

Curriculum Based Measurement and Precision Teaching in Writing Empowerment Enhancement: Results from an Italian Learning Center

I. Pelizzoni, C. Cavallini, I. Salvaderi, F. Cavallini

Abstract—We present the improvement in writing skills obtained by 94 participants (aged between six and 10 years) with special educational needs through a writing enhancement program based on fluency principles. The study was planned and conducted with a single-subject experimental plan for each of the participants, in order to confirm the results in the literature. These results were obtained using precision teaching (PT) methodology to increase the number of written graphemes per minute in the pre- and post-test, by curriculum based measurement (CBM). Results indicated an increase in the number of written graphemes for all participants. The average overall duration of the intervention is 144 minutes in five months of treatment. These considerations have been analyzed taking account of the complexity of the implementation of measurement systems in real operational contexts (an Italian learning center) and important aspects of replicability and cost-effectiveness of such interventions.

Keywords—Precision teaching, writing skills, CBM, Italian Learning Center.

I. INTRODUCTION

IN the traditional Italian school system, the percentage of correct answers is the learning marker of a content. At the basis of its use is the belief that it is sufficient to detect the level of accuracy of a performance to be able to define it as mastered. It therefore happens that the criterion "100% correct answers" is considered the highest level of performance achievable when the student could (and should) be given the opportunity to further practice the skill in order to acquire it fluently and without hesitation. The intervention referred to has more than 40 years of success in enhancing the learning of elementary skills [1]. In the epistemological behavioral framework, fluent is defined as the combination of accuracy and speed that characterizes a competent performance [2], [3] and is, at the same time, identified as the true mastery of a given skill. Fluency construction is a method used to develop both accuracy and adequate velocity (frequency) in elementary components [4]; frequency refers to the number of responses emitted in a specific working interval, which is usually one minute [5], [6]. This methodology is based on some key principles: a) the link between basic skills (component skill) and complex skills (composite skill); the definition of a reference numerical range (frequency aim) that must be flexible in consideration of the peculiarities of the person, his

age and his level of education; c) content free [7], or the possibility of using this strategy for any type of content, which makes it possible to create a curriculum logically articulated based on individual needs [4]. Resuming the theoretical contributions of authors who have better defined over the years the concept of a training based on fluency [8]-[10], authors [4], in 2004, have proposed a new model of description of this strategy called the Morningside Model of Generative Instruction.

In this text, the effects of this training on performance are specified and summarized with the acronym MESAG: Maintenance, endurance, stability, application and generativity. The term retention indicates the relationship between behavioral frequencies separated by a period of time, during which the subject has not had the opportunity to emit the specific behavior [10]. Endurance refers to the duration of attention on the task for extended periods of time. A quality directly related to endurance is stability, defined as the ability to perform the task even in the presence of distracted stimuli (noisy environment, television on, etc.) or stimuli in direct competition with the task required. It can therefore be said that a skill acquired in a fluent way is able to be maintained over time and be carried out for prolonged periods even in the presence of distracting stimuli. The term application, finally, indicates the link between the basic skills that form a task (Component skill) and complex skills (Composite skill). It is therefore important to have reference standards for each skill, so that it can be maintained over time, last for longer periods, resist distraction and combine in order to develop more complex performances.

Finally, the authors add the term generativity, i.e. the emergence of new behavioral repertoires, not directly taught, in contexts and situations different from those that characterized the moment of intervention or teaching, such as, for example, problem solving skills or creativity [4]. To verify the effectiveness of the intervention and in line with other studies already published [11]-[13], fluency training is often associated with the use of measurements by means of non-standardized criteria tests; specifically, the use of CBM, a system for monitoring learning performance, in this case reading, which allows numerical information to be collected with respect to speed and accuracy of performance in a very short time, representing an easy to use and rapidly administered evaluation method [14], [15]. CBM measurements have found numerous confirmations about their goodness both as screening procedures [16]-[18] and as tests

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to evaluate the progress of an intervention aimed at improving basic skills [17]-[19].

