Introducing Music notation to preschoolers: a preliminary study

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ABSTRACT
Research in music education suggests that children's participation in music programs can enhance cognitive development. However, limited research has investigated how teaching specifically music notation affects cognitive functions and music understanding. This paper presents two empirical studies that examined the effects of music interventions—based on standard or graphic notation—on preschoolers' executive functions and musical comprehension. In Study 1, preschoolers were randomly assigned to standard or graphic notation groups and were instructed basic music concepts. Study 2 introduced a control group to explore whether graphic notation could support learning standard music notation, which remains -after all- the universal music language, essential for musical engagement. Results highlight that standard notation positively affected cognitive performance and musical understanding, supporting its use in early education.

KEYWORDS
Preschool Music education, Music notation, standard Music score, graphic Music score

RÉSUMÉ
La recherche en éducation musicale suggère que la participation des enfants à des programmes musicaux peut améliorer le développement cognitif. Cependant, peu d'études ont exploré l'effet spécifique de l'enseignement de la notation musicale sur les fonctions cognitives et la compréhension musicale. Cet article présente deux études empiriques sur des enfants d'âge préscolaire, utilisant des interventions basées sur la notation standard ou graphique. Dans la première étude, les enfants ont été répartis aléatoirement dans deux groupes recevant un enseignement fondé sur la notation standard ou graphique. La deuxième étude inclut un groupe témoin pour examiner si la notation graphique peut soutenir l'apprentissage de la notation standard, langage universel essentiel à l'engagement musical. Les résultats soulignent que la notation standard a positivement influencé les performances cognitives et la compréhension musicale, soutenant ainsi son intégration dans l'éducation préscolaire.

MOTS-CLÉS
Éducation musicale préscolaire, notation musicale, partition musicale standard, partition musicale graphique

INTRODUCTION

Psychological research indicated that music is linked to cognitive development and that music education positively affects cognitive functions, particularly when introduced in childhood (Bautista et al., 2024). A key question is how music interventions, particularly those based on music notation, may impact preschoolers' executive functions, like memory and inhibition. It is useful to consider research findings that suggest a positive correlation between learning symbolic systems and enhanced executive functions (Carlson, 2005).

Music Education in preschool age: the case of Greece

In Greece, the first Kindergarten Teacher Training School was established in 1897, requiring preservice kindergarten teachers to pass exams in "songs" and "rhythmic games". In 1984, with the establishment of Pedagogical Departments, a new Music Education curriculum was established, incorporating the Orff method under the course title "Music, Movement, and Education".

However, a recent study, investigating formal childhood music education in four European countries (Estonia, Finland, Greece, and Iceland), revealed disparities between policy and practice mainly between Finland and Greece. In Finland, a well-established music education system poses challenges to children's musical learning, while in Greece, although there is a curriculum for preschool music education, kindergarten teachers often avoid singing, and/or playing musical instruments during activities (Hietanen et al., 2020).

Research shows that many kindergarten educators lack a strong music background (Barrett et al., 2019) and have limited opportunities for professional development in music. A study by Koutsoupidou (2010) on 108 Greek early childhood teachers found that 75% of them had no music background and that preservice training doesn't provide opportunities to observe other educators teaching music or implementing music activities in classrooms. This leads to a reported "lack of confidence" experienced by educators, which may contribute to the avoidance of providing meaningful music education.

As a result, preschool teachers often focus on singing songs without integrating music education in the same structured way they do with other subjects, like language or math. They typically expect children to replicate songs, leaving little room for creative expression. The assessment of children's musical development (from the age of 3) is often based on the number of songs they have learned to sing (Grieshaber & Lau, 2010).

Impact of music education in preschool years

According to the Institute of Child Health, during preschool years, children gradually develop memory skills and enhance attention through play and participation in various creative learning activities, among which music plays a significant role (Nousia & Batsis, 2023). Particularly, early music instruction supports a child's holistic development by enhancing creativity, critical thinking, problem-solving, self-awareness, and communication. It also helps preschoolers understand concepts such as high and low, and fast and slow (Dogani, 2012).

Furthermore, music education during the preschool years significantly influences various aspects of a child's development. Engaging in structured music curricula has been shown to enhance cognitive abilities, including memory, attention, and problem-solving skills. A study

involving 71 children aged from 4 to 6 demonstrated that participation in a 30-week music program led to significant improvements in cognitive assessments, particularly in spatial-temporal reasoning (Bilhartz et al., 1999). Thus, music education improves cognitive skills and musical abilities, including auditory perception and rhythm, which mainly develop in early childhood (Bautista et al., 2024).

The role of music notation

It is argued that music is a primary symbolic system reflecting our world, while notations are secondary systems translating experiences (Swanwick, 2001). Notations are considered cultural tools for intentionally documenting communicative and cognitive acts (Barret, 2003). Understanding how to read a score is challenging, as the 'reader' should be able to 'read' all the dots and lines (Pujadas, 2018).

