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Regular Article

Assessment of the impact of neuro-linguistic programming on primary Schoolchildren's intellectual capacity

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ABSTRACT

Background: Lebanon's education system confronts significant obstacles from political instability, economic downturns, and inequalities among children, underscoring the urgency for interventions like Neuro-Linguistic Programming (NLP). This study posits that NLP techniques hold promise in equipping students with the tools to surmount these hurdles and enhance their intellectual capabilities.

Objective: This study examines the influence of NLP on the intellectual capacity and abstract reasoning skills of primary school children aged 6 to 11.

Methods: Over four months, from April to July 2023, a before-and-after intervention study was conducted. The study involved children from a private urban school in Lebanon, and the Raven's Colored Progressive Matrices test was individually administered to assess their intellectual abilities. This test was administered before and after the NLP intervention, which comprised four sessions for teachers and one for students.

Results: The study involving 121 students (60.0% females, 40.0% males), indicated significant enhancements in performance, particularly among older students aged 8 to 11. Notable increases in mean scores were observed, such as 8-year-olds improving from 8.95 to 9.36 and 11-year-olds experiencing a significant boost from 6.86 to 12.69. Connectivity analysis revealed positive relationships between students' age and performance, with correlation coefficients of 0.328 before and 0.633 after the intervention. Similarly, strong correlations between grade level and performance were evident, with coefficients of 0.385 before and 0.716 after the intervention, both statistically significant ($p < 0.001$). Comparisons of intellectual abilities among students showcased more significant improvements among older age groups, emphasizing the potential benefits of NLP, particularly for students between 9 and 11 years old.

Conclusion: The NLP intervention yielded notable enhancements in children's academic performance, particularly demonstrating a more pronounced positive effect among those aged 8 and older. Despite weaker correlations with parental factors, the study underscores the promising impact of NLP interventions on cognitive development, particularly among older students. As a cost-effective technique, NLP can be implemented with minimal resources, increasing accessibility even in resource-constrained environments.

1. Introduction

Intellectual capacity is the human brain's capacity to identify problems, continuously learn, find solutions, and broaden thinking conduct (Colom et al., 2022). Several interventions are employed to improve human intelligence. Mindfulness intervention improved emotional intelligence and enhanced confidence, positive thinking, and endurance (Zhou et al., 2022). Cognitive behavioral therapy is used as an intervention that allows us to understand how emotions, thinking, and interactions work together, which, once recognized, can initiate strategies to alleviate stress and improve emotional intelligence (Taharani et al., 2020). Other interventions from the pharmaceutical field include nootropics (also called smart drugs) and Cortical Stimulation (Arif et al., 2021). Their mode of action is based on improving memory and intelligence and promoting cognitive thinking. They are available as drugs, supplements, or nutraceuticals (Malík & Tlustoš, 2022). Individual

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intelligence developed during childhood will reflect the same individual's intelligence level upon aging, showing the peak of intelligence during childhood (Sternberg, 2019). Other studies propose that in addition to the intelligence developed during childhood, additional parameters such as experience and exposure can add to the individual's level of intelligence and prevent its decline due to age (Masunaga & Horn, 2001).

Neuro-linguistic programming (NLP) is an interaction and human development method to arrange and sort emotions, thinking, and dialect (Kotera et al., 2019). NLP focuses on people's experiences shaped by their social interaction and its impact on their communication among themselves and their peers, specifically, the non-verbal type of communication (Drigas et al., 2022). Earlier research on NLP concluded that it has a high potential for nurturing psychological outputs within the professional environment by lowering individuals' stress and elevating their self-confidence (Kotera et al., 2019; Kotera & Van Gordon, 2019). Studies showed its beneficial effect in reducing post-operative pain by targeting the patients' senses to reduce pain perception (Sakallı & Kara, 2022). NLP can effectively overcome learning Difficulties (dyslexia/dysgraphia, dyscalculia, dyspraxia, attention-deficit/hyperactivity disorder, autism), anxiety disorders, and phobias (Anjomshoa et al., 2020; Drigas et al., 2022).

