Improving Written Output: The Efficacy of Handwriting Remediation Intervention or Assistive Technology?

PICO Question:
In children with handwriting disabilities, how does the handwriting remediation intervention compare to the use of assistive technology for improving written output?

How was the review conducted?
A database literature search was conducted in December 2006 using the following search terms: Child and (Handwriting or written output or written communication) and (Disability or Impairment). The search included articles published from 1995 to 2007 and was conducted in the following databases: Medline, CINAHL, and PsycInfo. Seven articles closely related to the PICO questions were identified of which three were selected for review as they were felt to provide the highest level of evidence.

Section 1 – Summaries of articles reviewed

The purpose of the study was to determine if occupational therapy interventions teaching word processing, either alone or with word prediction, was effective in improving the written communication skills of students with learning disabilities and identified handwriting problems. Outcomes in the categories of legibility, reduced spelling errors, quantity of written work, and rate of production were measured. This was a single-study alternating treatment format replicated across a convenience sample of 3 students in 4th and 5th grade. Students were trained in the use of keyboarding and word prediction prior to the start of the study. Intervention involved 12 to 24 sessions presented in 15-minute blocks 3 times weekly, using a randomized format of the 3 treatment conditions. The children wrote stories, alternating among handwriting, word processing, and word processing with word prediction. Results indicated that 2 children made gains in quality of writing using word processing and word prediction, though not at a level of statistical significance. No differences were seen in the amount written using any method. Two students wrote faster by hand, the other faster when word-processing. Limitations of the study included small sample size and lack of a standardized assessment measure with accepted reliability and validity.
The purpose of the study was to evaluate the effects of two interventions on improving handwriting in children. This was a randomized controlled study using pre and post test measures administered to children assigned to one of three groups: (1) sensorimotor intervention (SM), (2) therapeutic practice (TP) and (3) control. The sample population included 37 children ages 6-11 with handwriting dysfunction defined as attaining a score of 1.5 SD below the mean in the Gardner’s Test of Handwriting Skills (THS), which was administered to 200 children from 2 Midwest cities. 12 girls and 26 boys with no known physical or vision problems and with no identified educational needs participated. Pre and post tests included measures of handwriting (THS), visual perception (DTVPT-2), proprioception (Test of manual pointing-reliability not established), in-hand manipulation and finger to palm and palm to finger translations (normed for children 3-6.6 yrs. and adults, validity not established). Intervention occurred over a 5-week period. SM and TP groups received individual or small group intervention 4x/wk for 40-minute sessions divided into 3 segments with 5-minute breaks between segments for a total of 10 hours of intervention. Intervention was provided by 4 OTS and 1 PT with pediatric experience, all of whom received 8 hours of training. SM interventions included visual perception, visual motor integration, proprioceptive/kinesthetic and in-hand manipulation activities. TP interventions included handwriting practice books and worksheets for dictated, copied and memory writing in the child’s current style of writing, focusing on metacognitive self-evaluation skills, real life and fun writing activities. The Control groups received no intervention. Results indicated that there was a significant difference in mean scores between the SM and the TP group in handwriting performance; the performance of the SM group declined and the performance of the TP group increased, but neither was statistically different from the control group. Sensorimotor performance of the SM group improved more than the TP group in the area of visual perception, there was no significant change in proprioception or in-hand manipulation from pre to post test scores. Limitations of the study include: lack of information in the method of classroom instruction that occurred outside of the study, small sample size, lack of validity of some measures reported, and no information on power.

The article describes 2 studies. The purpose of each study was to investigate the effectiveness of task specific self-study intervention to improve handwriting of students with poor handwriting. Both studies were cohort studies: Study 1 was conducted in a regular education program and Study 2 in a special education program in a separate school. Participants in Study 1 were identified from a group referred by teachers and then tested using the Concise Scale for Children’s Handwriting (BHK), and found to be dysgraphic N=7 (6 boys; 1 girl). An age and gender matched control group was identified. None of the students had received OT prior to the study. In Study 2, all 145 students in grade 2-6 were tested and a group of 24 with dysgraphia were identified. The 24 subjects were divided into 2 groups: 18 who had had intervention services and 6 who had not. A control group of 36 was identified and split into 2
groups of 18. Outcome measures were determined by comparing pre and post-tests of handwriting speed and quality using the BHK.