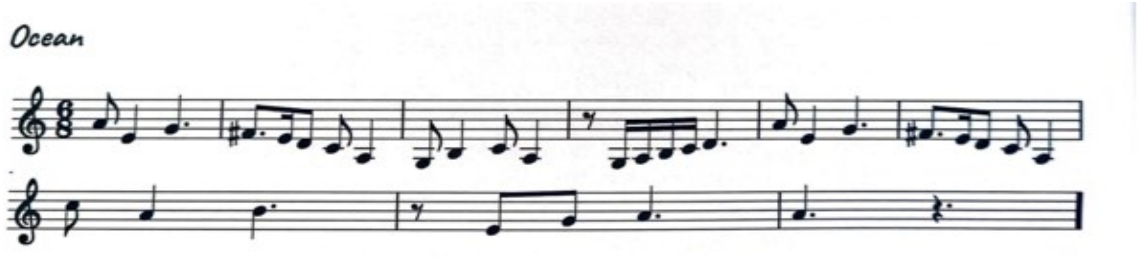
Music notation serves as a symbolic system that bridges auditory experiences with visual representations, facilitating cognitive development in children (Stewart, 2005). Engaging with music notation requires children to decode symbols, coordinate motor skills, and apply memory, thereby enhancing their cognitive skills. It appears that learning music notation is more than just decoding symbols; it cultivates multisensory processing and higher-order cognitive functions.

Taking into account research showing that even preschoolers can effectively learn to read musical notes, especially with the aid of color (Demirel, 2022), we suggest that music notation can be introduced in schools from an early age, and it may significantly enhance preschoolers' musical education and support their cognitive development. However, a question remains as to whether any type of music notation, such as graphic or standard, is equally suitable for teaching preschoolers to read music.

Standard music notation

The standard score is the Western diagrammatic system of musical notation, which uses the five-line structure known as the pentagram (music staff), represents pitch, rhythm, and dynamics and is conceived as a universal language for representing notes and melodies. Learning to read and interpret standard notation enhances children's ability to process complex information, improving their cognitive flexibility and working memory. A longitudinal study found that musical practice positively affects working memory development, with increased practice correlating with better performance in cognitive tasks (Nutley et al., 2014).

FIGURE 1



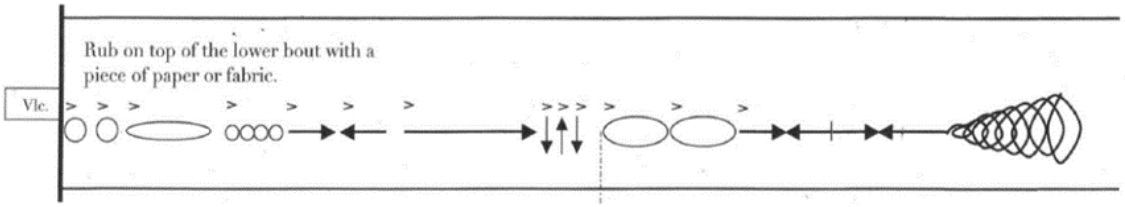
Standard Music Score (Pozzo, 2023)

Graphic music notation

Graphic music scores use visual symbols and images to represent musical concepts, making them accessible to young learners. It is supported that these simplified representations may help children grasp basic musical ideas without the complexity of standard notation. Researchers argue that this type of music notation can be more useful for preschool children because it includes images and symbols that correspond to their familiar representations (Mcnab 2015).

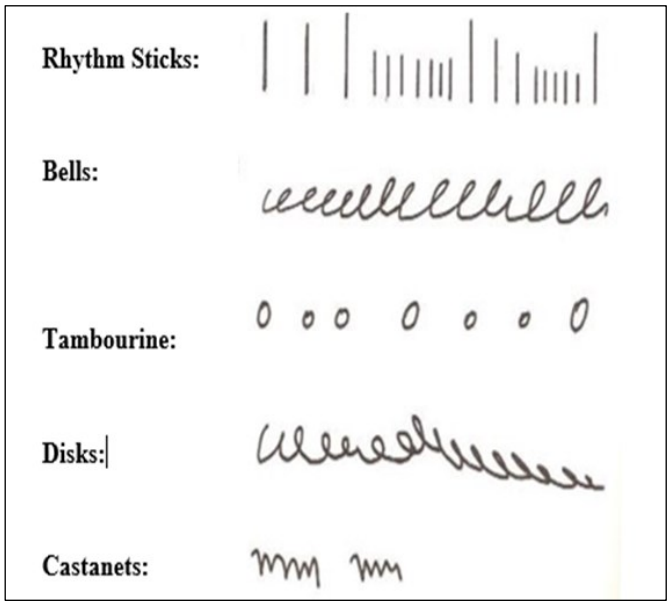
The use of graphic music scores to represent music has become increasingly common in modern times. Pujadas (2018) noted that graphic music notation can present action-based music, as it represents duration, tempo, dynamics, pitch, articulation, and timbre, and thus requires the performer to follow and interpret a series of depicted actions.