2. Literature review

NLP has emerged as a promising approach to enhancing the intellectual capacity of children in school settings (Mhanna et al., 2024). Rooted in the connections between neurological processes, language, and behavioral patterns, NLP techniques offer strategies for improving cognitive skills, critical thinking, and problem-solving abilities (Gran, 2021; Hamill, 2012). Research indicates that integrating NLP techniques into classroom instruction can positively impact students' academic performance (Abdo et al., 2024; Rayati, 2021). Techniques such as visualization, positive self-talk, reframing, and modeling have been associated with improved focus, concentration, motivation, and self-confidence among students (Fakehy, 2022). Moreover, NLP interventions foster the development of critical thinking skills by encouraging students to analyze their thought processes, challenge limiting beliefs, and explore alternative perspectives. Lebanon's primary education system provides universal access to free and compulsory education for approximately 1.5 million children aged 6 to 14, with a multilingual approach that includes Arabic, French, and, increasingly, English (Bacha & Bahous, 2011; Jalbout, 2015). While the country boasts over 1300 primary schools, there remains a significant gap in infrastructure and funding, particularly in public schools where overcrowded classrooms and inadequate facilities are prevalent (Nehme & Nehme, 2016). Although private schools offer better resources and facilities than their public counterparts, socioeconomic factors heavily influence access to them, leading to disparities in educational outcomes (Khafaja et al., 2020). Qualified teachers play a crucial role in delivering a diverse curriculum, yet there's a need for standardized curricula across schools to ensure consistency and quality (BouJaoude & Ghaith, 2006). In the context of Lebanon's urban private schools, where diverse socio-economic populations are served, the application of NLP techniques holds particular promise. Given the complex social dynamics and educational challenges in urban areas, NLP interventions could provide tailored strategies for addressing disparities in educational outcomes. Future research in Lebanon could explore the adaptation of NLP techniques to the local context, the effectiveness of interventions across different socio-economic backgrounds, and the integration of NLP strategies into existing educational frameworks. Few interventions have been conducted on Lebanese school children to improve their mental capabilities and productivity. Most students are usually challenged by their involuntary pre-judgments, undesirable beliefs, and implicit favoritism, which discourage their behavior and lessen their learning productivity (Manana et al., 2023). Such challenges are usually of high significance in students with special needs. Previous studies highlighted the impact of NLP on academic achievement and improvement in language proficiency through amplifying memory and learning (Al-shloul, 2023; Drigas et al., 2022; Rajasekaran, 2020). Particularly, in Lebanon, students face several triggers and are impacted by multi-faceted crises, with the highest impact of environmental and behavioral triggers on their performance (Ghanem et al., 2024). Research showed a significant reduction in headaches, stomachaches, and overall negative emotions among children, such as unhappiness, depression, or tearfulness, after NLP sessions (Chehabeddine et al., 2023), and a significant reduction in the report of academic difficulties (Abdo et al., 2024). Therefore, the current study aims to assess the impact of NLP intervention on improving primary schoolchildren's intellectual capacity.

3. Methods

3.1. Study design

A before-and-after intervention cohort study was conducted over four months, from April to July 2023. The study protocol is reachable by the public through the clinicaltrials.gov registry (NCT05870085). The overarching project is tailored for primary schoolchildren, their parents/legal guardians, and teachers within a private school setting in an urban area of Lebanon, employing various standardized tools. Two hypotheses were formulated to guide the inquiry:

1. Impact of NLP Intervention on Alleviating School Triggers: This hypothesis seeks to understand the effectiveness of NLP intervention in addressing triggers within the school environment.
2. Can NLP Improve the Intellectual Capacity of Primary Schoolchildren?: This hypothesis delves into the potential of NLP techniques to enhance the intellectual capabilities of primary schoolchildren.

By conducting two data collections at different timeframes, this cohort study is designed to address the second hypothesis primarily, focusing on the target group of schoolchildren. By employing rigorous methodology and analysis, the study aims to provide valuable insights into the efficacy of NLP interventions in educational settings.

3.2. Study sample

The study sample comprises grades 1 to 5 students aged between 6 and 11 years. This age group was specifically chosen due to its representation of a crucial stage of cognitive, linguistic, and emotional development (Szaflarski, Holland, et al., 2006; Szaflarski, Schmithorst, et al., 2006). Furthermore, selecting this age range aligns with the validation of the study tool, ensuring that the insights gained accurately reflect the experiences and responses of this specific developmental cohort. The enrollment criteria required students to have attended this specific school within a minimum of 1 year before data collection. This school was selected as the study site since it offers a strategic vantage point for investigating the interplay between socioeconomic status and education while also considering the unique dynamics of urban environments. This choice enabled exploring a broad range of factors that shape educational experiences and outcomes, ultimately contributing to a more nuanced understanding of the actual impact and viability of the NLP intervention. The required sample size was calculated using G*Power version 3.1 to test the mean difference between two dependent means (matched pairs). A priori calculation (95% confidence interval and 80% power) yielded a required sample size of 128 participants to allow the detection of at least 25% effect.