Interventions in Study 1 involved the handwriting self-instruction method using handwriting technique, semantic exercises, fun elements and writing short stories. A remedial teacher provided intervention in 1:1 setting, for 18, 30-min. sessions over 3 months. Interventions in Study 2 involved the handwriting self-instruction method, dynamic writing and strict letterform instruction. Special education teachers provided intervention in 2, 30-min/week group sessions for 6 months. Student peers provided feedback.

The results of the Study 1 were descriptive due to small sample size. In the intervention group, 4 remained the same and 3 improved. In the control group 6 remained the same and 1 moved to the dysgraphic category. In Study 2, there was a significant difference in handwriting quality but not speed. 13 children who received intervention moved out of dysgraphic category; 8 children from the control group moved from normal to dysgraphic or ambiguous categories. Nine children in the intervention group improved speed; none in the control group improved speed. The task oriented approach using self instruction helped students to improve the quality of writing for students with dysgraphia when compared to children identified as dysgraphic who did not receive the self-instruction method of instruction. Limitations include lack of reliability and validity information about the pre and post assessment tools and lack of information about the type and amount of handwriting instruction provided to subjects and the control group as part of their school curriculum.

**Section 2 – Implications for Practice**

1. **Summary of Research Findings:**
Two of the three articles reviewed did not address the technology portion of the PICO question. It should also be noted that the studies that were reviewed lacked power (number of subjects involved), so it is possible that even if a true difference between the interventions existed, the study did not have enough power to detect it. The study that compared output of students using handwriting, word processing, and word prediction with word processing did not show a significant difference in quality, legibility, spelling or speed across the 3 single cases. Results did indicate that the use of word processing with and without word prediction could facilitate written work by improving legibility and spelling. Two of the three subjects wrote a greater quantity using handwriting, and one did better with word processing. It is also impossible to draw reliable conclusions in the two studies of handwriting instruction methods. Again, sample sizes were small and measures of handwriting lacked established reliability and validity. One randomized controlled study using pre and post test measures of handwriting and sensorimotor skills indicted that students with poor handwriting skills benefited more with direct therapeutic instruction in handwriting than did the group who received sensorimotor intervention, but neither group differed significantly from the control group receiving no instruction. The final study reviewed suggested that a task oriented approach using self instruction helped students with writing difficulties to improve the quality of writing when compared to children who did not receive the self-instruction method.

There is so little research evidence on this topic that it is essential that therapists keep quality data to demonstrate that a child is benefiting from the strategies or interventions used to improve written output, whether they be handwriting or use of assistive technology. All
children with handwriting difficulties benefit from structured handwriting instruction. Students require training in the use of word processing approaches before their effectiveness can be assessed. There is no evidence to suggest that a focus on sensorimotor skills will improve handwriting. Teachers, as well as therapists, can provide handwriting intervention. Small group instruction and motor learning self-instruction approaches are effective. Intervention should be provided several times per week, utilize short periods of instruction with breaks and be provided for 3-6 months. Handwriting instruction should be consistent with styles used in the classroom. Use of assistive technology by students is supported in technology rich environments.

2. Trustworthiness of studies’ results:
The current studies did not provide high level of evidence for the efficacy of the interventions for improving written output for children with handwriting difficulties. Small sample size and use of measures that lack reliability and established validity suggest that results should be interpreted cautiously. Reported results were inconclusive as to the benefit of technology (word processing and word processing with word prediction) as compared to handwriting on components of written output.

3. Level of Evidence:
Currently levels of evidence for the use of handwriting remediation as well as the use of assistive technology to support written output is a level 4 for the studies reviewed, according to the criteria from Sackett and colleagues (2000). Level 4 evidence means that to date the best studies demonstrating benefits for these interventions are: case studies, poor quality cohort studies, and poor quality case-control studies.

TAKE-HOME MESSAGE
Related service providers and educators should attend to the enrichment of handwriting instruction for all children. Children with handwriting problems benefit from intervention targeted to handwriting; there is no evidence to support use of sensorimotor strategies to improve written output. The effectiveness of specific handwriting and assistive technology strategies needs to be supported by data related to the child’s program and goals. Technology rich environments may support the use of computers and provide multiple avenues for written expression for all children. Therapists and researchers should search for reliable and valid measures of written output as they emerge, including the FETCH, Minnesota Handwriting Assessment and the School Function Assessment section assessing written communication.