FIGURE 2



Graphic Music Score (Kojs, 2011)

FIGURE 3



Graphic Rhythm score - Percussion (Sergi 1998)

Music education and executive functions in early childhood

Many researchers argue that music education may work as a potent tool for enhancing executive functions in young children (Holochwost et al., 2017). Executive functions are higher cognitive processes that enable adaptive and flexible behavior (Miyake et al., 2000). Key executive functions include inhibition (the ability to suppress automatic responses in favor of appropriate ones, not automatically activated) and memory updating (the ability to update information relevant to problem-solving). Research indicates that executive function performance improves during early childhood (Zelazo et al., 2003).

Music practice engages executive functions, such as working memory and inhibition and learning a musical instrument further enhances these cognitive abilities. Grandin and colleagues (1998) showed that preschoolers (ages 3-4) who took six months of classical piano lessons improved spatial-temporal executive control by 30%, compared to peers who had computer lessons or no training. It is hypothesized that the key element, that may improve executive functions, is the child's devotion to exercise bimanual coordination (Diamond & Lee, 2011).

Furthermore, Degé and Frischen (2022) suggest that music training is fundamental to executive function development. For example, musical training seems to benefit various measures of working memory and inhibition in children (Bugos & DeMarie, 2017). Finally, a recent systematic review and meta-analysis (Lu et al., 2025) shows that music education has a positive effect on preschoolers' executive functions. The most substantial benefits were observed in interventions lasting at least 12 weeks, occurring three or more times per week, and lasting 20–30 minutes per session.

While most studies explore the effects of music education on cognitive skills few examine the role of music notation instruction in preschoolers' executive function development. Two studies were designed to investigate whether teaching standard or graphic music notation can enhance preschoolers' executive functions and music comprehension. We believe that integrating music notation into early childhood education may offer a structured and developmentally appropriate approach to fostering both musical understanding and cognitive growth. Educational programs that combine graphic and/or standard music notation may support children's progression from intuitive musical exploration to formal musical literacy. This transition engages multiple domains of executive function, including attention, working memory, and inhibition, as children learn to decode symbols, maintain temporal sequences, and coordinate motor responses.

These pedagogical approaches reflect the theoretical framework presented by Grandin and colleagues (1998), who emphasized the role of music training in enhancing spatial-temporal reasoning. They argue that music education activates cognitive processes that differ from traditional language-analytic reasoning and are particularly valuable for problem-solving. Engaging with the symbolic system of music notation fosters abstract thinking and pattern recognition—skills that underlie spatial-temporal cognition. Thus, music notation serves not only as a medium for musical expression but also as a cognitive tool that supports broader intellectual development in early childhood.

Research questions

1. Does a music intervention, based on music notation positively affect executive functions and music understanding of preschoolers?
2. Does any type of music notation (standard or graphic) may have a stronger impact on preschoolers' executive functions and music understanding? If so, which type of symbolic music notation (standard or graphic) has the greatest impact on preschoolers' executive functions and music understanding?

METHODOLOGY

The methodology used in both studies was that of a quasi-experiment. The Research Ethics Board of the Department of Educational Sciences and Early Childhood Education, University of Patras was aware of the procedures and approved the studies (No.1/27-9-2022). Verbal consent was obtained from participants' legal guardians, who were informed by the school director about the study's purpose and anonymity.

FIRST STUDY

Participants

A convenience sampling method was employed to recruit participants. Totally 62 children participated in the study; 26 boys and 36 girls. All of them were kindergarten students in Patras

(the third-largest city in Greece). Children's ages ranged from 58 to 70 months (mean age: 63.50 months).

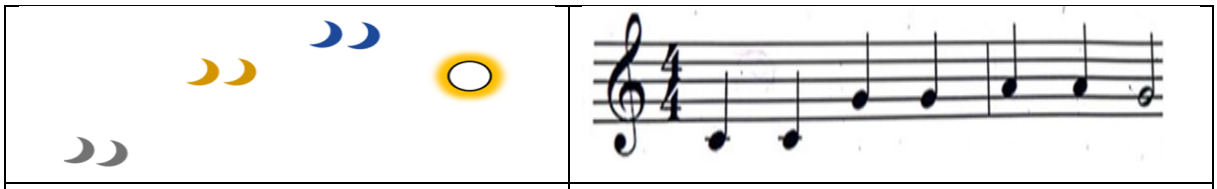
The participants were randomly divided into two groups. The first group included 28 children (12 boys–16 girls) aged from 58 to 70 months (mean age: 63.61 months). Children in this group received a music intervention based on graphic music notation and formed the Graphic Music Notation Group (thereafter GraphicMNG). The second group consisted of 34 children (14 boys–20 girls) aged from 58 to 68 months (mean age: 63.41 months). The children in this group received a music intervention using standard music notation and formed the Graphic Music Notation Group (thereafter StandardMNG).