3.3. Study tool and data collection

Students' general characteristics were filled in by their parent or

legal guardian. Some characteristics were child-specific, like age, sex, and grade; others were family-specific, such as marital status, the highest level of education, perceived economic situation, working and smoking statuses, and the total number of children. Raven's Colored Progressive Matrices (RCPM) test was provided independently for each student within an open time duration (during school hours), using an electronic tablet. A trained researcher presented a drawing made of a missing element in front of the students and explained the student action required to select one out of the six options to complete the missing part without any further support. The test was conducted two times. The initial visit occurred in April, while the second was in June 2023 (one month and a half after the intervention). Each session took around 55–65 min.

3.4. Description of the intervention

A Neuro-Linguistic Programming (NLP) expert and another trained study member performed the interventions together. The intervention was divided into two parts; one was for teachers, while the other was children-oriented (Table 1). The school director reviewed and approved the plan, led by a certified psychologist and NLP expert.

- Teachers' intervention encompassed four different sessions, each of 30 min, with different themes and interactive pitches, including a grounding exercise, an introduction to NLP in schools, communication skills with students, possible adopted techniques (meta-model, generalizations, and deletion), applications of technics (reframing and anchoring), practical activities with children, matching and mirroring exercise, calming skills, thermometer and breathing exercises, and finally sharing and exchanging kind words.
- Students' intervention took 1 h, including gameplay activities such as breathing exercises, image interpretation, drawing, and writing bad feelings and positive quotes. The intervention coincided with two of the teachers' sessions and was conducted with careful consideration for student autonomy, allowing them the right to refuse participation. However, to optimize engagement and outcomes, each classroom received support from two team members and two auxiliary teachers. Students were organized into four teams to facilitate interactive learning, and exercises were administered using electronic tablets. These exercises were thoughtfully designed to incorporate real-life examples and role-play scenarios, drawing from students' negative experiences. Moreover, students actively participated in these sessions, sharing their challenges and experiences, which served as valuable learning opportunities for themselves and their peers. Alongside identifying these hurdles, the intervention also equipped students with practical tools and strategies to overcome them.

3.5. Ethical considerations

The institutional review board of the faculty of pharmacy of the Lebanese University reviewed and approved the current study protocol (reference: 3/23/D), tool, and consent form. Representatives of the study team convened a meeting with the school teachers and concerned management members, outlining the study's goals. Discussions occurred during this meeting, where minor changes were raised and implemented, followed by a written authorization issued by the school management. Students' data were kept confidential and anonymous through a specific coding system applied by the school management. Written informed consent was obtained from parents/legal guardians. Participation was voluntary (students or parents could withdraw their participation at any time). No financial entitlements were provided, and the study findings are collated for research purposes only.

Table 1
Description of the NLP intervention and different activities provided.

Intervention component/number of sessions and time	Name of the intervention	Description of the intervention
Teacher's intervention (4 sessions: each for 30 min)	Greeting and Overview	- introducing the session's objectives. - overview of NLP and its relevance to teaching and learning.
	Introduction to NLP	- Defining NLP as a method of understanding and influencing human behavior, communication, and thinking patterns. - Explaining the key components of NLP: neurology (brain and nervous system), language (verbal and non-verbal communication), and programming (patterns of behavior and thinking). - Emphasizing the practical applications of NLP in education, such as improving teaching effectiveness, fostering positive relationships with students, and enhancing classroom management.
	NLP core principles	- The map is not the territory: Emphasizing the subjective nature of individual experiences and perceptions. - Rapport: Highlighting the importance of building rapport and establishing connections with students to enhance communication and learning. - State management: Discussing techniques for managing emotional states and maintaining a positive mindset in challenging situations. - Outcome orientation: Encouraging teachers to clarify their goals and outcomes to guide their teaching practices effectively.
	Practical Applications in Teaching	- Using language patterns to motivate and engage students. - Incorporating sensory-rich experiences to facilitate learning. - Employing visualization and anchoring techniques to support student well-being and confidence.
	Interactive Discussion	- Sharing participants' thoughts, questions, and experiences related to NLP and its potential impact on teaching and learning. - A brief discussion on how teachers can integrate NLP principles and techniques into their daily practice.
	Closing Remarks	- Summarizing key takeaways from the session. - Providing resources for further learning and exploration of NLP. - Expressing gratitude to the participants for their engagement and participation.
Students' intervention (One session: 60 min)	Breathing Exercises	- Involving techniques such as deep, belly, or rhythmic breathing, known to have calming effects on the mind and body.

