The Effects of Vibration Signal Devices on Motivating Struggling Secondary Students to Write Longer and Better Stories

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Writing is considered the most arduous academic task in school. Many students struggle with motivating themselves to engage in text production due to the enormous cognitive load it requires. In this pilot study, we used a simple electronic device that emits silent vibration signals at programmed intervals to help five sixth graders to stay focused on their writing assignments. All participants had limited academic abilities and found it hard to stay on task. We applied a single-case reversal design (ABA) to test the efficacy of the intervention. Results indicated that the students wrote considerably longer stories whenever the electronic devices were used. In addition, the quality of their texts increased as assessed by two independent raters. The findings beg for replication and more research on the topic, as this was the first study on using vibration signal devices to foster writing performance in struggling students.

Keywords: **Writing motivation, writing performance, struggling secondary students, vibration signal devices, self-monitoring, single-case research**

Introduction

The Importance of Good Writing Skills

Good writing skills are needed in most key areas of life, including school, the workplace as well as for private communication. Most academic tasks require putting ideas on paper or on a computer screen. Almost any kind of occupation involves some kind of written communication, such as passing information to others and keeping a record for future reference. In addition, a great part of private exchange today takes place through electronic forms like emails and text messages. Individuals who fail to meet even basic writing standards are at a heightened risk of becoming socially excluded and vulnerable members of our society (Graham, 2006; Graham & Perin, 2007; Rogers & Graham, 2008).

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The Nature of the Writing Process

Text composition requires a sophisticated interplay between cognitive, metacognitive, mental, and emotional competencies (Santangelo, 2014). According to the widely acknowledged model by Hayes and Flower (1980), this involves three main processes: planning (drafting, structuring, note-taking), translating (actually putting thoughts on paper or into a digital device), and revising (adding, subtracting, rearranging, proofreading). These activities happen recursively – writers move back and forth instead of just going through them sequentially.

A so-called monitor is responsible for coordinating these three processes. Its purpose is to determine when to shift from one activity to the next. Such decisions are guided by the goals and the writing habits of a given individual (Hayes, 2012). Some students are not capable of writing longer texts. That is, they lack the routine that not only causes them to occasionally switch from one process to the next, but also encourages them to plan, translate, or revise and invest more time and energy in each of these activities (Kellogg, 2022). Deficits in this area become especially critical at the secondary level.

The Crucial Role of Motivation in Keeping the Writing Process Going

Without a well-functioning monitor, writers are unable to put forth the will, effort, and self-regulation necessary to produce adequate writing (Graham et al., 2017; O'Shea et al., 2017). The significance of this reality prompted Hayes to make adaptations to the original model (Hayes & Flower, 1980). Thus, he acknowledged that with a cognitive process as intricate as text production, the driving force that makes individuals take on enormous mental loads must receive more attention. As a result, Hayes (2012) explicitly made room for the concept of motivation in his revised approach and recognized that the inner state that initiates, guides, and maintains goal-oriented behaviors is the fuel without which no text composition is possible. He noted: "… whether people write, how long they write, and how much they attend to the quality of what they write will depend on their motivation" (2012, p. 373).

Accordingly, motivation can be considered a determining factor in whether text production processes are initiated and sustained (Camacho et al., 2021; Fayol et al., 2012). It develops in a given context when individuals have the repeated experience of achieving goals that are meaningful to them, igniting effort, resiliency, self-efficacy, and a positive self-concept (Ehm et al., 2014; Graham et al., 2007; Pajares et al., 2000). Thus, it is widely recognized that motivation contributes to greater persistence during a task and predicts academic success (Graham et al., 2018; Troia et al., 2012). In contrast, experiencing failure usually results in a decreased effort and the build-up of negative attitudes toward a challenging task (Wehmeyer et al., 2017), including apprehension and avoidance of writing situations (Schiefele et al., 2012).

Writing Problems due to a Lack of Motivation

Text production is seen as the most challenging skill to learn in school – more so than reading, spelling, or numeracy (Wu, 2017). Thus, many students shy away from writing, and some do not even want to give it a try (Hidi & Boscolo, 2006). Even if they have acquired all the prerequisite handwriting, spelling, and grammar skills to an acceptable level, for some, engaging in arranging words, phrases, and sentences to create a coherent product appears too arduous and beyond their ability. Hence, it is no wonder that the percentage of young people with severe difficulties in writing exceeds those with deficits in other academic areas. According to Katusic et al. (2009), 6.9% to 14.7% of adolescents are diagnosed with a learning disability (LD) in written language. Far more students have serious problems with text production without having received an official diagnosis (Blood et al., 2010). While difficulties in written expression can have many root causes, lack of motivation seems to always come into play. Because text composition does not get easier over the school career (due to teachers giving more and more demanding assignments), the challenge of having to pull oneself together to channel all mental resources towards a task remains (Camacho et al., 2021).