Music interventions

Two teacher-based music interventions were conducted, where students were interactively engaged in a step-by-step, constructive learning process. Children interacted with each other or with the educator; the interaction with the educator was done both individually and in groups. Opportunities for interaction were frequently provided within the context of music practice to promote synchronization, which is an important principle in musical performance.

Each intervention lasted approximately two months and consisted of four visits. In the first visit, children were introduced to music elements: notes and their values (whole, half, quarter notes). The GraphicMNG saw images of moons—half-moons for half notes, and full moons for whole notes, while the StandardMNG used cards with notes (see figure 4). After the instruction, both groups actively participated in a comprehensive task, by clapping for whole, half, and quarter notes.

FIGURE 4



a. Graphic Music Score	b. Standard music score

Note: The graphic score's design mirrored the standard score. The placement of moons in the graphic score indicated the pitch of the notes in the standard score. This arrangement visually represented the music, corresponding to its sound in a similar way to standard notation

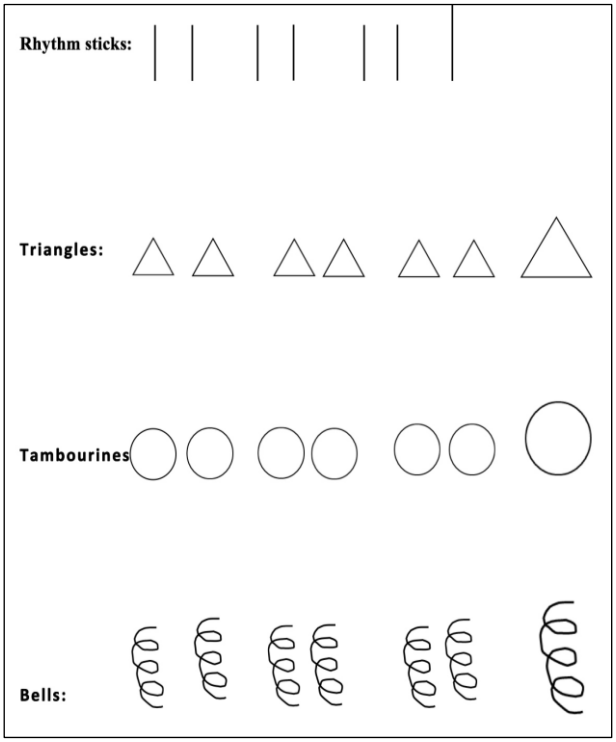
Music Scores used for the two music interventions

In the second visit, children explored musical instruments, categorized as strings, percussion, and wind based on their characteristics. After the basic presentation of the musical instruments, children were asked exploratory questions (i.e. how do you think sound is produced in string instruments?). Then the researcher played "Twinkle, Twinkle, Little Star" on piano and guitar. The GraphicMNG used a graphic rhythm-based score (see figure 5), while the standard notation group learned the corresponding standard score. At the end of the session, both groups were encouraged to identify notes and symbols within a music comprehension task.

In the third visit, the instructor aimed to engage children as singers by having them perform "Twinkle, Twinkle, Little Star" using either graphic or standard music scores. The GraphicMNG was encouraged to play percussion instruments to follow the rhythm and sing, while the StandardMNG was encouraged to clap the rhythm and sing. The entire activity was based on everything the children had learned in previous visits. The researcher coordinated and supported the whole process.

The fourth visit emphasized music notation since children replicated their scores of the songs they were already taught. Finally, the GraphicMNG played the rhythm on a drum while singing, and the StandaardMNG clapped and sang.

FIGURE 5



Graphic rhythm score of "Twinkle twinkle little star"

Materials

Questionnaire

An open-ended questionnaire was constructed, which was given to all participants through individual interviews. The questionnaire aimed to investigate the children's musical experience, their musical knowledge, and their musical perception. The questions of the questionnaire are shown in Table 1. The first part of the questionnaire was designed to investigate children's previous exposure to music by examining whether they had attended music lessons in the past. The second part of the questionnaire investigated children's music knowledge and music perception.

TABLE 1

Questionnaire on children's musical experience, knowledge, and understanding

Part 1
1. Do you play any musical instrument?
2. If yes, for how long?
3. Do you attend a conservatory?
4. If yes, for how long?
Part 2
5. Do you know the musical notes?
6. There are different groups of musical instruments: Do you know them?
7. There are string instruments. Can you think of any?
8. There are percussion instruments. Can you think of any?
9. There are wind instruments. Can you think of any?