(*continued on next page*)

Table 1 (*continued*)

Intervention component/number of sessions and time	Name of the intervention	Description of the intervention
	Image Interpretation	- Analyzing photographs, artwork, or other visual materials to express thoughts, emotions, or perceptions.
	Drawing	- Express their negative thoughts and feelings through drawing
	Writing Positive Quotes	- Focusing on uplifting and empowering messages, students shared optimism, self-confidence, and a sense of agency in overcoming challenges.

3.6. Statistical analysis

Statistical analyses were performed using Statistical Package for Social Sciences (SPSS Inc, Chicago, Illinois) Version 29. A comparative analysis may be conducted between the intervention group (after the intervention) and a control group (before the intervention) to determine whether any observed changes in intellectual capacity can be attributed specifically to the intervention, rather than external factors. Each correct answer the student gives counts as one point. Correct answers are added to provide the final score, with 36 being the maximum limit. Frequencies and percentages represented categorical variables, while the ages and scores were presented as means and standard deviations. The paired sample T-test was used to examine differences in the features before and after the NLP intervention. The Pearson correlation between the features and the outcome of interest (total score in this case) was performed since these relationships involved quantitative variables. Descriptive analyses of children's intellectual capacity before and after the NLP intervention were done based on recommended values (Manana et al., 2023). A significance level of $p < 0.05$ was used to determine statistical significance.

4. Results

4.1. General characteristics of the study sample

Table 2 displays the difference between the characteristics of the students in this study before and after the NLP intervention. No significant differences in the distribution between sexes were noticed, with around 40% males and 60 % females ($p = 0.939$). Before the intervention, the mean age of the students was 8.6 (1.5) years, whereas after the intervention, a slight increase was noted to reach 8.8 (1.6) ($p = 0.403$). Before the intervention, the mean age of the parent filling out the survey was 39.7 (6.2), comparable to their age following the intervention (39.9 (6.1); $p = 0.939$). Around 82% of questionnaires were completed by students' mothers, with no statistically significant disparities before and after the NLP intervention ($p = 0.890$). Concerning the parents' marital status, before the intervention, 90% were married, and 10% were divorced or widowed, whereas after the intervention, the sample had slightly fewer married parents (86.7%; $p = 0.435$). The highest level of education of the parents was comparable before and after the intervention ($p = 0.847$). Before the intervention, fewer parents perceived their economic situation as less than average (23.5%) than after the intervention (27.0%), with no statistically significant differences ($p = 0.542$). When comparing the working status and total number of children before and after the intervention, relatively similar reports were noted (p-values = 0.980 and 0.971, respectively).

Table 2
Differences in the baseline characteristics of students before and after the NLP intervention.

		Pre-intervention (N = 121)	Post-intervention (N = 122)	
		Frequency (%)	Frequency (%)	p-value
Sex	Male	51 (39.5%)	52 (40.0%)	0.939
	Female	78 (60.5%)	78 (60.0%)	
Age of the student (years)	Mean ± SD	8.6 ± 1.5	8.8 ± 1.6	0.403
	≤9 years	80 (66.1%)	70 (62.5%)	0.565
	>9 years	40 (33.9%)	42 (37.5%)	
Age of the parent (years)	Mean ± SD	39.7 ± 6.2	39.9 ± 6.1	0.939
Relationship with the student	Mother	100 (82.6%)	100 (82.0%)	0.890
	Father	21 (17.4%)	22 (18.0%)	
Grade	Grade 1	24 (19.8%)	20 (17.9%)	0.986
	Grade 2	17 (14.0%)	17 (15.2%)	
	Grade 3	27 (22.3%)	23 (20.5%)	
	Grade 4	28 (23.1%)	27 (24.1%)	
	Grade 5	25 (20.7%)	25 (22.3%)	
Marital status of the parents	Married	108 (90.0%)	98 (86.7%)	0.435
	Divorced/ Widowed	12 (10.0%)	15 (13.3%)	
The highest level of education of parents	Elementary school or less	16 (13.3%)	12 (10.9%)	0.847
	High school	50 (41.7%)	48 (43.6%)	
	University or more	54 (45.0%)	50 (45.5%)	
Perceived economic situation	Less than average	28 (23.5%)	30 (27.0%)	0.542
	Average or more	91 (76.5%)	81 (73.0%)	
Working status	Both parents work	38 (31.4%)	35 (31.5%)	0.980
	One parent works	74 (61.2%)	67 (60.4%)	
	Both parents don't work	9 (7.4%)	9 (8.1%)	
Total number of children	One	16 (13.2%)	14 (12.7%)	0.971
	Two	56 (46.3%)	48 (43.6%)	
	Three	38 (31.4%)	37 (33.6%)	
	4 or more	11 (9.1%)	11 (10.0%)	

Results are given in frequency (percentage) or mean ± standard deviation. p-values<0.05 are presented in bold and represent statistical significance.