At the same time, writing becomes increasingly more important as students' progress from elementary to high school. In secondary education, they are increasingly expected to demonstrate their skills through written tests. It is not enough to know something – one has to also be able to put it on paper in a coherent form. Therefore, it seems particularly important to continue to motivate students to engage in writing tasks at the beginning of their secondary school years and to do so in a sustainable way (Wright et al., 2020).

Ways to Foster Writing Motivation in Students

To counteract the risk of avoidance, it is crucial to increase students' willingness and perseverance to produce texts despite high demands on working memory. Several systematic literature reviews and meta-analyses have focused on ways to help struggling students to compose written work that is longer than just a couple of short sentences (e.g., Camacho et al., 2021; Darrington & Dousay, 2015; Pajares, 2003; Wehmeyer et al., 2017). Accordingly, several techniques have proven to be helpful in this respect. For example, it has been found that cognitive self-awareness has the potential to facilitate positive changes in performance (Demetriou et al., 2020). Managing one's own behavior can reduce the demands on working memory and affect academic success (Rafferty, 2010). Different motivational components, including cognitive reconstructions of maladaptive functions, direct feedback through graphing, and positive reinforcement, have also been shown to be effective (García & de Caso, 2004; Grünke et al., 2017, 2018).

Immediate feedback through graphing is one way to increase students' writing. This simple strategy involves visually representing the students' progress, allowing them to compare current outcomes with previous ones (Stotz et al., 2008). Several studies have found that graphing enhances the performance in different domains (Grünke, 2019; Grünke et al., 2018; Hattie, 2012; Hisgen et al., 2020; Sutherland & Snyder, 2007).

The Accentuated Role of Self-Monitoring in Enabling Students to Write Longer and Better Texts

However, among all the different approaches to fostering the inner drive to produce relatively long texts of acceptable quality, methods that facilitate the ability to observe, regulate, adjust, and control one's behavior seem to stand out. That is, strategies that support the monitor in Hayes and Flower's model (1980) to fulfill its role as a component in charge of initiating, guiding, and maintaining one's writing activity appear to be especially potent. This ability to systematically evaluate and alter somebody's own behavior is often described as "self-monitoring." First introduced into the scientific literature in the 1970s by Snyder (1974, 1979), this concept has gained rapid popularity since then.

Self-monitoring is part of the self-management process and consists of two components that record whether or not a student performed expected behaviors: self-assessment ("Am I on task?") and self-recording (taking notes) (McDougall et al., 2012; Wells et al., 2017). The strategy draws on an individual reference norm that is intended to promote intrinsic motivation (Graham et al., 1992; Trevino-Maack et al., 2011). Self-monitoring turns out to be a useful tool for students who have already mastered a particular academic or social skill but are unable to observe and regulate their behavior consistently. Such students often benefit from frequent reminders to stay on task despite high demands on their working memory (Shapiro & Cole, 1999).

Previous research has focused on two areas of self-monitoring: self-monitoring of task-related behavior (Chafouleas et al., 2012; Graham-Day et al., 2010; Prater & Hogan, 1991; Stotz et al., 2008; Sutherland & Snyder, 2007) and self-monitoring of academic performance (Ives, 2007; Maag et al., 1993; McCallum et al., 2011; Reid, 1996). The findings indicate that self-monitoring activities positively affect task-related behavior. However, to date there is no consensus on the effects on academic achievement. For example, in a multiple-baseline design across participants, Lannie and Martens (2008) revealed differential effects on students' accuracy and productivity, whereas Caldwell and Joseph (2012) documented a mid-size association between self-monitoring and academic productivity.

A limited number of studies have evaluated the effects of self-monitoring on students' writing performance (Harris et al., 1994; Martin & Manno, 1995; Wolfe et al., 2000). Harris et al. (1994) conducted an experiment to de-

termine the effects of an intervention on the number of written words in stories and the quality of students' writing. The results showed improvements in both areas. A study by Martin and Manno (1995) suggested corresponding conclusions: After the treatment, which implemented the use of simple check-off system to plan the work, students wrote longer stories of better quality.

The Benefits of Electronic Vibration Signal Devices to Promote of Self-Monitoring Skills

Most research on self-monitoring has used acoustic cues. An alternative form is a tactile vibrating stimulation through electronic devices. By vibrating, such devices only affect the students who need a reminder without distracting their classmates (Flaute et al., 2005). A limited number of published studies have examined self-monitoring combined with a tactile prompt provided by a device called MotivAider® (Amato-Zech et al., 2006; Battaglia et al., 2015; Christensen et al., 2004; Legge et al., 2010; Moore et al., 2013). This wearable electronic tool invented by Levinson in the early 1980s resembles a pager and emits silent vibration signals at programmed intervals to remind and urge users to make desired changes in their behavior (Levinson & Young, 1988).