II. PARTICIPANTS

The participants were 94 students aged between six and 10 years. The participants diagnosed with attention-deficit hyperactivity disorder (ADHD) [20] consisted of 23 students (20 males and 3 females; Group A); the training for this group was carried out from two to three times a week for a total duration of six months (239 minutes). The participants with a special educational needs condition [20] consisted of 35 students (17 males and 18 females; Group C); the weekly frequency of their intervention ranged from two to three times a week with an average duration of four months (92 minutes). The participants with specific learning disorder diagnosis [20] consisted of 36 students (27 males and 9 females; Group B); the weekly frequency ranged from two to three times and the overall average duration of the intervention was six months (134 minutes). All participants of the study were chosen because in the school year 2018/2019 their families approached a learning and research center in Northern Italy for different educational needs; however, all the participants, after an initial assessment phase, showed deficiencies in writing skills that motivated the choice of an evidence-based intervention with fluent didactics.

TABLE I
SUMMARY OF INFORMATION FOR EACH OF THE GROUPS OF PARTICIPANTS

Group	Diagnosis	Average duration (minutes)	Effectiveness (> 0.83 graph./ month)	Efficiency (graph./sec/ month)
A	ADHD (n = 23)	228	3.33	0.12
B	LD (n = 36)	134	4.66	0.28
C	No diagnosis (n = 35)	92	4.29	0.29

III. METHOD

A. Setting

The study was conducted in a learning center in Northern Italy. Interventions and tests took place in one of the rooms of the center; intervention was carried out, after training, by students or trainees in psychology under the supervision of a coordinating psychologist trained in the use of these strategies (Master in Applied Behavior Analysis). Students could work individually or in pairs with a peer who followed a similar intervention program.

B. Material and Procedures

The study was planned and conducted with a single-subject experimental plan for each of the participants, in order to confirm the results proved in the literature, including with other diagnostic populations. The descriptive analyses were, instead, carried out considering the participants as a group. The dependent variable measured is the score obtained in the CBM test [21] of writing, the number of correctly written graphemes during a writing test in an interval of one minute (using excerpts from school books appropriate to the school grade attended). In the present study, the pre- and post-test

scores were obtained by calculating the average score of three writing tests under aloud dictation of three different passages, never written before, taken from a textbook corresponding to the school grade attended by each student. No performance feedback was provided during the rehearsals to avoid motivational change effects on the recorded performance.

The independent variable of the present study is, therefore, the fluency-based treatment (PT). Specifically, during each meeting, each subject followed a path of writing enhancement with the learning channel "see/write" (experimenter shown behaviors and the participants repeat them in line until the end of the sprint). The writing methods presented for each letter are those that prove to be the least expensive in terms of speed and fluidity of the graphic trait and that will allow the writer to tie each letter to the next. The letters are also divided into groups according to the similarity of the graphic trait:

- *a, d, g, q;*
- *b, f, h, l, p, t*
- *e, o*
- *e, i, u, v*
- *m, n*
- *r, s, z*

The training is divided into two levels of difficulty: grapheme exercises, writing letters and words in italics and capitals font. The intervention consisted in writing the assigned letter for short intervals of time (15 or 30 seconds sprints). The student is invited to write as quickly as possible, trying to exceed their maximum frequency score, while maintaining accurate writing. The sprint starts after checking the correct grip of the pen, the correct frontal posture with respect to the paper and an adequate pressure of the pen on the paper. At the end of each sprint, the psychologist records the score on a special data sheet and provides the student with feedback on their performance, correcting any errors that may have been made. During each meeting, the student performs five sprints for each letter; at the end of each fifth sprint, the best score is recorded on a graph in which the final objective for each card is highlighted (fluency aims). In order to define the writing frequency objectives, the authors have chosen, in line with the literature on fluency-based instruction, PT and the model of generative instruction [4], [11], to refer to the scores of the BVSCO-2 normative tests [22]. Once a month the student is given a CBM writing test to verify the effectiveness of the intervention.

