IMPLEMENTATION OF THE TALE-BOT ROBOT FOR DEVELOPING EXECUTIVE FUNCTION IN PLANNING AND ORGANISATION: PILOT TEST

Elena Pérez-Vázquez, & Alba Gilabert-Cerdá
Department of Developmental Psychology and Didactics/University of Alicante (Spain)

Abstract

Executive functions (EF) are a set of essential skills involved in all daily activities, allowing individuals to adapt to their surroundings. These skills, which are fundamental for behaviour control and regulation, require specific attention within the educational field. Among these EF skills, planning and organisation stand out, referring to the ability to anticipate and structure future events and goals. Learning through robotics could represent an effective methodology for fostering planning and organisation skills in primary school students. Currently, among the available floor robots for this purpose is the Tale-Bot robot. This robot contains directional symbols that allow users to programme its routes, provides instant voice feedback, and has the capability to record narrations. For activity development, 10 x 10 cm grid playmats are used. In this context, the present research aims to evaluate improvements in the executive skill of planning and organisation in a primary school pupil following the implementation of a protocol based on the use of the Tale-Bot floor robot. To achieve this general objective, a methodology based on a quantitative approach with a single-case quasi-experimental design, using pretest and posttest, will be implemented. For this design, the sample was intentionally selected in a non-probabilistic manner, comprising a 7-year-old female pupil. Specifically, the BRIEF®-2 (Behaviour Rating Inventory of Executive Function-2) was used as the instrument to measure planning and organisation skills. The intervention was conducted in a state-subsidised school in Alicante, Spain. As for the procedure, it consisted of five individual sessions of 30 minutes each, where activities based on challenges were carried out using the "Let's go to the zoo" playmat. During the sessions, the pupil was required to programme the robot's route according to the previously provided challenge. The results showed an increase in scores on the clinical scale of planning and organisation. In conclusion, these findings suggest that the Tale-Bot robot activity protocol could be a potentially beneficial educational approach for developing this executive function.

Keywords: Tale-Bot, executive functions, planning and organization, primary education.

1. Introduction

Executive functions (EFs) are high-level cognitive processes essential for mentally playing with ideas, taking time to think before acting, and staying focused (Diamond, 2013). Recent research (Pascual et al., 2019; Spiegel et al., 2021) has shown a significant relationship between executive functions and academic development during the Primary Education stage. Specifically, school-based interventions targeting EF can improve academic achievement, as demonstrated by studies such as the one conducted by Jacob & Parkinson (2015). Among the different executive functions, the ability to plan and organise is a central component of the cognitive control system. It enables individuals to set goals, design strategies to achieve them, prioritise tasks, and manage resources and time effectively (Maldonado Belmonte et al., n.d.). This executive function is involved in initiating and maintaining social interactions, managing emotions and behaviours, and adapting to the dynamic demands of the school environment (Freeman et al., 2017). Primarily, the use of robots like Tale-Bot in Primary Education supports the development of executive functions by promoting key cognitive skills in an engaging and interactive manner. With this robot, students must set goals, sequence steps, and anticipate outcomes. This involves planning and organising skills, as they need to determine the correct order of actions for the robot to accomplish a specific task, such as reaching a destination on an interactive mat. Various studies (Di Lieto et al., 2017; Urlings et al., 2019) suggest that educational robotics enhances executive functions in Primary Education children. By integrating programming and interactive games, complex cognitive processes are stimulated, contributing to the student's holistic development (Marras et al., 2024). For these reasons, using robots like

Tale-Bot not only introduces students to computational thinking and programming but also strengthens their executive functions, better preparing them to face academic and social challenges more effectively.

2. Objectives

The aim of this research is to apply the Tale-Bot robot to develop the executive component of planning and organisation in a 7-year-old neurotypical student. From this general objective, the following specific objectives arise, which will guide our research:
- SO1. To describe the executive functioning in terms of planning and organisation of the participant, both before and after the intervention.
- SO2. To evaluate any significant differences in the planning and organisation of the participant following the intervention.

3. Methodology

This section details the various components that constitute the research methodology.