Amato-Zech et al. (2006) conducted a study examining the effects of the MotivAider® on the attention of three elementary school-aged students. Self-monitoring triggered by a tactile prompt increased on-task behavior by up to 100%. Moore et al. (2013) extended the work of Amato-Zech et al. (2006) by additionally examining maintenance of intervention effects. The results were consistent with those of Amato-Zech et al. (2006).

Despite these promising findings, evidence is sparse with regard to the impact of MotivAider®s on academic productivity (McDougall et al., 2012; Rames-La Pointe & Hixon, 2021). McDougall et al. (2012) conducted two simple AB single-case studies. In the first experiment, they demonstrated that the number of tasks completed in algebra classes increased with the use of a MotivAider®. The second study produced similar results concerning the time needed to solve vocabulary tasks in English. Both experiments indicate a positive impact of tactile prompting on academic performance. However, the results must be interpreted with caution, as the studies do not meet common standards in single-case research (see Kratochwill et al., 2013; Tate et al., 2016; What Works Clearinghouse, 2022). In another study using a multiple-baseline design across classrooms, Battaglia et al. (2015) evaluated the impact of a tactile self-monitoring intervention on classwide work completion as measured by teachers' direct behavior rating. Results varied across the three classrooms and do not allow for conclusive interpretations.

However, the available evidence seems to indicate that electronic signaling devices can have a motivating effect on students. Self-monitoring can also be improved, which can lead to an overall increase in their performance. It has to

be assumed that the proficiency level stays relatively high as long as the devices are in use but returns to baseline once they are no longer applied.

Purpose of the Present Study

To our knowledge, no research has been conducted to date on improving writing performance through boosting students' motivation with the help of vibration signal devices designed to encourage self-monitoring. Therefore, we conducted a pilot study with struggling sixth graders and added visual performance feedback to help students see how they improved over the course of the intervention. Our research questions were as follows:

Research Question 1: Does using an electronic vibration alarm in combination with performance feedback increase the length of text written by sixth graders with writing difficulties? Based on previous studies on the effects of self-monitoring and motivational strategies, we expected medium to large level effects (García & de Caso, 2004; Grünke et al., 2017; McDougall et al., 2012).

Research Question 2: Does using an electronic vibration alarm in combination with performance feedback increase the quality of texts produced by sixth graders with writing difficulties? Grünke et al. (2015) confirmed that in the early stages of writing development, text length correlates positively with measures used to determine the quality of stories. Since we assume effects on the amount of text, following the results of Grünke et al. (2015), we expected small effects.

Methods

Setting and Participants

The study was conducted in an urban secondary school in Northrhine-Westphalia (Germany) that enrolled around 360 students from Grades 5 to 9. More than 50% of the students were from culturally and linguistically diverse backgrounds. We applied a multistep process to select learners from two sixth-grade classrooms to be eligible for the experiment. First, we conducted a standardized spelling test (SLRT II; Moll & Landerl, 2014) with every student to make sure that none of the subjects scored lower than the 30th percentile. We chose this criterion because we wanted to make sure that participants had already acquired this crucial prerequisite skill for writing to an acceptable standard. Next, we asked everyone above this benchmark to compose a story in response to a short writing prompt ("An unforgettable vacation"). We considered the 12 children who produced the shortest texts for participation in our study. Finally, we consulted the teachers of the two classes about the absence of their students from school during the last two months. Based on their feedback, we selected six children who had not missed lessons for more than a week. However, one of them was absent for more than three days during the course of the study and was thus eliminated from the data analysis.

Three of the students were female (Anna, Bekime, and Christine), two were male (Damian and Elias). (All names have been changed to ensure confidentiality.) Participants were between 12 and 14 years of age. Bekime and Damian had immigrant backgrounds; the rest of the group grew up in households with parents born in Germany and spoke German at home. Only one student (Christine) was officially diagnosed with an LD. However, according to their teachers, all of them struggled severely with basic academic skills and had difficulty staying on task for longer than 5 minutes.

Interventionists

Three college graduate students of special education (two female and one male) served as interventionists. In preparation for the study, they were extensively trained by the first and last authors during four 45-minute in-service sessions. The interventionists took turns measuring the performance of the participants and using the vibration signal devices with them.

Measurement

We used the number of total words written (TWW) to capture the level of students' competence. The words in each text were counted regardless of accuracy (i.e., spelling, grammar, and syntax). TWW is viewed as a suitable way to quantify writing performance in students who have not yet developed a very sophisticated skill level (Keller-Margulis et al., 2015).