4.2. Assessment of the impact of NLP on students' fluid intelligence and abstract reasoning abilities

Table 3 displays a comprehensive analysis of student's performance across different factors before and after implementing the NLP intervention. Regarding factor I - Continuous and Discrete Pattern Completion, the mean score for 6 and 7-year-olds decreased after the intervention. For 8-year-olds, a significant increase was noted after the intervention (9.36 (3.34). Similarly, 9-year-olds had a mean score of 11.82 (2.97), which increased to 12.45 (2.77). This pattern was also noted for other students, with the highest improvement among students of 11 years (6.86 (3.34) vs. 12.69 (6.86); $p < 0.001$). This has led to a significant overall effect on the sample (9.23 (4.30) vs 10.17 (4.14); $p < 0.001$), with an effect size of 22.4% ($p = 0.018$). Regarding factor II - Closure and Abstract Reasoning, the mean scores for 6 and 7-year-olds scores declined after the intervention. Whereas 8-year-olds' scores started at 2.33 (1.53) and increased to 2.86 (1.72) post-intervention. Older students also showed significant improvement in their scores with age, with the highest among 11-year-old children (1.71 (0.91) vs. 4.56 (2.68); $p = 0.002$). An overall effect size of 15.7% was noted, with a significant improvement in the total sample scores (2.8 (2.25) vs. 3.23 (2.38); $p < 0.001$). Concerning factor III - Simple Pattern Completion, the mean score for 6-year-olds was 6.54 (3.44) before the intervention, which increased to 6.80 (3.77) afterward, whereas 7-year-olds' scores

Table 3
Comparison of students' scores in the different factors before and after the neuro-linguistic programming intervention.

	Continuous and Discrete pattern Completion (Factor I)			Closure and Abstract Reasoning (Factor II)		
	Pre-NLP intervention	Post-NLP intervention		Pre-NLP intervention	Post-NLP intervention	
	Mean (SD)	Mean (SD)	p-value	Mean (SD)	Mean (SD)	p-value
6 years	5.00 (3.46)	5.40 (5.17)	< **0.001**	1.91 (1.51)	1.10 (0.88)	**0.002**
7 years	6.17 (3.93)	5.08 (3.07)		2.00 (0.95)	1.46 (1.56)	
8 years	8.95 (3.26)	9.36 (3.34)		2.33 (1.53)	2.86 (1.72)	
9 years	11.82 (2.97)	12.45 (2.77)		4.23 (2.79)	4.41 (2.38)	
10 years	11.92 (3.55)	12.40 (2.33)		3.52 (2.86)	4.12 (2.26)	
11 years	6.86 (3.34)	12.69 (6.86)		1.71 (0.91)	4.56 (2.68)	
Overall	9.23 (4.30)	10.17 (4.14)	< **0.001**	2.8 (2.25)	3.23 (2.38)	< **0.001**
Effect size	0.224		**0.018**	0.157		0.095
	Simple pattern completion (Factor III)			Total score		
	Pre-NLP intervention	Post-NLP intervention		Pre-NLP intervention	Post-NLP intervention	
	Mean (SD)	Mean (SD)	p-value	Mean (SD)	Mean (SD)	p-value
6 years	6.54 (3.44)	6.80 (3.77)	< **0.001**	13.45 (7.48)	13.30 (9.01)	< **0.001**
7 years	8.42 (2.43)	7.46 (3.28)		16.58 (5.81)	14.00 (6.49)	
8 years	8.76 (2.49)	10.0 (1.93)		20.05 (5.55)	22.22 (5.14)	
9 years	9.73 (2.47)	10.0 (1.44)		25.77 (7.17)	26.86 (4.93)	
10 years	10.28 (1.21)	9.88 (1.51)		25.72 (6.74)	26.40 (4.85)	
11 years	8.78 (1.76)	10.13 (1.50)		17.36 (4.94)	27.38 (5.49)	
Overall	9.09 (2.39)	9.44 (2.29)	**0.003**	21.15 (7.68)	22.84 (7.43)	< **0.001**
Effect size	0.120		0.201	0.227		**0.016**

decreased post-intervention. Children aged 8 and 11 had substantially greater scores after the intervention (10 (1.93) and 10.13 (1.50), respectively). Moreover, 9-year-old students showed a slight improvement to 10 (1.44), while 10-year-olds initiated at 10.28 (SD = 1.21) and decreased to 9.88 (1.51); ($p < 0.001$). Despite the significant increase in the overall score (9.09 (2.39) vs. 9.44 (2.29); $p = 0.003$), a minimal effect size of 12% was reported ($p = 0.201$). When summing up all the scores, a significant overall improvement was reported (21.15 (7.68) vs 22.84 (7.43); $p < 0.001$), with an effect size of 22.7% ($p = 0.016$).