3.1. Research approach and design
This investigation employed a quantitative research methodology, which is primarily characterized by numerical data analysis to ensure objectivity, reproducibility, and the ability to generalize findings (Zawawi, 2007). This approach enables the systematic measurement of the studied phenomena and facilitates the identification of relationships among multiple variables (Stockemer et al., 2019). Moreover, a quasi-experimental pretest-posttest design was utilized. This particular methodological framework allows for the evaluation of intervention effects by comparing data collected before and after its implementation (Rogers & Revesz, 2019).

3.2. Participants
A non-probability purposive sampling method was used to select the participant. This sampling technique involves choosing an individual who meets specific criteria relevant to the research objectives. In this case, the participant was a 7-year-old neurotypical female student enrolled in primary education. The selection criteria included: (1) typical neurodevelopment without any clinical diagnoses, (2) enrolment in a regular classroom, and (3) parental consent along with a signed participant assent form.

3.3. Measurement instrument
The study focused on assessing executive functions, specifically planning and organization skills, through selected items from the Behaviour Rating Inventory of Executive Function – Second Edition (BRIEF-2). Consistent with the primary research objective, this instrument was used for both pretest and posttest evaluations to assess these skills in the participant. The teacher completed a questionnaire containing 53 items rated on a three-point Likert scale: never (0), sometimes (1), and frequently (2). To facilitate the process, the researcher read each item aloud, allowing the teacher to select the most appropriate response, which was subsequently recorded. The assessment was conducted online, with responses documented using the *TEAcorrige platform.*

For this study, items 4, 9, 14, 19, 29, 39, 44, and 49 from the BRIEF-2 were utilized to evaluate planning and organizational abilities. These items assess the student's capacity to structure information, establish objectives, and sequence necessary steps to achieve them. Unlike its predecessor, the BRIEF-2 conceptualizes planning and organization as a single domain, supported by empirical evidence indicating their strong interconnection (Maldonado Belmonte, n.d).

3.4. Research procedure
The study was conducted in several sequential phases, as described below:
- Phase 1: Institutional Approval and Consent Collection. Initial contact was made with the educational institution, followed by an introductory meeting where comprehensive details regarding the study were shared. During this meeting, informed consent was obtained from the parents of the participating students. Once all necessary permissions were secured, a schedule was established to conduct the intervention.
- Phase 2: Pretest Administration of the BRIEF-2. Prior to the intervention, participants were assessed using the BRIEF-2 inventory [21]. The evaluation took place in collaboration with the regular teacher. The researcher verbally presented each item, while the teacher responded using

the Likert scale (never, sometimes, frequently), and a second researcher recorded the responses in the TEAcorrige system. This process was identical for both participants.

- Phase 3: Implementation of the Tale-Bot Pro Robot Intervention. The intervention comprised five individual sessions, each lasting approximately 30 minutes. These sessions were conducted over a three-week period, from November 25th to December 13th. Throughout the sessions, participants engaged in progressively complex programming challenges aimed at enhancing planning and organizational skills. The "Let's Go to the Zoo" interactive mat (Figure 1) was used to support these activities.

Figure 1. Carpet of Tale-Bot Pro.

- Phase 4: Posttest Administration of the BRIEF-2. Following the intervention, the BRIEF-2 inventory was re-administered to assess any changes in executive function skills. The procedure mirrored that of Phase 2 to ensure consistency in data collection.
- Phase 5: Data Processing and Conclusion Formulation. The final phase involved analyzing the collected data, interpreting the results, and drawing conclusions based on the findings.

3.5. Data analysis

To process and analyze the collected data, the SPSS 28 statistical software package was utilized. Initially, descriptive statistical analyses were conducted to determine measures such as mean, standard deviation, and median for the pretest and posttest results. Subsequently, a non-parametric statistical test, the Wilcoxon signed-rank test, was applied to examine potential significant differences between pretest and posttest scores for both participants.

4. Results

The following presents the results of the research, which respond to the specific objectives of the study.

4.1. Descriptive results of executive functioning regarding planning and organisation for the participant, before and after the intervention

Figure 2 displays the scores obtained by Participant on the items related to executive functioning in terms of planning and organization from the BRIEF-2. Specifically, the scores for both the pretest and posttest are shown.