IV. RESULTS

For descriptive purposes only, as the characteristics of this experience have not allowed the formation of statistically distributed samples, we will present the results separately for each diagnostic situation. For each of the participants was calculated the difference in the measurement of the speed, expressed in graphemes per minute, of writing under dictation of passages (CBM [16]).

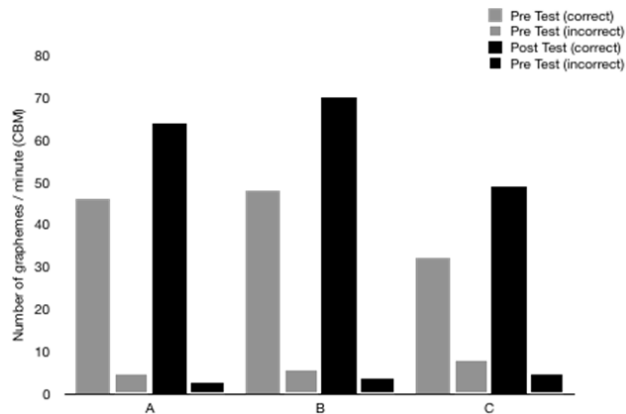


Fig. 1 Test scores CBM in pre- and post-tests expressed in graphemes write per minute for each of the three groups (A, B, and C)

The average total duration of the intervention is 144 minutes, in five months of treatment. Participants with ADHD [20] achieved an average improvement of 17 graphemes per minute and a reduction of two errors per minute; participants with special educational needs [20] achieved an average improvement of 16 graphemes per minute and a reduction of four errors per minute; participants with specific learning disorder diagnosis [20] achieved an improvement of 22 graphemes per minute and a reduction of two errors per minute. Considering the reference regulatory scores of the BVSCO-2 tests [24], an average increase of 10 graphemes per year (+ 0.83 graphemes per month) is expected at each school grade change. Bearing in mind this reference index, all participants obtained an increase in the number of correctly written graphemes, higher than expected in the post-test phase (average = +5 graphemes per month). Since there are no reference procedures for these conclusions, we consider this a demonstration of the efficiency of the proposed intervention.

Table I compares the effectiveness and efficiency data for each of the three groups. Fig. 1 shows the scores obtained by the different groups in the pre- and post-test phase. Figs. 2-4 show the acceleration of learning that occurred. Fig. 2 shows a "take-off" learning picture with a median acceleration for corrects of x 2.32; Fig. 3 shows a median acceleration for corrects of x 2.19; Fig. 4 shows a median acceleration for corrects of x 3.76 and Fig. 5 shows a median acceleration for corrects of x 2.58 for all participants. To verify the agreement between the observers, during all pre- and post-probe sessions, the interobserver agreement (IOA) has been calculated [13], dividing the number of answers on which the observers agreed for the total of answers and multiplying it by one hundred. The data expressed an agreement between the observers over 95%.

V. DISCUSSION AND CONCLUSION

The main aim of this study was to establish if a PT intervention could serve to increase the number of correctly written graphemes and reduce the number of errors in the CBM test with 96 participants with special educational needs. This study also aimed to evaluate the effectiveness and