The connectivity between the associated features and the different scores before and after the NLP intervention is described in the correlation matrix displayed in Table 4. Before the intervention, positive correlations were found between the increasing age of the student, grade, and parents' highest level of education. This was also significantly observed for the scores post-intervention, with the highest correlation between the student's age and factor I (0.633; $p < 0.001$) and total score (0.616; $p < 0.001$). This finding was also noted per increase in grade (factor I (0.716; $p < 0.001$) and total score (0.711; $p < 0.001$). Females had lower scores in both time frames with no statistically significant differences ($p > 0.05$). After the intervention, the parents' age was positively correlated with factor II (0.196; $p < 0.05$) and total score (0.190; $p < 0.05$). A significantly negative correlation was found if students' fathers answered the survey and factor II post-intervention (−0.195; $p < 0.05$) compared to before the intervention (−0.104; $p < 0.05$). In contrast, there were minimal to non-significant correlations identified between the parents' marital status, level of education, perceived economic situation, working status, and the total number of children with any of the factors after the NLP intervention.

Table 4
Correlation between study features and the factor's scores before and after the intervention.

Feature	Correlation	Factor I	Factor II	Factor III	Total score
Age of the student	Pre-NLP	0.328**	0.130	0.324**	0.323**
	Post-NLP	0.633**	0.476**	0.384**	0.616**
Sex	Pre-NLP	−0.069	−0.028	−0.031	−0.056
	Post-NLP	−0.098	−0.038	−0.082	−0.092
Age of the parent	Pre-NLP	−0.004	0.001	0.016	0.003
	Post-NLP	0.165	0.196*	0.117	0.190*
Relationship with the student	Pre-NLP	0.104	−0.104	0.079	0.052
	Post-NLP	−0.078	−0.195*	0.012	−0.100
Grade	Pre-NLP	0.385**	0.182	0.341**	0.375**
	Post-NLP	0.716**	0.585**	0.433**	0.711**
Marital status of the parents	Pre-NLP	−0.059	−0.048	−0.059	−0.066
	Post-NLP	0.009	−0.108	−0.158	−0.079
Highest level of education	Pre-NLP	0.130	0.113	0.037	0.118
	Post-NLP	−0.056	0.041	0.115	0.018
Economic situation	Pre-NLP	0.069	−0.048	0.168	0.078
	Post-NLP	0.104	0.133	0.073	0.122
Working status	Pre-NLP	−0.149	−0.230*	−0.052	−0.168
	Post-NLP	−0.061	−0.143	−0.087	−0.106
Total number of children	Pre-NLP	−0.005	0.016	−0.041	−0.011
	Post-NLP	−0.038	−0.022	0.109	0.006

Significance was assessed through the Pearson correlation test. *$p < 0.05$; **$p < 0.001$.

Table 5 compares children's intellectual capacity before and after the NLP intervention. For 6-year-old students, only 1 child (9.1%) was intellectually average before and after the intervention. Four children (36.4%) were below average before the intervention, while 5 children (50.0%) were under this category after. For students aged 7 years, 2 children (16.7%) were definitely below-average before the intervention, and 4 children (30.8%) fell into this category after, and no children were intellectually impaired before or after the intervention. Regarding students aged 8 years, 3 children (14.3%) were definitely below-average before the intervention, and no children were classified for this category after the intervention. None was intellectually impaired before or after the intervention. For students aged 9 years, 2 children (9.1%) were definitely below average before the intervention, and this number diminished to only one child (4.5%) after the intervention. Among 10-year-old students, 10 were classified as intellectually average (40.0%) after the intervention compared to 6 (24.0%) pre-intervention. One child (4.0%) was classified as intellectually impaired before the intervention, while none was after it. For older students (11 years), 3 children (18.8%) were definitely below average before the intervention and none after it. No students were classified as intellectually impaired post-intervention in comparison to 7 children (50.0%) at the beginning of the study.