In addition, we applied a rubric that was less production dependent than TWW and was designed to verify whether certain story elements were included in a narrative and whether they were used appropriately, based on the Teacher Evaluation of Story Elements by Troia and Graham (2002). The rubric consisted of five statements: (a) The story was coherent in its introduction, main part, and ending, (b) the introduction contained information on the where, when, who, and what of the narrative, (d) the main part entailed a consistent climax, (d) the story had a comprehensible ending, and (e) the text used appropriate stylistic means to make it interesting for its readers. Each statement was assessed on a scale from 0 to 5, for an overall possible score between 0 and 25.

Experimental Design

The study used an ABA reversal design to evaluate the effectiveness of the intervention in motivating participants to invest more time and energy into composing their stories (Riley-Tillman et al., 2020). According to Tawney and Gast (1984), this strategy allows for tentatively functional conclusions. Experimental control is demonstrated by a notable change from baseline to intervention across all participants. A return to the initial proficiency level upon termination of the treatment would speak to the assumption that the vibration signal devices were responsible for the increase in performance (Dowdy & Jessel, 2021).

Procedures

Each day of the study, all five participants were seated in a separate section of the classroom, away from their classmates. The interventionists then handed them envelopes that included 15 slips of paper, each with a different writing prompt printed on them. Subsequently, every student was asked to randomly draw one of the tapes and to write a narrative about the given topic on 8.27 x 11.69-inch lined pieces of paper. The prompts were short headlines like "An incidence on my way to school," "A bitter disappointment," or "Surprised by a windstorm" (a complete list is available from the authors upon request). Students were granted 10 minutes to complete their texts. After the time was up, they were asked by the interventionists to hand in their work. A given topic was never used twice. Once a paper strip was drawn, it was discarded.

During the first baseline phase (A1), students just wrote their stories and received no further instructions or feedback. Upon completion of the baseline, the interventionists introduced an electronic vibration signal device that was similar to a MotivAider®, but with limited functions and markedly less costly (details about the tool and where to purchase it may be obtained from the authors upon request). For each session during the intervention (B), students were given a checklist with 10 checkboxes, each with the sentence "I am still on task" printed next to them. The electronic devices were set to emit a vibration signal every minute. Whenever students noticed that it went on, they turned it off, and if in that very moment they were engaged in planning, translating or revising, they checked off a box on the list and immediately went back to work.

An additional motivational feature during the treatment phase was individual reflections on the students' performances from the previous day at the beginning of each session. That is, the interventionists calculated students' TWW scores every day and informed them about the number of words they had written. Furthermore, students were presented with an 8.27 x 11.69-inch line diagram depicting their output up to the respective day. At the beginning of each writing task, participants were strongly encouraged to try to beat their score from last time during the upcoming 10 minutes. In case students outperformed themselves (i.e., if they had written more words yesterday than the day before), they received a smiley sticker as a token. The same applied if their story was at least twice as long as the average TWW from baseline. In case of an improvement, the interventionists gave verbal feedback and attributed the enhancements to the students' efforts. The token system was linked to the in-class token system. After the intervention, the students could exchange their stickers for a small plastic star and use it for the in-class reinforcer system. When reaching a minimum number of stars, the children are reward with a class field trip.

The second baseline phase (A2) resembled the first. Students again just wrote their stories. No electronic vibration signal devices were used, and no

feedback was given. After 10 minutes, they were asked to hand in their texts. The three interventionists took turns working with the five sixth graders. However, another graduate student was usually present to help if needed.

Reliability and Procedural Fidelity

Upon completion of the study, two specifically trained research assistants independently reappraised the results to enhance the reliability of the data. The interrater-reliability equaled 100% for TWW and over 90% for the writing rubric. In case a difference occurred, it was resolved by discussion until agreement was reached.

Procedural fidelity was measured using a checklist consisting of 18 items that focused on external circumstances, materials, processes, assessment, and contact with students. Each of them could be rated on a 4-point Likert scale as "applies very much," "applies a little," "does rather not apply," or "does not apply at all" (the instrument is available from the authors upon request). Every interventionist was observed by another interventionist during every B phase session. The assessment of procedural fidelity indicated that the treatment was delivered as intended (100% accuracy).

Social Validity

To capture the social validity of the study from the viewpoint of the students, each interventionist interviewed one or two sixth graders a couple of days after the end of the second A phase using a questionnaire that contained eight statements that were related to the level of acceptance concerning the use of the electronic vibration signal devices and the visual performance feedback ("The device has helped me to concentrate better," "The device has helped me to write more," "I have learned a lot during the intervention," …). Students rated the statements using a 3-point scale with responses ranging from "disagree," "either agree or disagree" to "agree." (The complete instrument is available from the authors upon request.)

