriting performance; identify the problem areas; and develop an intervention plan with teachers, students, and parents (Chu, 1997).

Legibility is one of the most important components of handwriting assessment and is defined as the ease with which a letter, word, or number can be identified and read in isolation (Amundson, 1995; Graham, Boyer-Shick, & Tippets, 1989). The primary factors that determine legibility are letter formation, spacing, size, slant, horizontal alignment, and general appearance (Daniel & Froude, 1998; Graham et al., 1989; Hamstra-Bletz & Blöte, 1990). Talbert-Johnson, Salva, Sweeney, and Cooper (1991) evaluated the legibility of cursive handwriting and found that easy-to-read handwriting ranged from 95% to 100% legibility ($M = 99\%$) and that difficult-to-read handwriting ranged from 60% to 90% legibility ($M = 78\%$).

Cronbach and Meehl (1991) proposed that to improve the construct validity of an assessment, the composition of the tasks must be a heterogenous mix of the construct to be measured. According to Kaminsky and Powers (1981), a good handwriting assessment should include classroom observation of the student during a writing task, far-point copying, near-point copying, dictation, and a paragraph-length composition task. Most handwriting assessments developed by occu-
pational therapists, including the Handwriting Performance Test (Ziviani & Elkins, 1984), the Handwriting Evaluation Scale (Malloy-Miller, 1985), the Minnesota Handwriting Test (Reisman, 1987), the Tseng Teacher Handwriting Test (Tseng, 1994), and the Handwriting Profile (Chu, 1997), produce scores based on only one or two types of writing tasks or provide the therapist with only qualitative information on handwriting skills. Amundson (1995) developed the Evaluation Tool of Children’s Handwriting (ETCH) for school-based occupational therapists to use when assessing elementary-age students with illegible printing or cursive handwriting. The ETCH differs from other handwriting assessments in that it allows the examiner to assess up to eight different types of writing tasks. Limitations of the test are that it does not evaluate handwriting endurance through a paragraph-length composition task and does not provide separate scores for letter formation, size, case, alignment, and spacing.

School-based occupational therapists require valid and reliable instruments to effectively interpret the scores of children with handwriting problems and to establish the efficacy of handwriting assessments for scientific research (Feder, Majnemer, & Synnes, 2000; Schneck, 1998). Diekema, Deitz, and Amundson (1998) studied the test–retest reliability of the Evaluation Tool of Children’s Handwriting–Manuscript (ETCH-M) and found reliability coefficients of .63 for total numeral, .77 for total letter, and .71 for total word legibility percentage scores. Total legibility percentage scores were more reliable than individual task scores, so the researchers recommended that therapists use total legibility percentage scores when evaluating progress and making intervention decisions.

Although the reliability of the ETCH has been studied, the validity of the ETCH still needs to be established. This study extends the research on the psychometric properties of the ETCH. According to theorists Cronbach and Meehl (1991), no test is simply valid or invalid but always has multiple validities and invalidities. The validity of any test depends on the degree to which the test measures the intended traits or attributes compared with the degree to which it measures ancillary traits or attributes (Cronbach & Meehl, 1991; Ghiselli, 1964; Snow & Wiley, 1991). To establish concurrent validity, the researcher seeks to demonstrate a relationship between the predictor variables and the criterion (Ghiselli, 1964). In a concurrent validity study, it is important that the individuals’ scores on each measure result in similar rankings (Ghiselli, 1964). The purpose of this study was to establish the Evaluation Tool of Children’s Handwriting–Cursive (ETCH-C) as a valid assessment of handwriting in school-based occupational therapy practice by comparing ETCH-C results with the established standard of teacher grades obtained by personal judgment (Reisman, 1993) for cursive handwriting completed within the classroom setting. The study addressed the following research questions:

1. Will ETCH-C total legible words and letters scores rank the students’ cursive handwriting similarly to the teachers’ grades?
2. What is the strength of the relationship between ETCH-C total legible words and letters scores obtained from a setting outside the classroom and the handwriting grades assigned by teachers on the Cursive Practice and Review work sheets administered within the classroom setting?
3. What are the legibility percentage scores that discriminate satisfactory cursive handwriting from unsatisfactory cursive handwriting?