Table 5
Comparison of children's intellectual capacity before and after the NLP intervention.

Classification (Before vs. After)	Age (years)					
	6	7	8	9	10	11
Intellectually superior	3 (27.3%)	4 (33.3%)	8 (38.1%)	11 (50.0%)	11 (44.0%)	–
	4 (40.0%)	3 (23.1%)	10 (45.5%)	13 (59.1%)	9 (36.0%)	7 (43.8%)
Definitely above-average in intellectual capacity	6 (54.5%)	5 (41.7%)	14 (66.7%)	16 (72.7%)	15 (60.0%)	–
	5 (50.0%)	5 (38.5%)	15 (68.2%)	18 (81.8%)	15 (60.0%)	10 (62.5%)
Greater than median	7 (63.6%)	10 (83.3%)	18 (85.7%)	16 (72.7%)	18 (72.0%)	2 (14.3%)
	5 (50.0%)	8 (61.5%)	20 (90.9%)	21 (95.5%)	16 (64.0%)	12 (75.0%)
Intellectually average	1 (9.1%)	6 (50.0%)	7 (33.3%)	6 (27.3%)	6 (24.0%)	4 (28.6%)
	1 (10.0%)	5 (38.5%)	9 (40.9%)	5 (22.7%)	10 (40.0%)	5 (31.3%)
Definitely below-average in intellectual capacity	4 (36.4%)	2 (16.7%)	3 (14.3%)	2 (9.1%)	4 (16.0%)	10 (71.4%)
	5 (50.0%)	4 (30.8%)	–	1 (4.5%)	–	3 (18.8%)
Intellectually impaired	1 (9.1%)	–	1 (4.8%)	–	1 (4.0%)	7 (50.0%)
	2 (20.0%)	2 (15.4%)	–	–	–	–
Total	11 vs. 10	12 vs. 13	21 vs. 22	22 vs. 22	25 vs. 25	14 vs. 16

Results are presented through Frequency (Percentage).

5. Discussion

The primary objective of this study was to assess the impact of NLP on the same cohort of students by analyzing the before and after intervention outcomes across various facets. The baseline characteristics of the students were comparable before and after the NLP intervention, revealing no significant differences. The ratio of female to male students remained consistent, with a higher percentage of females. Consequently, the sample exhibited a high level of reliability. This impact was measured using the RCPM assessment tool, which evaluated students' performance across three distinct factors, denoted per order of difficulty as III, I, and II). After the NLP intervention, a discernible enhancement was noted in the academic performance of most students, evidenced by their post-intervention scores, exceeding their pre-intervention counterparts for each factor and the aggregate score. However, students aged 7 exhibited a regression in their scores, indicating that NLP may have diminished efficacy at this particular age. It is advisable to consider introducing such interventions commencing at the age of 8 and above, as these students demonstrated an increased level of readiness to engage in the assessment without the fear of failure and had a better comprehension of the underlying purpose of these evaluations (Gran, 2021). This observation is congruent with extant research, which concluded the significance of an additional milestone in self-regulation manifesting around 8 years and above, evident in the ability to cope with internalizing and externalizing challenges (Robson et al., 2020). Further research has endorsed the age of 8 as the optimal threshold for the first developmental evaluations for conditions such as autism (Maenner et al., 2020).