Results

All data analyses were carried out using the SCAN package for R (Wilbert & Lüke, 2022). The descriptive analysis (see Table 1) and visual inspection (see Figures 1 and 2) revealed improvements in both quantity and quality from A1 to B. For TWW, all students showed stable baselines (see Figure 1). It must be noted that Anna and Christine already started with higher scores in A1 (Min = 65/82; Max = 102). All the others did not exceed 63 words Max. With introducing the treatment, a rapid increase in written words was observed. The number of TWW rose from an average of $M = 53.10$ in A1 to $M = 186.63$ in B. Additionally, there was a gradual improvement towards the end of the intervention phase. All five participants reached their maximum scores at the last intervention measurement point. With respect to the transition from B to

A2, Elias and Christine showed a decline. However, there was a slight increase for Damian, Anna, and Bekime. Regardless, all five children's maximum scores exceeded the highest scores of the intervention phase. Visual analysis showed a following downward trend over time. In total, the average score dropped (M = 135.7) compared to the intervention phase. It must be noted that the values of the second baseline phase appeared to be unstable.

As depicted in Figure 2, data for the writing rubric were less consistent, although the average in Phase B (M = 10.79) was higher than the average in both baseline phases (M = 7.25; M = 7.7). While the first baseline phase of Elias, Damian, and Christine was low and stable, the A1 scores of Bekime and Anna were higher and more varied. There was an overall level effect in the transition from A1 to B with the exception of Damian, whose performance decreased on the first treatment day. Nevertheless, like the other four children, his performance did improve during the intervention. No ceiling effects were observed, as no one reached the maximum score of 25 points. When comparing Phase B to the A2 phase, Bekime's, Christina's and Elias' scores decreased, whereas Damian's stagnated and Anna's increased. In general, moderate negative trends were observed for Anna, Bekime, Damian, and Elias during the second baseline condition. In contrast, Christine showed a slight positive trend.

Table 1. ***Descriptive Statistics for TWW and Writing Rubric Scores in each Phase***

TWW															
Name	*N*			*M*			Min			Max			*SD*		
	A1	B	A2	A1	B	A2	A1	B	A2	A1	B	A2	A1	B	A2
Anna	4	4	4	79.75	154.70	118.00	65	133	78	102	183	229	17.34	21.23	74.08
Bekime	4	4	4	51.50	169.50	74.25	30	133	30	63	190	197	15.33	25.59	81.87
Chris-tine	4	4	4	88.75	232.50	244.00	82	197	154	102	292	356	9.06	43.82	83.43
Damian	4	4	4	23.00	194.75	147.50	17	127	33	34	237	256	7.71	47.40	122.06
Elias	4	3	4	22.50	180.33	99.75	17	153	17	27	198	307	4.12	24.00	138.94
Writing Rubric Scores															
Name	*N*			*M*			Min			Max			*SD*		
	A1	B	A2	A1	B	A2	A1	B	A2	A1	B	A2	A1	B	A2
Anna	4	4	4	13.25	16.25	12.50	10	14	9	19	20	22	3.94	2.63	6.35
Bekime	4	4	4	10.25	13.00	4.75	7	8	1	15	17	8	3.59	3.74	3.34
Chris-tine	4	4	4	5.75	7.25	10.25	4	2	8	7	11	13	1.25	3.86	2.06
Damian	4	4	4	2.25	6.50	4.75	1	1	3	4	13	6	1.50	4.93	1.50
Elias	4	3	4	4.75	11.00	6.25	2	9	2	6	15	14	1.89	3.46	5.43

Note. N = Measurement points; A1 = Baseline 1; B = Intervention; A2 = Baseline 2; M = Mean;
SD = Standard deviation; Min = Minimum; Max = Maximum.
Quality: Maximum of 25 points.