10. You will hear a melody coming from different instruments. Can you recognize them?
   a. piano and guitar together
   b. piano
   c. guitar
11. I will play a sound and then two other sounds, and I want you to tell me what the difference is between the first one and the other two.
   a. Whole note
   b. Half note
   c. Quarter note

Executive Function Tasks

To evaluate executive functions, we used tasks assessing working memory and inhibition.

Working Memory Tests. For working memory, we used Span tests: the Forward Digit Span Test and the Backward Digit Span Test (Gardner, 1981) and a forward and a backward span test developed by the researchers, based on the logic of digit span tests, while the stimuli were musical notes (Forward Note Span Test and Backward Note Span Test). In memory tests, we read sequences of stimuli that participants had to recall in the order they were presented (forward tests) or the reverse order (backward tests).

Inhibition Test. To assess inhibition, we used the NEPSY II test (Frischen et al., 2019). The children were instructed to remain seated and keep their eyes closed for 75 seconds. During this time, a recording of 85 seconds was played, which included sounds designed to distract the child from the relevant task and potentially encourage them to open their eyes or get up from their seat (e.g., the sound of a pencil dropping). At the 75-second mark, the song "Twinkle Twinkle Little Star" started to play in the same recording, indicating that the task was over.

Expansion Music tasks. Expansion music tasks, such as the Pattern Recognition Memory test and the Go-NoGo task, were adapted and given to children. In the Pattern Recognition Memory test children were given 6 pairs of standard graphic music scorecards, depending on the group they belonged to during the intervention. They had to recognize which one belonged to the music piece they had been taught. After selecting the cards, they were asked to put them in the correct order. In the Go/No-Go task, children were given standard or graphic music scorecards, depending on the group they belonged during the intervention. A consistent sequence of 15 cards was used across all participants. They were instructed to clap for recognized cards ("Go") and remain still for unrecognized cards ("No Go").

Procedure

The research procedure included three phases: (1) pre-test, (2) music intervention, and (3) post-test. In the pre-test, the open-ended questionnaire and the executive function tasks were given. Each participant responded individually firstly to the open-ended questionnaire, which was conducted as an interview, and then in the executive function tasks. The pre-test lasted approximately 20-25 minutes. In the next phase, children were randomly divided into two groups and received either the graphic or the standard music notation intervention. The post-test was administered in the last phase of the study. The students responded again to the second part of the open-ended questionnaire, completed again the executive function tasks, and were also given the two expansion music tasks.

Results

Firstly, we collected children's responses in the open-ended questionnaire. The results of the first part of the questionnaire are presented in Table 2. It was found that almost half of the participants had engaged with a musical instrument, either at a conservatory or at home, though (as they mentioned) without any music teacher guidance. The remaining 60% claimed that their only music experience was in kindergarten, where the number of instruments was limited. As

expected, most of the children had not received formal music instruction, such as music theory, solfège, or learning to play musical instruments.

TABLE 2

Frequency/Percent of response categories in the first part of the questionnaire as a function of group intervention

Questions	Types of responses	Graphic Music Notation Group (N=28)	Standard Music Notation Group (N=34)
1.	No	17 (61%)	20 (59%)
	Yes	11 (39%)	14 (41%)
2.	Do not play	17 (61%)	20 (59%)
	Less than a year	4 (14%)	6 (18%)
	About a year	7 (25%)	8 (23%)
3.	No	21 (75%)	32 (94%)
	Yes	7 (25%)	2 (6%)
4.	Do not attend	21 (75%)	32 (94%)
	Less than a year	1 (4%)	1 (3%)
	About a year	6 (21%)	1 (3%)

The results of the second part of the questionnaire, which was used in the pre-test and post-test, are shown in Table 3. In question 5 only 25% of the children from both groups remembered correctly the seven notes. In the post-test, most of the children in both groups recalled correctly all the notes.

In question 6, most children in both groups did not know the three categories of musical instruments. Although this number was lower in the post-test, there were still children who did not know the categories of musical instruments, even though they had the opportunity to interact with musical instruments.

In questions 7, 8, and 9 most of the children from each group knew at least one musical instrument from each category. This was also the case in the post-test, for most of the children in the graphic score group, while most of the children from the standard score group, mentioned at least two musical instruments from each category.

In question 10 children listened to a music piece played by piano and guitar (10a), then only piano (10b), and finally just guitar (10c). Each time, they had to recognize the musical instrument(s). In the pre-test, most children from both groups struggled to recognize musical instruments. In the post-test, results showed improvement, especially in the standard score group; 65% in the standard score group identified the two instruments compared to 32% from the graphic score group.

In question 11 children listened to three sounds of different duration (whole, half, and quarter notes). None recognized the durations in the pre-test, prompting a facilitative question: ["For how long did each sound that you heard last?"]. After the intervention, many children could identify the note values, with significant improvement noted in the standard score group.