efficiency of the proposed interventions. Results pertaining to these aims will be discussed in turn, with reference to the literature. The primary finding of this study concerns the significant increase in the number of correctly written graphemes of pupils following the five-month PT intervention. This effect size was large, with a mean increment of 19 graphemes per minute and a reduction of three incorrectly written graphemes in the post test phase. This is proof not only of the achievement of the frequency objectives, but also of a higher quality of the graphic trait. Although the importance of verifying the effectiveness and efficiency of the proposed interventions is fundamental to allow professionals to choose the intervention that, for the same number of hours of treatment, allows the more significant improvement, it is also underlined by the Consensus Conference of 2011, which focuses on the criteria of effectiveness and efficiency [22]. As far as the efficiency of the intervention is concerned, reference is made to the indications given by [22], in 2003, for reading skills. The authors used the same indications for the writing tests, i.e. the number of graphemes written per second per hour of treatment, obtained by dividing the effectiveness calculated previously with the average number of hours used and evaluated as a percentage. The formula used is as follows: $\text{efficiency} = (\text{efficacy} / \text{months of treatment} / \text{intensity (hours of month of treatment)}) * 100$. This measure allows to have a parameter of how many graphemes per second this intervention allows to gain, considering the costs in relation to intensity and time of work. The final aim of this study pertained to the effectiveness of PT as a tool to facilitate formative assessment. This intervention was planned and conducted in an learning center by psychologists and students in psychology who have completed the specific training course for the implementation of fluent programs and, therefore, have transferred the use of these strategies in their professional practice [23]. The considerations about efficiency and effectiveness are particularly significant in public and private operating environments, where the use of a shared procedure allows to standardize the working methods between different operators for different populations and potentially to share the results with specific attention to those diagnostic categories of comorbidity with other specific difficulties. It must be acknowledged that this study was limited by a relatively small sample size, short time-frame and absence of a control group. The extreme variability of the data, the scarce number and the different representativeness, together with all the limitations connected to the studies carried out in application contexts, make any general consideration concerning the three categories into which, for descriptive reasons, the participants have been divided unjustifiable. The data confirm the results of previous studies [24] and extend these clinical reflections to participants with different diagnostic situations. In this way, PT can be used optimally, either alone, or as part of a larger literacy strategy, to enhance automaticity at the sub-skill level and advance writing skills of pupils, in other Italian realities (public and private).