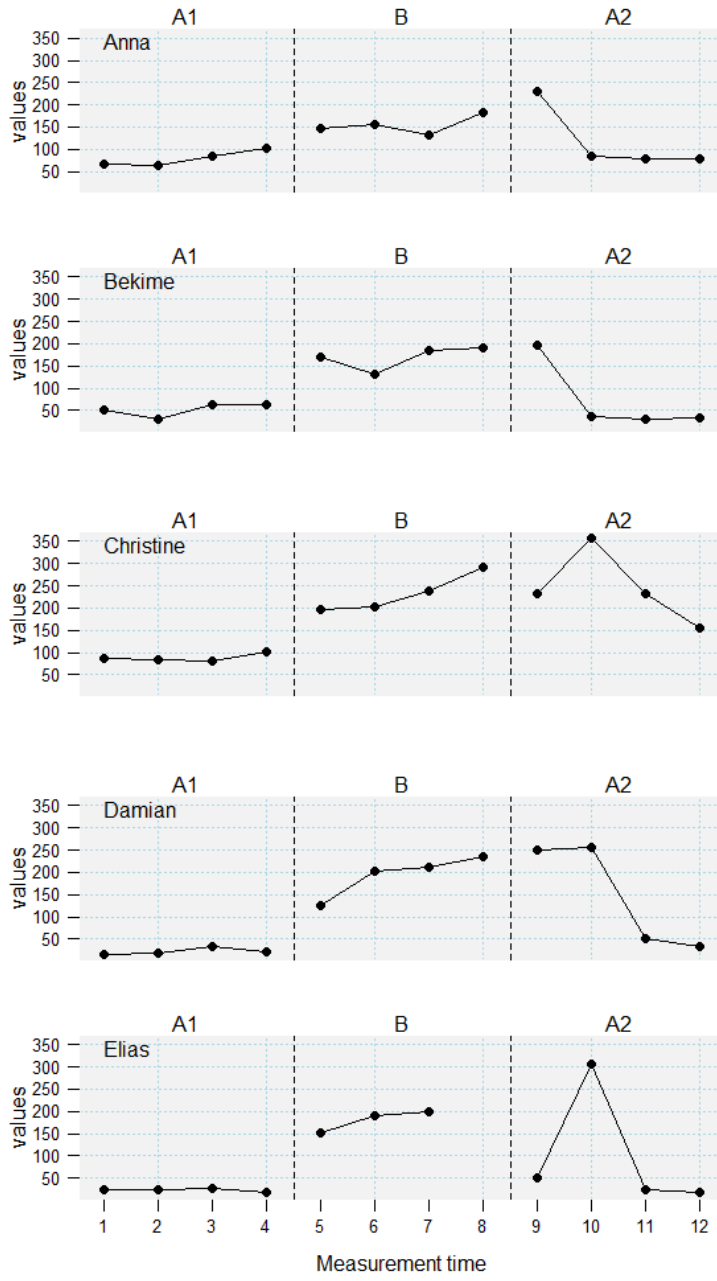

Figure 1. **TWW per Participant for Each Treatment Condition**

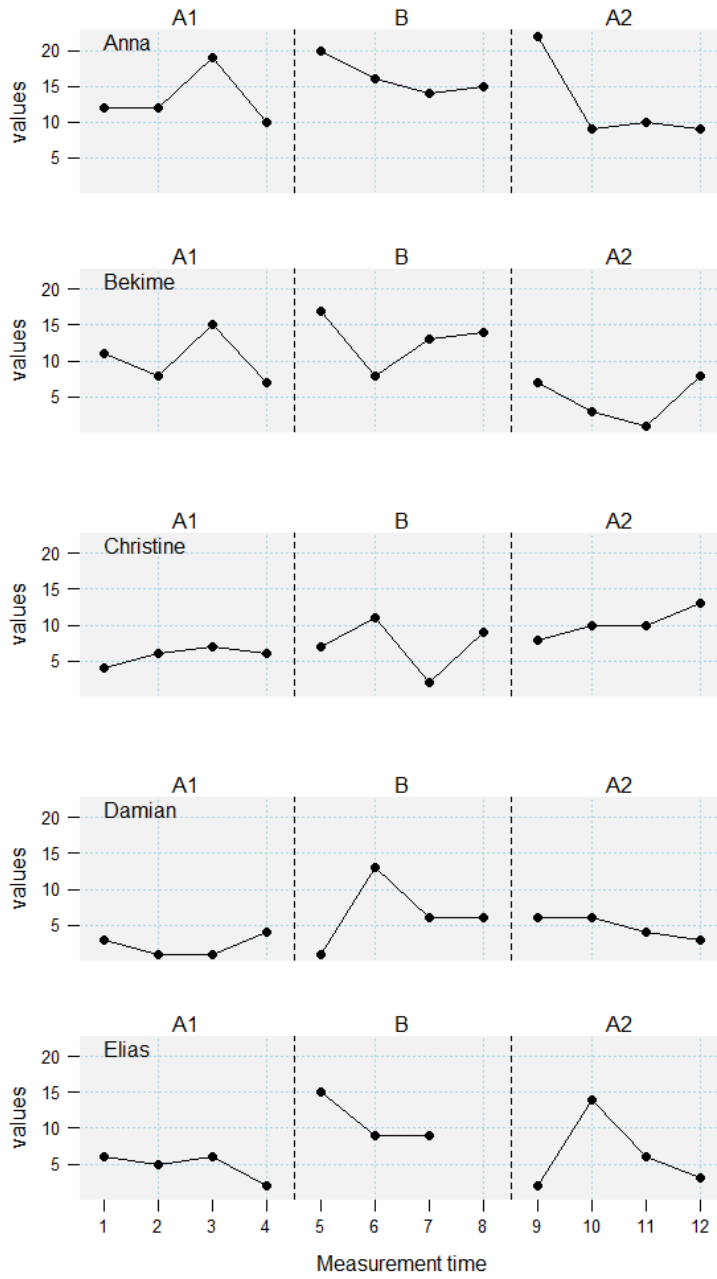

Figure 2. **Writing Rubric Scores per Participant for Each Treatment Condition**

We calculated the percentage of non-overlapping data (PND; Tarlow & Penland, 2016), which is the most commonly used non-overlap method in single-case research. Moreover, we chose non-overlap of all pairs (NAP), which is very robust against outliers (Parker et al., 2011). In addition, we applied the mean baseline difference (MBD) to measure the average change from the first baseline to the treatment phase (O'Brien & Repp, 1990). With respect to the PND and the NAP for TWW (A1 vs. B), all participants reached the maximum score of 100%. The MBD ranged from 93.98% to 746.73%, averaging 386.65%.