TABLE 3

Frequency/Percent of response categories in the second part of the questionnaire as a function of group intervention

		Graphic Music Notation Group (N=28)		Standard Music Notation Group (N=34)	
Questions	**Types of responses**	**Pre-test**	**Post-test**	**Pre-test**	**Post-test**
5.	No	19 (75%)	6 (21%)	25 (74%)	8 (23%)
	Yes	7 (25%)	22 (79%)	9 (26%)	26 (77%)

6.	No	26 (93%)	19 (68%)	24 (71%)	18 (53%)
	Yes	2 (7%)	9 (32%)	10 (29%)	16 (47%)
7.	0	3 (11%)	4 (14%)	3 (9%)	1 (3%)
	1	16 (57%)	6 (21%)	30 (88%)	10 (29%)
	2	8 (29%)	8 (29%)	1 (3%)	12 (35%)
	3	1 (4%)	10 (36%)	-	10 (29%)
	4	-	-	-	1 (3%)
8.	0	6 (21%)	2 (7%)	3 (9%)	2 (6%)
	1	17 (61%)	12 (43%)	31 (91%)	10 (29%)
	2	5 (18%)	9 (32%)	-	16 (47%)
	3	-	5 (18%)	-	6 (18%)
9.	0	6 (21%)	2 (7%)	3 (9%)	2 (6%)
	1	17 (61%)	12 (43%)	31 (91%)	11 (32%)
	2	5 (18%)	9 (32%)	-	15 (44%)
	3	-	5 (18%)	-	6 (18%)
10a.	Wrong	17 (61%)	19 (68%)	28 (82%)	12 (35%)
	Correct	11 (39%)	9 (32%)	6 (18%)	22 (65%)
10b.	Wrong	6 (21%)	4 (14%)	8 (24%)	1 (3%)
	Correct	22 (79%)	24 (86%)	26 (76%)	33 (97%)
10c.	Wrong	4 (14%)	1 (4%)	7 (21%)	1 (3%)
	Correct	24 (86%)	27 (96%)	27 (79%)	33 (97%)
11a.	Wrong	8 (29%)	2 (7%)	12 (35%)	2 (6%)
	Correct	20 (71%)	26 (93%)	22 (65%)	32 (94%)
11b.	Wrong	12 (43%)	2 (7%)	13 (38%)	2 (6%)
	Correct	16 (57%)	26 (93%)	21 (62%)	32 (94%)
11c.	Wrong	2 (7%)	1 (4%)	18 (53%)	2 (6%)
	Correct	26 (93%)	27 (96%)	16 (47%)	32 (94%)

Total performance in the Open-Ended Questionnaire

Children's responses to all the questions from the second part of the open-ended questionnaire received a score. The scores were added, and each participant received a total score for her/his performance in the pre-test and post-test.

TABLE 4

Total performance of students in the second part of the open-ended questionnaire as a function of group and experimental phase

		Mean	**Std Deviation**
Graphic Music Notation Group (N=28)	Pre-test	10.68	5.631
	Post-test	16.89	4.508
Standard Music Notation Group (N=34)	Pre-test	8.47	4.172
	Post-test	16.71	4.380

The total scores were subjected to non-parametric statistical analyses to detect any differences between the groups in the pre-test and the post-test or within the groups from the pre-test to the post-test. The Wilcoxon test indicated that both groups demonstrated significant improvement from the pre-test to the post-test (GraphicMNG [Z=-3.548; N=28; p<.005] StandardMNG [Z=-4.956; N=34; p<.001]).

On the other hand, the Mann-Whitney test indicated that the difference between the two groups in the post-test was not statistically significant [U=467.000; N=62; n.s.], while it marginally was in the pre-test [U=362.500; N=62; p<.05]. The StandardMNG initially

performed significantly lower compared to the GraphicMNG, but after the musical intervention, their performance improved to a similar level to that of the GraphicMNG.

Executive Function Tasks

Participants' scores in executive function tasks were added by category resulting in total scores for forward working memory, backward working memory, and inhibition tasks for pre-test and post-test (see table 5). Non-parametric statistical analyses assessed between-group differences and within-group changes. For the forward working memory tasks, no statistically significant differences were found in the pre-test [U=388.000; N=62; n.s.] or post-test [U=458.500; N=62; n.s.]. A statistically significant drop from the pre-test to the post-test was found for the GraphicMNG [Z=-2.797; N=28; p<.05] and the StandardMG [Z=-2.105; N=34; p<.05].