The impact of NLP intervention exhibited notable variations across the three studied factors. Factor I demonstrated a remarkable positive effect, showing a substantial increase of 22.4%. In contrast, factors II and III displayed comparatively insignificant effects, with improvements of 15.7% and 12.0%, respectively. An age-dependent effect size was also evident. NLP proved effective on Factor I, which represents a medium level of complexity, focusing on integrated perceptual abilities related to both the 'whole' and 'parts' of the task. In contrast, NLP exhibited reduced efficacy on the most complex Factor II and the least complex Factor III (Smirni, 2020). These findings suggest that NLP may be used as a supportive tool, boosting students' productivity rather than exerting a profound influence on their outcomes. This observation is consistent with similar studies, which describe NLP as an assisting technique that reinforces the existing academic environment, enabling individuals to harness their full potential and enhance their capabilities (Zhang et al., 2023). A comprehensive analysis of the impact of NLP was conducted across the three factors, encompassing all the baseline characteristics of the students under investigation. Before the intervention, students' scores consistently increased in parallel with their age and grade levels, with substantial improvement after the sessions. Notably, The correlation with the scores for factors I and II doubled, while factor III displayed a relatively lower impact. This positive trend was further reflected in an apparent increase in the total score across all factors. These observations align with findings from other studies, which have confirmed that age is a significant factor influencing the success of interventions (Benoit & Gabola, 2021). NLP operates by harnessing the existing resources of individuals, particularly those who are augmented by advanced academic levels, such as higher grades (Hartati & Ginting, 2023). Consequently, It can contribute to the advancement of students, resulting in improved scores alongside higher grades (Manana et al., 2023; Zhang et al., 2023). Sex exhibited no discernible correlation before and after implementing the NLP intervention. It is noteworthy that females consistently displayed lower scores both before and after the intervention. These findings are consistent with existing research, which found no significant variation between males and females or any indication of females having lower reasoning abilities than males (Csapó, 2020; Sun et al., 2022). These data underscore the consistent pattern of sex-related differences in scores, both pre- and post-intervention, and corroborate the broader body of research that has similarly not detected substantial disparities in reasoning abilities between the two sexes (Csapó, 2020; Sun et al., 2022). The parents' age, their relationship with the student, and their working status exhibited a modest correlation with Factor II and the overall total score. Research supports that delayed parenthood positively correlates with enhanced academic achievements (Cantalini et al., 2020). Furthermore, increased maternal involvement in a child's daily activities and academic pursuits has been consistently linked to tremendous academic success (Stright & Yeo, 2014). NLP had minimal impact on younger students aged 6–7, and optimal benefits for older students with above-average intellectual capacity. Significant improvements were noted in students classified as below average at ages 8 and 10, with age 9 seeing a reduction in such students. These findings correlate with the onset of puberty, which affects learning abilities and mental capacities (Laube et al., 2020).

The results presented in our study substantiate the concept that NLP is designed to complement the pre-existing capabilities of individuals rather than effecting an overhaul of their behavior by primarily addressing their weaknesses and gaps. This perspective is reinforced by other studies that have also characterized NLP as a problem-solving approach focused on addressing current issues (Qushoy et al., 2023). This study bears certain strengths and limitations that merit consideration. It represents the first of its kind conducted in Lebanon, utilizing a standardized assessment tool. As a pioneering effort, it lays the groundwork for further investigations to encompass a more diverse and representative sample from various regions across Lebanon. Testing the impact of NLP on the same sample can support the validity of the results. Nevertheless, data collection was exclusively conducted within a private school environment. This context implies that the participants may possess a relatively higher socioeconomic status, possibly enjoying

support beyond the confines of the school. Moreover, the information provided by the parents may predominantly originate from those less actively involved in their child's daily life, potentially affecting the accuracy and completeness of the data collected. Despite being a before and after intervention, which will minimize the confounding variables, other factors can affect students' intellectual development and achievement due to temporal variations in data collection. These include seasonal/environmental factors, children's aptitude and motivation, parental support and involvement, physical and mental health, and peer and community support.

6. Conclusion

The present study is characterized by a high degree of reliability, underpinned by the comparability of baseline characteristics among our participants. Overall, the NLP intervention significantly improved children's intellectual capacity, namely on factor I and moderate effects on factors II and III. Significant improvement in academic performance was noted, with an optimal benefit on older children (age 8 and above) but had limited or detrimental effects on younger age groups (6 and 7 years). Findings suggest that NLP can positively address gaps and weaknesses, particularly in individuals below the intellectual average and those with intellectual impairments. In a limited resource environment, NLP can be used as a proactive approach to addressing students' socio-emotional needs and enhancing their overall well-being and academic performance. Future research in the application of NLP intervention in schools should focus on longitudinal studies to assess long-term effects, explore diverse student populations, examine teacher training and implementation strategies, integrate NLP with existing programs, investigate technology-assisted interventions, and explore avenues for parent and community involvement.

Ethics approval and consent to participate

The institutional review board of the faculty of pharmacy at the Lebanese University reviewed and approved the study protocol, questionnaire, and consent form (reference: 3/23/D). Written informed consent was obtained from every participant's parent/legal guardian.

Consent for publication

Not applicable.

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CRediT authorship contribution statement

Marwa Manana: Writing – original draft, Validation, Methodology, Formal analysis, Data curation. **Sarah Tarhini:** Writing – original draft, Software, Resources, Methodology, Formal analysis, Data curation. **Diana Ghanem:** Writing – original draft, Validation, Resources, Methodology, Investigation, Formal analysis, Data curation. **Roula Bou Assi:** Writing – review & editing, Visualization, Investigation, Conceptualization. **Sanaa Awada:** Writing – review & editing, Project administration, Investigation. **Georges Hatem:** Writing – review & editing, Writing – original draft, Investigation, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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