Taking a look on the writing rubric scores (A1 vs. B), the PND showed very strong effects in the case of Elias (100%) and acceptable effects for Bekime and Damian (75%). In the case of Anna and Christine, the indices were low. The NAP indicated very strong performance increases only for Elias (100%). For the remaining participants, indices ranged from 72 to 81%, representing moderate to strong benefits. With respect to the MBD, three out of the five students showed an average increase of less than 30%, whereas two students' average gain equaled about 130% and 190%.

Table 2. ***Effect Sizes for TWW and Writing Rubric Scores***

TWW					
	A1 vs. B				
	PND	*p*	NAP	*p*	MBD
Anna	100	< .01**	100	< .05*	93.98
Bekime	100	< .01**	100	< .05*	229.12
Christine	100	< .01**	100	< .05*	161.97
Damian	100	< .01**	100	< .05*	746.73
Elias	100	< .05*	100	< .05*	701.46
Writing Rubric Scores					
	A1 vs. B				
	PND	*p*	NAP	*p*	MBD
Anna	25	> .05	81	> .05	22.64
Bekime	75	< .05*	72	> .05	26.82
Christine	50	> .05	72	> .05	26.08
Damian	75	< .05*	81	> .05	188.88
Elias	100	< .05*	100	< .05*	131.57

Because the performance of our five participants during the A2 phase was anything but stable, we decided not to calculate PND and NAP for the dif-

ferences between B and A2 as the results would not have been very meaningful. However, we did determine the MBD for B vs. A2, which resulted in a decrease in TWW of 31.10% for Anna, 128.28% for Bekime, 32.03% for Damian, and 80.78% for Elias. Only Christine demonstrated a slight increase of 4.71% from B to A2. The MBD for the writing rubric scores indicated a 30.00% decrease from B to A2 for Anna, 173.68% for Bekime, 36.84% for Damian, and 76.00% for Elias. Again, Christine stood out, with an increase of 29.27%.

In addition to the analyses of TWW and writing rubric scores, we aggregated the five cases into one and used a hierarchical piecewise regression model to determine the overall effects of the intervention. Because we only predicted a level effect from A1 to B as well as from B to A2, we neglected to determine a slope effect. As depicted in Table 3, there was a significant increase in performance from the initial baseline to the treatment phase. Contrary to what we expected, there was no distinct drop in TWW or in writing rubric scores once the intervention was discontinued. However, as Figures 1 and 2 indicate, the last two measurements were more or less on the same level as the probes during A1 (with Christine as the only exception). Hence, even though the regression analyses were not able to reflect this, the increases in performance were not lasting.

Table 3. ***Piecewise Regression Model for TWW and Writing Rubric Scores***

	B	*SE*	*df*	*t*	*p*
			TWW		
Intercept	77.19	26.92	51	2.87	> .05
Trend	-9.64	7.51	51	-1.28	> .05
Level A1 to B	170.32	35.83	51	4.75	< .01*
Level B to A2	-9.64	36.86	51	-0.26	> .05
			Writing Rubric Scores		
Intercept	8.55	1.97	51	4.34	< .01**
Trend	-0.52	0.45	51	-1.16	> .05
Level A1 to B	5.51	2.15	51	2.57	< .05*
Level B to A2	-0.90	2.21	51	-0.41	> .05

In terms of social validity, the intervention was perceived positively across the students. Four of the five participants reported that they had fun working with the tactile device for self-monitoring and would like to do the intervention more often in school setting. They specified that they agreed to all eight statements in the questionnaire. However, one student indicated that he did not like the treatment. Nevertheless, he found the intervention helpful and agreed with seven out of the eight statements.

Discussion

Main Findings

This pilot study was the first to evaluate the effects of vibration signal devices combined with visual feedback on the writing performance of struggling students. We assumed that the intervention would motivate the participants (5 sixth graders), enhance their self-monitoring abilities, and thus lead them to produce longer and qualitatively better stories. The results indicated that the number of words in a text increased drastically as soon as the intervention was initiated. In fact, the average increment equaled almost 390%. Upon termination of the treatment, performance eventually returned to its original level. However, it took a couple of days before the intervention effects faded.