**Method**

**Participants**

The participants in the study were a socioeconomically representative sample (1990 state census) of 101 (57 female, 44 male) fourth graders from four elementary schools in a large suburban school district. The participating schools represented one school with the highest percentage, two schools with an average percentage, and one school with the lowest percentage of students with free and reduced cost lunches in the school district. Consent for the study was obtained from the sponsoring University Human Investigation Committee, school administrators, teachers, parents, and students. Parental informed consent was obtained for 43.46% (102 students) of all fourth graders enrolled in the four elementary schools participating in the study.

The participants ranged in age from 9 years 0 months to 10 years 7 months (M = 9 years 2.3 months). Ninety-three percent were right-handed, and 7% were left-handed. The participants were 78% White, 13% East Indian, 4% Asian, 3% Black, and 2% Hispanic. Because the ETCH-C was intended for all students, special education students were not restricted from the study. Ninety-four percent of the participants were regular education students, 5% were certified speech and language impaired, and 1 was hearing impaired and learning disabled. No participants were receiving occupational therapy services at the time of the study.

**Instruments**

Two instruments were used to collect data for the study: the ETCH-C (Amundson, 1995) and the Cursive Practice and Review work sheet. The ETCH-C is a criterion-referenced handwriting assessment with standardized administration.
and normed scoring procedures that evaluate handwriting legibility and speed in elementary school students. The ETCH-C includes the following writing tasks: writing the lowercase and uppercase alphabets from memory in cursive (a–z), writing numerals from memory (1–20), near-point copying (5 words, 31 letters), far-point copying (7 words, 29 letters), manuscript-to-cursive transition (6 words, 31 letters), writing from dictation (3 words, 1 zip code, 15 letters, 5 numerals), and sentence composition (of at least 5 words). The test also includes sections for documenting observation of the biomechanical aspects of handwriting and classroom observation of a writing task. Total letter legibility percentage scores are derived from the sum of all tasks, except for the task of writing numerals from memory. Total word legibility percentage scores are derived from the near-point copying, far-point copying, manuscript-to-cursive transition, dictation, and sentence composition writing tasks. ETCH-C total legibility percentage scores are calculated for words, letters, and numbers by dividing the number of words, letters, or numbers judged as legible by the number of words, letters, or numbers possible. Legibility scoring focuses on letter formation, size, alignment, case, and spacing. The test manual instructs test administrators on the complex scoring criteria and evaluates their scoring competency through a quiz. The examiners review the scoring criteria and take the quizzes until they score 90% or better (Amundson, 1995). The test requires 15 min to 40 min for students to complete, depending on the student’s written language skills, memory, and speed. For purposes of this study, only the ETCH-C total word and letter legibility percentage scores were used to evaluate concurrent validity.

The second instrument was the Cursive Practice and Review work sheet. This tool was used as the classroom-administered work sample that would later be graded by a panel of teachers to establish the cursive handwriting grade. The cursive handwriting grade is the criterion against which the validity of the ETCH-C was evaluated in this study. This one-page instrument was developed in Zaner-Bloser–style cursive script with the School Font Collection version 4.0 software (Mountain Lake Software, 1998). The researcher included three different types of writing tasks to improve the validity of the work sheet. The first task of the work sheet is a near-point copying sentence (The quick brown fox jumped over the lazy dogs) used in many other handwriting assessments (Reisman, 1993; Wallen, Bonney, & Lennox, 1996; Ziviani & Elkins, 1986). The second task is a manuscript-to-cursive transition section consisting of six printed words to be copied in cursive. The last task requires students to compose a minimum of a five-word sentence in cursive describing a friend or family member. The Cursive Practice and Review work sheet was pilot tested in the spring of 1999 to refine construct validity. Three experienced occupational therapists and classroom teachers agreed that the work sheet would measure a variety of cursive handwriting skills. The researcher used the ETCH-C scoring procedures and criteria to calculate total word and letter legibility percentage scores for the work sheet.