TABLE 5

Mean performance of students in the executive function tasks as a function of group and experimental phase

Tasks		**Graphic Music Notation Group (N=28)**		**Standard Music Notation Group (N=34)**	
		Mean	S.D.	Mean	S.D.
Forward Working Memory	Pre-test	10.25	2.25	9.74	1.96
	Post-test	9.05	2.90	9.22	1.72
Backward Working Memory	Pre-test	2.46	1.62	3.21	2.46
	Post-test	2.71	1.27	3.56	2.21
Inhibition	Pre-test	1.61	.629	1.59	.61
	Post-test	1.86	.525	1.62	.826

In backward working memory tasks, the Mann-Whitney test indicated no significant differences between the groups at the pre-test [U=397.000; N=62; n.s.], but a significant difference in the post-test [U=291.500; N=62; p<.01] in favor of the StandardMNG. Both groups improved their performance from pre-test to post-test, but this improvement was statistically significant for the StandardMNG [Z=-4.324; N=34; p<.005] but not for the GraphicMNG [Z=-1.640 ;N=28; n.s.].

For the inhibition task, no significant differences between the groups were found in either the pre-test [U=464.000; N=62; n.s.] or the post-test [U=383.000; N=62; n.s.]. Both groups showed minor improvements from the pre-test to the post-test, but these were not statistically significant (GraphicMNG [Z=-1.539; N=28; n.s.] StandardMNG [Z=-.683; N=34; n.s.]).

Expansion Music Tasks

The participant's scores in the expansion music tasks were subjected to non-parametric statistical analyses to see if there were any differences between the groups (see Table 6). Our research indicated that the GraphicMNG achieved higher scores in both expansion music tasks, however, the Mann-Whitney test showed that this difference was not statistically significant (insert table 6 here) neither for the Go/NoGo task [U=348.500; N=62; n.s.] nor for the Pattern Recognition Memory task [U=383.000; N=62; n.s.].

The results of the first study showed that the StandardMNG outperformed the GraphicMNG in some of the questions in the open-ended questionnaire and in the backward memory span tests, while whenever the GraphicMNG showed better performance compared to the StandardMNG the difference was not statistically significant. In order to further investigate the predominance of one of the two music interventions, a second study was conducted. It aimed to assess whether prior exposure to graphic or standard notation would benefit students in tasks involving standard notation, which is the one that students should eventually learn when they

get systematic music instruction. Our further goal was to investigate if students who participated in the GraphicMNG would have benefits or face any difficulties when attending a music intervention based on StandardMNG compared to those who received instruction based on standard music notation or other students who received no music instruction.

TABLE 6

Mean performance of students in the expansion music tasks as a function of group

Tasks	Graphic Music Notation Group (N=28)		Standard Music Notation Group (N=34)	
	Mean	S.D	Mean	S.D.
Pattern Recognition Memory	6.00	.005	5.80	.826
Go/NoGo	14.01	.659	13.88	1.532

SECOND STUDY

Participants

In general, 87 children participated in our study: 38 boys and 49 girls. The children in the sample ranged in age from 58 to 70 months (Mean age: 63.69 months). The 62 participants were the same individuals who took part in the two different music interventions in the first study. The remaining 25 participants were randomly selected from two kindergartens in Patras to form the control group for the current study. The students in the control group were aged 58 to 70 months (Mean age: 64.20 months) and had not received any music instruction before. The additional 25 participants were recruited using convenience sampling.

Music intervention

In this study, all students received identical music instruction to assess whether the preschoolers who were instructed with standard notation or with graphic notation would have any advantages compared to those who received no relevant instruction before. The lessons were based on standard music notation referring to different songs than those used in the first study. The intervention lasted two months and consisted of four visits.

The first visit was based on a general Introduction to Music (notes, values, standard notation). The standard music score of the song *"Twinkle Twinkle Little Star"* was displayed, and students were asked to sing, clap to the rhythm, and play instruments like drum, or xylophone. The first visit aimed to introduce all students to the basic concepts and symbols of the standard music score.

On the second visit, the researcher introduced a traditional well-known Greek song "My Red Apple", presented firstly on the standard music score. Then the researcher showed a colorful version of the score and simultaneously played the xylophone and sang the notes. The children were asked to play along or sing with her.

The third visit focused on reading the score while singing "My Red Apple". The researcher played the song on the keyboard encouraging children to sing individually or with a partner while clapping the rhythm. Finally, the researcher pointed to the notes while the children were actively engaged as they sang along.

The final visit reviewed the previous sessions. Children participated in a comprehension task, as the researcher posed questions to gather feedback from them. Finally, children chose to use percussion instruments (drums, shakers, triangles, maracas) or clap, while the researcher played "My Red Apple" on the keyboard. All children actively participated and collaborated to synchronize and achieve the desired musical outcome successfully.

Music tasks

Music tasks were given to the students to evaluate their musical understanding after completing the music intervention. The music tasks used were the Pattern Recognition Memory test and the Go-NoGo task as they were used in the first study. An additional music task was administered, the Play and Choose Task, adapted for this study. Specifically, the researcher played a song on the xylophone unknown to the children. She provided them the standard score of the piece they had learned during the intervention, along with unfamiliar scores or simple note sequences. The children were asked to determine which score corresponded to the music they listened to. The scoring process included three attempts.