We also detected a rise in quality, but it was not nearly as strong as the one for quantity. In three out of five cases, the average gain equaled less than 30%, whereas two students showed a boost of between about 130% and 190%. The effects did not carry over to the second baseline phase for long. All in all, the participants viewed the treatment very favorably and expressed their approval.

The results square well with previous findings on using vibration signal devices to sharpen students' self-monitoring skills and enhancing their motivation to increase their performance. Even though no similar study has ever focused on improving writing skills, the outcome of our experiment did not come as a surprise as previous research has demonstrated the potential of tactile devices that signal when self-monitoring should occur on on-task behavior and assignment completion (e.g., with math) (Boswell et al., 2013; Jellison, 2009; Legge et al., 2010).

Limitations

As a pilot study with five participants and a simple ABA design, this research has limited validity and cannot be generalized. The phases included just four probes and, due to the upcoming summer vacation, we were not able to incorporate a second B phase. Thus, we do not know how well the students would have performed if they had been asked to use the vibration signal devices again after putting them aside for a number of days. An ABA design does not yield the most robust findings (Gast & Hammond, 2010). Besides, four measurement points per phase is not a solid basis for drawing convincing conclusions. Further, the fact that the application of the electronic tools was combined with an immediate feedback procedure make it impossible to discern what component was to what extent accountable for the positive effects on writing productivity and quality. We can only ascertain that the performance increased significantly as soon as we introduced the vibration devices and gave students feedback on how well they did the previous day. Finally, the social validity interviews with the participating sixth graders were conducted by the individuals who carried

out the intervention. This is not ideal. Because students had built a relationship with the interventionists over the course of the study, there might have been a tendency for a social desirability bias in responding (Gittelman et al., 2015).

The fact that the interventionists took turns working with the participants cannot be considered a serious threat to the validity of the experiment. Similarly, it is unreasonable to assume that the increases in performance were due to the sixth graders' awareness of taking part in a research project. Both circumstances applied before, during, and after the intervention. However, the consistently low performance prior to the treatment and the impressive leap in productivity that happened simultaneously with its onset leave little room for believing that changing interventionists or the participants' knowledge about their involvement in a study were relevant factors causing the effects.

Practical Implications

Despite its limitations, this study provides valuable information on how to help struggling secondary students overcome their resistance to writing with minimal means. The increases in performance demonstrated by the sixth graders in this experiment were remarkable. Given the fact that so many children and teens need help in motivating themselves when having to perform such a challenging task as producing a text, strategies that are easy to implement and effective are needed more than ever. After long years of COVID restrictions and students not attending school for a significant amount of time, many young people show increased trouble concentrating and focusing (Meinck et al., 2022). To counteract these reactions, they need experiences that give them a sense of achievement and illustrate to them what they are capable of. The intervention presented here seems to have accomplished just that. As soon as the vibration signal devices (combined with visual feedback) were applied, students wrote considerably longer texts than before.

If a pilot study yielded promising results about an intervention program requiring a considerable amount of time and effort, it would seem appropriate to wait for further findings before considering its dissemination in schools. But even if the positive effects of a certain treatment have been repeatedly and reliably documented, it might still not be justifiable to directly recommend its practical application. Some interventions demand exceptionally large expenditures – too large to be outweighed by the benefits. However, in the case of the treatment evaluated in this study, the costs are minimal and the potential benefits are extraordinary. Teachers and students have a lot to gain and little to lose. Thus, it appears absolutely reasonable to make the advantages of vibration signal devices combined with visual feedback available to the many students who are in desperate need of a motivation boost.

Future Research

Further work on the benefits of vibration signal devices on motivating students to write longer and better stories should focus on replicating the reported findings but with a withdrawal design involving at least two A phases and at least two B phases. Applying an alternative treatment plan to test the two interventions (vibration signal devices vs. visual feedback) would help to gain more insights into the benefits that each treatment can contribute to a performance increase in struggling writers. An even more sophisticated option would be an A(B+C)ABAC design. The letters in the parentheses refer to the two different treatments. After applying them both in combination, the researcher returns to baseline before replicating each treatment in isolation (Dowdy & Jessel, 2021).

Single-case research is not the only approach to gaining more insights into the way these electronic tools can be of benefit. Group studies are also required to shed more light on the topic. In addition, solid research on long-term effects is needed. It cannot be ruled out that the effects of using the electronic tools wear out over time. Moreover, we need more insight into how the intervention works with different groups of students. In this study, we focused on sixth graders with learning problems that were not further specified. Future research could look at using vibration signal devices with typically achieving students as well as with students with different kinds of disabilities. Lastly, there is a need to test the effects of these tools on different writing outcomes. Indeed, the length and quality of a story are not the only areas of interest.

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