Procedure

The researcher reviewed the ETCH-C administration section of the test manual (Amundson, 1995) to ensure standardized administration of the ETCH-C before beginning the study and before each day of testing. Two samples of handwriting were collected from each student during a 4-week period in the fall of 1999. Each student was administered the ETCH-C individually by the researcher according to standardized directions in an area outside of the classroom. Students were tested before school, during the morning and afternoon school hours, and after school. Their names were kept confidential by the use of code number labels. To minimize an instrumentation threat (Fraenkel & Wallen, 1996), each student was given identical sharpened number 2 HB pencils to complete the ETCH-C, and the researcher limited testing to five consecutive students before taking a break.

Simultaneous to administration of the ETCH-C, the researcher distributed the Cursive Practice and Review work sheets to fourth-grade teachers in the participating classrooms. Students completed the Cursive Practice and Review work sheets with their own pencils at their own desks to make this writing sample more representative of actual school writing tasks. The work sheets were graded A, B, C, or unsatisfactory by a teacher panel to establish the criterion against which to compare the validity of the ETCH-C scores.

Scoring Procedure

After all tests had been administered, the researcher scored the ETCH-C response booklets in random order to obtain total legible words and letters scores. According to ETCH-C standardized scoring directions (Amundson, 1995), legibility percentage scores were calculated by dividing the total number of legible words or letters written by the total number of words or letters possible. To minimize an instrumentation threat, the researcher was blind to the students’ identity, classroom, and school. Scoring accuracy was checked against the scoring competency quiz in the ETCH-C manual, and greater than 90% agreement was achieved for every 10th response booklet to maintain standardized scoring. The researcher was the sole data collector and scored all response booklets.
Next, before scoring the Cursive Practice and Review work sheets, a code number label was placed over students’ names to protect confidentiality. The researcher randomly mixed and scored the Cursive Practice and Review work sheets according to ETCH-C scoring criteria to obtain total legible words and letters percentage scores.

To measure the reliability of the researcher’s scoring, a second occupational therapist with 3 years of experience using the ETCH-C scored a random sample of 15 each of the Cursive Practice and Review work sheets and ETCH-C response booklets. Interrater reliability, or the strength of agreement between raters (Guilford, 1954), using the intraclass correlation coefficient (ICC) alpha scale was .86 for ETCH-C total legible words, .93 for ETCH-C total legible letters, .89 for Cursive Practice and Review work sheet total legible words, and .92 for Cursive Practice and Review work sheet total legible letters scores between the researcher and experienced occupational therapist. Results support reliable scoring because ICC scores were above the .85 level recommended for strong reliability (Fraenkel & Wallen, 1996).

Next, grading guidelines were developed for the teachers who graded the Cursive Practice and Review work sheets. The three fourth-grade teachers each had more than 5 years of elementary school teaching experience and were selected on the basis of their willingness to assist with the study. The literature supports that teachers with more than 5 years of experience are reliable raters of handwriting using personal judgment but recommends the use of specific criteria and training of teachers to minimize subjectivity when grading handwriting (Graham, 1982). To improve the reliability of the teachers’ grades, the researcher developed guidelines for sorting the Cursive Practice and Review work sheets into piles of A, B, C, and unsatisfactory using a modified Q-sort, where ratings are based on comparisons among the stimuli (i.e., the work sheets) (Nunnally, 1967).

Before developing sorting guidelines, the researcher determined how many of the work sheets might be classified as A, B, and C according to total word and letter legibility percentage scores achieved by the researcher on the Cursive Practice and Review work sheets. According to the literature, handwriting that is 95% to 100% legible is easy to read and would likely be graded as A; handwriting that is 85% to 95% legible is satisfactory and would likely be graded as B; and handwriting that is below 85% legible would likely be graded as C by the teachers (Amundson, 1995; Talbert-Johnson et al., 1991). Based on interviews with the participating teachers, the researcher discovered that the lowest handwriting grade given in the school district was a C, which also limited the grades for this study. The researcher sorted the work sheets in accordance with the literature and obtained 27 A work sheets, 50 B work sheets, and 25 C work sheets.