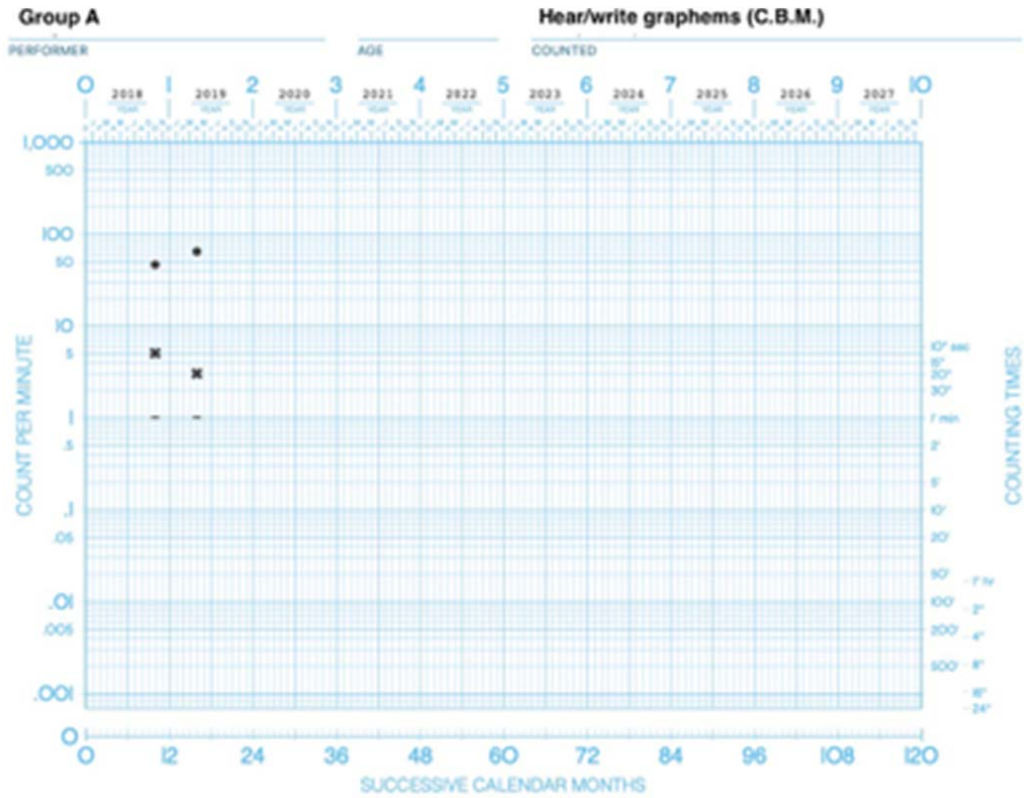


Fig. 2 The average data of CBM pre- & post-test of all participants of group A

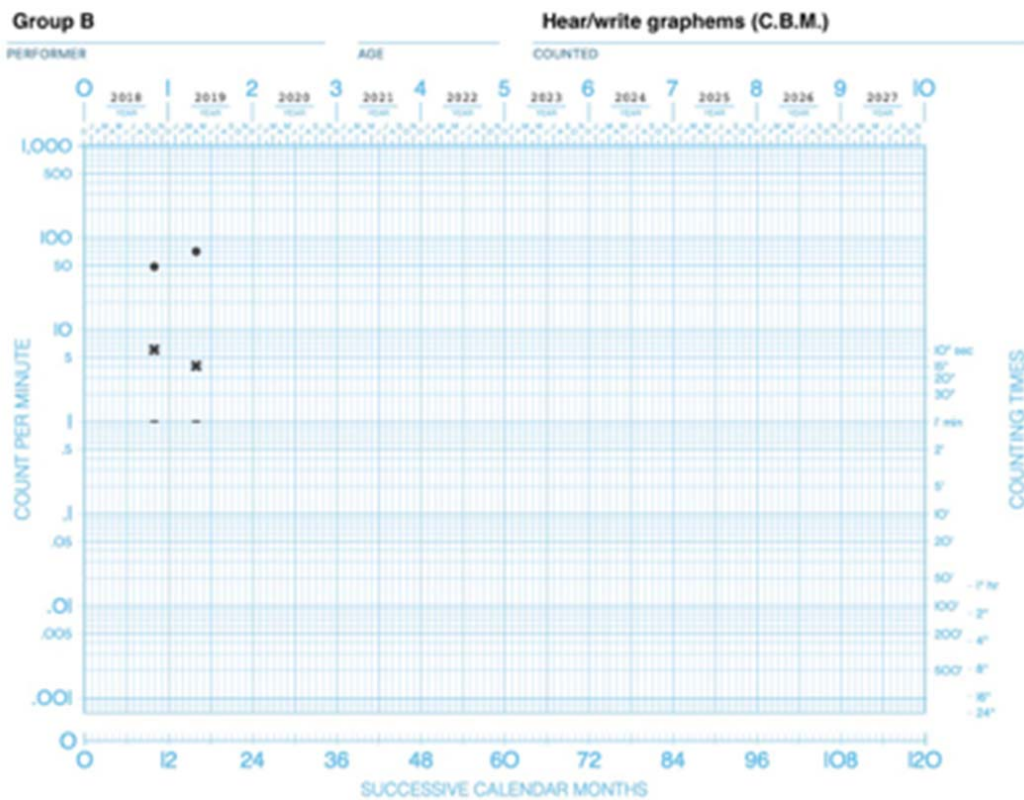


Fig. 3 The average data of CBM pre- & post-test of all participants of group B