Figure 2. Results of participant.
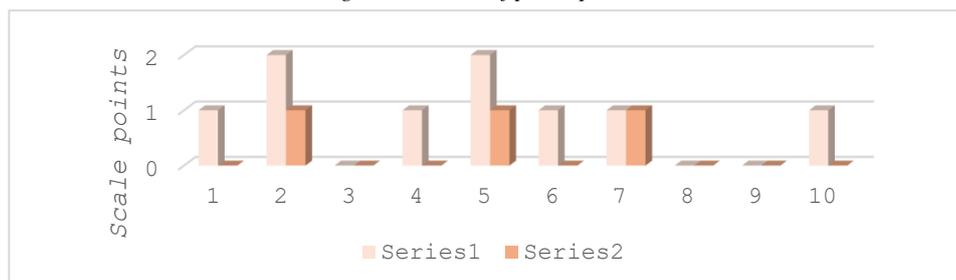
As shown in Figure 2, on the one hand, the scores decreased in 60% of the items (items 4, 9, 19, 24, 29, and 49). Specifically, in items related to organizing objects in an orderly manner when instructed (item 4), difficulty finding personal belongings despite receiving clear instructions (item 19), struggling to consider alternative solutions when encountering difficulties in problem-solving (item 29), and leaving tasks incomplete even after receiving guidance on how to complete them (item 49), the participant's responses shifted from "sometimes" (point 1 on the Likert scale) to "never" (point 0 on the Likert scale). Additionally, in items concerning the need for external prompting to initiate a task despite being willing to do so (item 9) and difficulty adhering to established routines for sleeping, eating, or playing (item 24), the participant's responses changed from "frequently" (point 2 on the Likert scale) to "sometimes" (point 1 on the Likert scale). It is important to note that, according to the BRIEF-2, higher scores indicate greater difficulties in executive functioning. On the other hand, in the remaining 40% of the items, including difficulties remembering what to retrieve when sent to fetch something (item 14), becoming overly focused on minor details rather than the main objective of a task (item 39), and struggling to locate personal items in familiar environments despite receiving explicit instructions (item 44), the participant obtained the same scores in both the pretest and posttest, indicating no observed change in these areas.

Secondly, Table 1 presents the descriptive results.

Table 1. Descriptive statistics of the first participant.

	Number of items	*Mean (M)*	*Standard Deviation (SD)*	*Median*
Pretest	10	0.9	0.738	1
Postest	10	0.3	0.483	0

4.2. Evaluation of potential significant differences in planning and organisation for the participant after the intervention.

After analysing the data using the non-parametric Wilcoxon signed-rank test for related samples, the results obtained are presented in Table 2.

Table 2. Wilconox signed-rank test results for subject 1.

	Ranks	*N*	*Average Rank*	*Sum of Ranks*
Postest - Pretest	Negative Ranks	6[a]	3.5	21
	Positive Ranks	0[b]	0	0
	Ties	4[c]		
	Total	10		

Note: (a) Post < Pre; (b) Post > Pre; (c) Post = Pre

Next, the statistics of the Wilcoxon Signed-Rank Test are presented.

Table 3. Wilconox signed-rank test statistics for subject 1.

Z	*Sig. asin. (bilateral)*
-2.449	0.014

As can be seen in Table 3, the results for participant number 1 show a significance level of $p < .05$.

5. Discussion

In pursuit of the general objective, the research has addressed several specific research objectives. Specifically, on the one hand, the results of specific objective number one, concerning the participant, show a decrease in the mean and standard deviation from the pretest (M = 0.9, SD = 0.738) to the posttest (M = 0.3, SD = 0.483). According to Maldonado Belmonte et al. (n.d), demonstrate an improved performance in the planning and organisation skill. According to the interpretation criteria of the BRIEF-2, a lower score indicates fewer difficulties. These results are consistent with those presented by Urlings et al. (2019) where students of Primary Education showed improvements in executive function after the implementation of a floor robot with features similar to the Tale-Bot Pro robot. Regarding the second specific objective, the results show significant differences after the intervention with the robot. These results are consistent with Urlings et al. (2019) research.

6. Conclusions

The following conclusions were drawn based on the specific objectives outlined:

− The participant achieved a lower score in 60% of the items in the posttest, relating to the executive skill of planning and organisation. As a result, the mean and standard deviation were higher in the pretest than in the posttest. According to the interpretation criteria of the BRIEF-2, the student demonstrated improved executive function following the intervention with the Tale-Bot Pro robot.

− Significant differences were observed with p = 0.014 in the executive function of the participant following the intervention with the Tale-Bot Pro robot.

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