The researcher then developed one page of grading guidelines for the teachers to sort the work sheets until they had piles of 27 A, 50 B, and 25 C work sheets. The guidelines asked the teachers to consider how easy the handwriting was to read, the frequency of formation errors, the presence of erasures, accuracy of copying and spelling, and consistent use of cursive. Finally, the teachers were asked to take the 25 C work sheets and further sort them into piles of C and unsatisfactory work sheets. They were told that the unsatisfactory pile should consist of work sheets with handwriting so poor that the teachers would recommend the student for handwriting remediation. They were not told how many unsatisfactory work sheets they should have.

The researcher met with and trained each teacher for 10 minutes on the one-page grading guidelines for the Cursive Practice and Review work sheets. Each teacher then sorted the 102 work sheets according to the guidelines while blind to the researcher’s total legibility percentage scores and the grades given by the other teachers. The final grade on the work sheets for data analysis was the grade that was agreed on by at least two of the three teachers as the cursive handwriting grade. One work sheet was given a different grade by all three teachers. This student’s data were dropped from the study analyses. Interrater reliability among the three teachers was ICC = .91. Therefore, reliability was strong among the teachers and did not seem to be a threat to the internal validity of the study.

For data analyses, the groups for comparison of total legibility percentage scores with the criterion of cursive handwriting grades were 26 Cursive Practice and Review work sheets with an A grade, 53 with a B grade, 10 with a C grade, and 12 with an unsatisfactory grade. The 12% of students whose handwriting was graded unsatisfactory by the teachers is consistent with the 6% to 18.9% of students with poor handwriting reported in the literature (Phelps & Stempel, 1987; Reisman, 1991).

Data Analysis

The researcher used descriptive statistics to view distributions, central tendencies, histograms, and scatterplots. Cursive handwriting grades were changed to numerical grades (A = 1, B = 2, C = 3, U = 4), and legibility percentages were used in their decimal form to perform parametric statistics. The one-way analysis of variance (ANOVA) was calculated to determine whether a difference existed between each predictor variable (ETCH-C total legible words, ETCH-C total legible letters, Cursive Practice and Review work sheet total legible words, Cursive Practice and Review work sheet total legible letters) and the criterion
variable of cursive handwriting grade groups (McNemar, 1969). Pearson correlation coefficients were used to calculate concurrent validity because they provide in the simplest manner the most precise description of the degree of the relationship between the predictor variables and the criterion (Ghiselli, 1964). Therefore, the researcher calculated Pearson correlation coefficients to determine the strength of the relationship between the predictor variables and the criterion of the cursive handwriting grade. To determine the legibility level that discriminated between satisfactory and unsatisfactory cursive handwriting, the researcher used the receiver operating characteristic (ROC) curve to determine the legibility score that represented the cut point between the true satisfactory and unsatisfactory scores (Metz & Kronman, 1980). The ROC procedure is useful in determining the area of correct predictions versus the area of incorrect predictions for a data set and recently has been recommended for use in summarizing a test’s diagnostic ability (Biggerstass, 2000). Chi-square analysis was performed to confirm the ability of one legibility score to categorize accurately the satisfactory (A, B, C) or unsatisfactory graded work sheets (Fraenkel & Wallen, 1996).

Results

The computation of means and ranges for the four legibility percentage scores by cursive handwriting grade indicated that the mean legibility percentage scores improved as the handwriting grade improved (see Table 1). This finding supports conclusions that the legibility percentage scores did rank the students’ cursive handwriting similarly to the teachers’ grades as outlined in first research question. The one-way ANOVAs supported a significant difference between legibility percentage scores for the four handwriting grade groups at $F(3, 97) = 25.10, p < .01$, for ETCH-C total legible words; $F(3, 97) = 27.45, p < .01$, for ETCH-C total letters; $F(3, 97) = 46.24, p < .01$, for Cursive Practice and Review work sheet total legible words; and $F(3, 97) = 56.23, p < .01$, for Cursive Practice and Review work sheet total legible letters and handwriting grade.