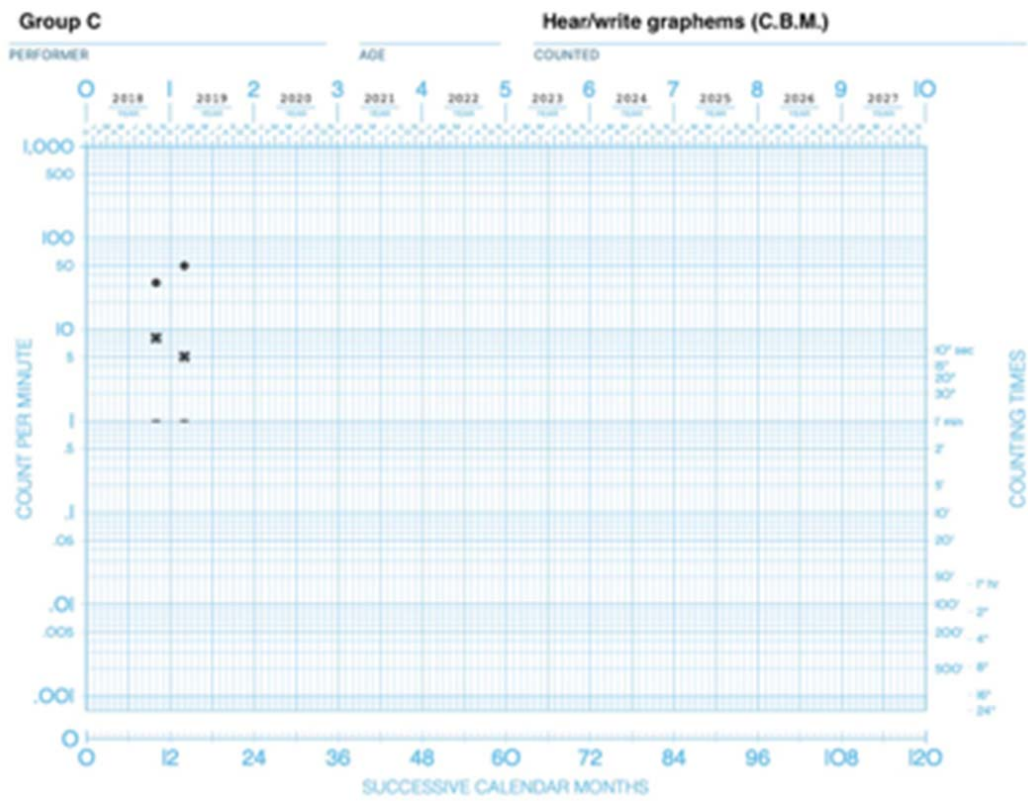


Fig. 4 The average data of CBM pre- & post-test of all participants of group C

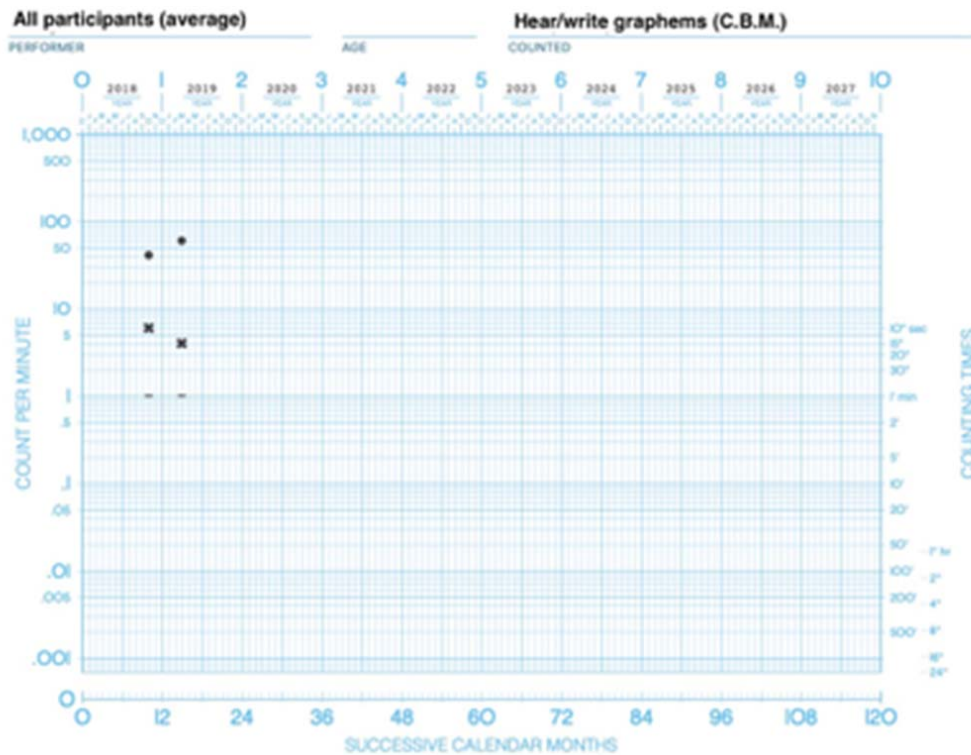


Fig. 5 The average data of CBM pre- & post-test of all participants

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