Procedure

The research process included two phases: (1) music intervention and (2) music tasks. Firstly, all the students participated in groups in the music intervention and in the next phase, children were given the three music tasks.

Results

The participant's scores in the music tasks were subjected to non-parametric statistical analyses to see if there were any differences between the groups. The results show that the StandardMNG outperformed in all three music tasks, followed by the control group (see table 7). The Kruscal-Wallis analysis showed that this difference was statistically significant in the Play and Choose task only [χ^2=7.228; p<.05] in favor of the children who participated in StandardMNG in the first study. The post-hoc analysis showed that the statistically significant effect was due to the mean difference between StandardMNG and GraphicMNG performance [-.480; p<.05].

TABLE 7

Mean performance of students in the music tasks as a function of group

Tasks	Control Group (N=25)		Graphic Music Notation Group (N=28)		Standard Music Notation Group (N=34)	
	Mean	S.D.	Mean	S.D	Mean	S.D.
GoNoGo	14.65	.690	14.50	1.00	14.68	.727
Pattern Recognition Memory	5.86	.359	5.85	.525	5.96	.200
Play and Choose	2.38	.880	2.00	.816	2.48	.836

DISCUSSION

The results of the present studies show that when music interventions incorporate symbolic systems like graphic or standard music notation, there is a marked improvement in music understanding (Barret, 2003), which is reflected in participants' responses to the open-ended questionnaire of the first study. It is worth noting that there was a small positive impact in favor of the StandardMNG compared to the GraphicMNG, revealing a possible impact of standard notation to preschoolers in music understanding. This finding aligns with Fautley's hypothesis (2017) who argues about the importance of integrating notation instruction within meaningful musical activities, rather than treating it as an isolated skill.

Regarding executive functions, the results were inconclusive. In the first study, a slight improvement was observed in the inhibition task and a more substantial in the working memory task—specifically in the backward memory span tests, and predominantly in the case of the StandardMNG. However, no statistically significant results were found in the expansion tasks.

Therefore, the hypothesis that teaching musical symbolic systems may enhance executive functions (Carlson, 2005) was partially supported and only in favor of the StandardMNG.

Findings from the second study showed that the participants from both groups performed equally well, while slightly better the ones from the StandardMNG. It appears that teaching graphic notation had the lowest influence on participants' performance even compared to the group that received no training in music notation. The findings add to the literature supporting the idea that standard music notation may positively affect children's cognitive development (Nutley et al., 2014) but not to the literature that claim that graphic music notation support the cognitive development of preschoolers specifically, because it includes images and symbols that correspond to their familiar representations (Mcnab 2015). Although graphic music scores are commonly used in modern times as a tool to teach music in young ages (Pujadas, 2018), the present study did not find its superiority compared to standard music scores.

While not conclusive, the results provide initial insights into two key issues. The first concerns what children are capable of understanding and whether they can be taught music using standard notation from their preschool years. The results showed that they easily learned to use graphic music notation, but at the same time did not appear to struggle understanding the standard musical notation symbols, interpret them or use them during instruction and comprehension-cognitive tasks. These findings support approaches suggesting that preschool children are capable of understanding and using symbolic systems like the one of standard music notation (Tommis & Fazey, 1999).

The second issue concerns the preschool education curriculum. Since children do not appear to face significant difficulties in understanding and using the standard music notation symbolic system, music education could reasonably begin in preschool, much like it does in other foundational domains. Children enter school already able to speak; thus, the school provides them with the symbolic system behind language. Similarly, children come to school with the ability to sing; therefore, the school should also provide instruction in the symbolic system behind melodies. Graphic music notation may serve as a useful mediating tool— either before introducing standard music notation or in parallel— particularly when preschoolers encounter challenges. Nevertheless, the goal should be the introduction of standard music notation from the kindergarten level.

Naturally, preschool teachers must be equipped with the necessary musical knowledge to fulfill this role effectively. The training of preservice teachers should place greater emphasis on music education and its symbolic systems. As all symbolic systems -such as language, mathematics and music- contribute to children's cognitive development, it is essential that teacher educational programs provide comprehensive instruction in these areas. Well-prepared educators can then confidently integrate symbolic representations into their pedagogical practices. To this end, high-quality, specialized music training programs for preschool teachers should be developed and implemented, as structured early music education significantly contributes to the holistic development of young children (Bautista et al., 2024).

LIMITATIONS

The preliminary findings of the studies are inconclusive, due to the small sample size and the exclusive focus on preschoolers. Future studies should involve larger and diverse age groups, to better evaluate the impact of music education, programs based on music notation (graphic & standard) on the participants' executive functions and their music understanding.

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