Scatterplots demonstrated linear relationships between the four legibility percentage scores and cursive handwriting grade. The Pearson correlation coefficients for all scores showed at least a moderate relationship with handwriting grades on the Cursive Practice and Review work sheet at $p < .01$ (see Table 2), ranging from .61 for ETCH-C total legible words scores and handwriting grade to .78 for Cursive Practice and Review work sheet total legible letters scores and handwriting grade.

ETCH-C and Cursive Practice and Review work sheet total legible words (.70) and letters (.78) scores correlated with each other at a moderate level (see Table 2). These results support a moderate relationship between the cursive handwriting the students performed on the work sheet in the classroom setting and the handwriting they performed on the ETCH-C outside of the classroom.

The ROC analysis for ETCH-C total legible words by satisfactory or unsatisfactory handwriting grade showed that a score of 73.24% maximized sensitivity (true-positives) at .83 and 1 – specificity (false-positives) at .03. On the ROC curve for ETCH-C total legible words scores (see Figure 1), the area under the curve was .94, which can be interpreted as the probability that a randomly selected satisfactory handwriting case will have higher ETCH-C total legible words than a randomly selected case having an unsatisfactory handwriting grade. The ROC analyses for other measures were as follows: a score of 81.87% for ETCH-C total legible letters maximized sensitivity at .83 and 1 – specificity at .05; a score of 77.94% for Cursive Practice and Review work sheet total legible words maximized sensitivity at .83 and 1 – specificity at .05; and a score of 74.85% for Cursive Practice and Review work sheet total legible letters maximized sensitivity at .83 and 1 – specificity at .02.

Table 2. Validity Coefficients for Total Legible Words and Letters Scores and Handwriting Grades

<table>
<thead>
<tr>
<th>Variable</th>
<th>Within-Methods Correlations</th>
<th>Validity Coefficients</th>
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<tbody>
<tr>
<td></td>
<td>Total Legibility Scores</td>
<td>Teacher Grades for Work Sheets</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>1. ETCH-C words</td>
<td>—</td>
<td>.88</td>
</tr>
<tr>
<td>2. ETCH-C letters</td>
<td>—</td>
<td>.72</td>
</tr>
<tr>
<td>3. Work sheet words</td>
<td>—</td>
<td>.67</td>
</tr>
<tr>
<td>4. Work sheet letters</td>
<td>—</td>
<td>.70</td>
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<tr>
<td>5. Work sheet grade</td>
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</table>

Note: ETCH-C = Evaluation Tool of Children’s Handwriting–Cursive; work sheet = Cursive Practice and Review work sheet; work sheet grade = final grade assigned by at least two of the three teachers.
After careful consideration of all mean total word legibility percentage scores for the work sheets graded as C and unsatisfactory, ROC results, and information from the literature, the researcher hypothesized that the 75% score would separate the satisfactory and unsatisfactory papers. Hence, chi-square analyses were $X^2(1, 101) = 39.04$, $p < .01$, for Cursive Practice and Review work sheet total legible words scores by handwriting grade and $X^2(1, 101) = 50.50$, $p < .01$ for ETCH-C total legible words scores by handwriting grade. Chi-square analyses also showed correct classification of 88.1% of the ETCH-C and Cursive Practice and Review work sheet total legible words scores by handwriting grades using the 75% legibility score.

**Discussion**

The primary purpose of this study was to establish the concurrent validity of the ETCH-C total legibility percentage scores with total legibility percentage scores calculated by the researcher on the Cursive Practice and Review work sheet and cursive handwriting grades assigned by teachers using personal judgment. These findings are similar to and supported by Tseng and Murray’s (1994) findings that handwriting legibility scores were able to discriminate between groups of students with good and poor handwriting. They also agreed with Reisman’s (1991) study that used legibility scores on the Minnesota Handwriting Test to classify students into four separate handwriting groups.

Validity coefficients (Pearson correlation coefficients) supported a significant moderate relationship between ETCH-C and Cursive Practice and Review work sheet total legible words and letters scores and cursive handwriting grades assigned by teachers using personal judgment. These findings are supported by similar validity coefficients found between legibility percentage scores and teacher ratings by Tseng (1994) ($r = .71–.79$) and Ziviani and Elkins (1984) ($r = .52–.76$). The current study's findings support those of past studies that found experienced teachers to be good judges of handwriting legibility when provided with specific criteria and guidelines for grading papers (Graham, 1982; Tseng & Murray, 1994; Ziviani & Elkins, 1984). However, because the validity coefficients were only moderate, random error occurred in both ratings. The ETCH-C must measure traits that are not measured by teacher grading based on personal judgment and vice versa. Graham et al. (1989) found that teachers place a higher value on appearance (e.g., neatness, smudges, pencil pressure) when grading handwriting. Appearance only affects ETCH-C scores when legibility is impaired.

The result of a moderate correlation between ETCH-C and classroom work sheet legibility percentage scores (see Table 2) provides some support for the ETCH-C as a valid test for measuring classroom handwriting skills. These correlations support the premise that the students used similar cursive handwriting on the two instruments across the two different settings.

This study found that a 75% total legible words score (chi-square), 75% classroom work sheet total legible letters score, and 82% ETCH-C total legible letters score (ROC procedure) could discriminate between satisfactory and unsatisfactory handwriting. These scores are lower than the less than 85% legibility level suggested by Amundson (1995) as a possible beginning point for intervention. The current study’s findings are closer to Talbert-Johnson et al.’s (1991) findings that the difficult-to-read papers in their study averaged a 78% legibility rate and Reisman’s (1991) findings that students receiving occupational therapy intervention for handwriting impairments averaged a 76% legibility rate.
Directions for Future Research

Additional studies need to examine the concurrent validity and reliability of the ETCH-C and the ETCH-M for all other grade levels and with other standardized handwriting assessments, such as the Denver Handwriting Analysis (Anderson, 1983), the Minnesota Handwriting Test (Reisman, 1993), or the Children’s Handwriting Evaluation Scale (Phelps, Stemple, & Speck, 1982), before the current study’s results can be generalized. Second, more research is needed to examine the ability of legibility scores from standardized handwriting assessments to classify handwriting grades correctly so that therapists can choose the best instruments for use in the schools. This study has shown that it is possible for legibility percentage scores from the ETCH-C to correlate with and similarly rank students’ cursive handwriting with grades assigned by teachers, but more studies need to replicate and substantiate these findings to support the validity of the ETCH-C for school use. Third, clinicians need more studies that investigate the legibility level that discriminates between satisfactory and unsatisfactory handwriting in order to decide whether the 75% level found in this study is the correct level to use when making intervention decisions.

Implications for Occupational Therapy Practice

Several findings from this study are important to clinicians and researchers. The strength of the validity coefficients should help school-based therapists feel more comfortable with using this instrument to measure handwriting legibility and more confident in the scores they achieve and the treatment decisions they make based on those scores. This study found that a 75% total legible words score on the ETCH-C discriminated between satisfactory handwriting and handwriting that required intervention according to teachers. Because the ROC procedure showed this level to range from 73% to 82% across the four legibility percentage scores, therapists may want to reconsider the legibility level they use to begin intervention.

Conclusion

School-based therapists need valid and reliable assessments to perform outcomes-based research on handwriting remediation programs, develop treatment plans, and make intervention decisions. The results of this study lend moderate support to the concurrent validity of the ETCH-C when comparing total word and letter legibility percentage scores with teacher’s handwriting grades on a work sheet completed in the classroom by fourth-grade students.

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References


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