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Effects of a Music-Movement Program in Elementary School Physical Education Classes on Pupils' Rhythmic Ability

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Abstract
The aim of this study was to develop a short music-movement program and evaluate its effectiveness in improving elementary school pupils' rhythmic ability. The sample of the study comprised two hundred forty-five pupils (10.5±.526 years) assigned to control and experimental group. Pupils were tested on their ability to synchronize hand clapping and walking to 48beats at the rhythmic patterns of 2/4, 7/8, and 9/8 using the Digital Rhythmic Ability Evaluation Tool (DRAET). Participants completed DRAET before, immediately after and two months after the implementation of the program. Pupils in the intervention group attended the music-movement program during the warm-up phase of the lesson, whereas those in the control group attended the regular warming up proposed in the national curriculum. The program was implemented twice a week for 13 weeks. The results of the ANOVA with repeated measures on time revealed a significant improvement of rhythmic ability in intervention group pupils as compared to control group pupils. The effect of the program was retained in the follow-up measurement. The findings of the study support the effectiveness of a music-movement program on pupils' rhythmic ability.
Keywords: rhythmic ability, physical education, music-movement, intervention program

1. Introduction

Motion is based on rhythm and helps children perform fundamental movements with dexterity, and in turn supports locomotor development (Galahue, 1996). Moreover, Weikart (1989) argued that the inherent rhythmic ability is developed through participation in locomotor activities which demand accurate reaction to a stimulus. When music and rhythm accompany motions, they can be understood and performed more easily and efficiently (Karageorgis & Terry, 1997; Sousou, 1997). Also, a positive effect on performing with greater precision has been reported (Martin & Ellerman, 2001). Hotz (1992) and Erikson (2004) suggested that rhythm assists in motor learning through the pleasant mood music establishes. Motor ability development is related to the central nervous system (CNS) and, thus, is strongly related to maturation and activation of motor control mechanisms (Cratty, 1975). Past evidence showed that human motor development and cognitive functions are intertwined (Haapala et al., 2013). Therefore, educators have been encouraged in using rhythmic exercises to improve students' attention and concentration (Juntunen, Perkiö, & Simola-Isaksson, 2010; Fross, 2000).

Prior studies implementing music-movement programs were largely focused on preschool education and supported the effectiveness of these programs on preschoolers' rhythmic ability (Bailey & Penhune, 2010; High, 1994; Moor, 1984; Pollatou, Pantelakis, Agdiniotis, Mpenta, Zissi, & Karadimou, 2012; Venetsanou, Dondi, & Koutsouba, 2014; Zachopoulou, Derri, Chatzopoulos, & Ellinoudis, 2003), locomotor and cognitive development of preschool children (Blasi & Foley, 2006; Derri, Tsapakidou, Zachopoulou, & Gini, 2001; Freshwater, Sherwood, & Mbugua, 2008; Gillespie & Glider, 2010; Salmon, 2010; Winsler, Ducenne, & Koury, 2011; Zachopoulou, Tsapakidou, & Derri, 2004). Still, the number of studies investigating the effect of music-movement programs on elementary and secondary school children is rather scarce. Notable exceptions are the studies by Chatzipandeli, Pollatou, Diggelidis and Kourtesis (2007), Likesas and Zachopoulou (2006) and Lykesas, Koutsoumba and Tyrovola (2009). These studies also suggested that music-movement programs can influence pupils in various factors. More specifically, Chatzipandeli et al. demonstrated that a program including exercises with music improved 1st-grade elementary pupils' manipulative skills. Similarly, Likesas and Zachopoulou (2006) indicated that a music movement program increases elementary pupils' pleasure and intrinsic motivation while teaching them Greek traditional dances during the physical education lesson. Lykesas, Koutsoumba and Tyrovola (2009) examined the creativity of secondary pupils during the traditional dance lessons, indicating a strong effect on it. In addition, Murray (1975) recommends teachers to use dance in elementary education because of its effectiveness on rhythmic abilities' parameters and many other locomotor and non-locomotor abilities. This evidence demonstrates that rhythmic exercises can effectively be applied in a wide range of grades in elementary school in order to promote pupils' rhythmic ability. However, such activities are typically integrated only in the first three grades of elementary school. Yet, past evidence demonstrated that simple rhythms (i.e., 2/4, 6/8) can be used for younger pupils aged between 6 and 8 years-old, whereas more complex rhythms (i.e., 7/8 and 9/8) can be used in older elementary school pupils (Serbezis & Panagopoulou,

2008). Moreover, rhythms that have a regular temporal structure are discriminated and reproduced better than irregular rhythms (Grahn & Brett, 2007; Patel, Iversen, Chen, & Repp, 2005). Such rhythms have been found to effectively increase pupil's rhythmic ability (Pavlidou, Mertzanidou, & Zissi, 2009). Importantly, as Zachopoylou et al., (2003) noted these activities are enjoyable and do not require special equipment.

Typically, national physical education curricula decrease the time allocated in music-movement education in higher grades at the elementary schools in favor of games and sports (Hardman, Klein, Patriksson, Rychtecký, & da Costa, 2008). However, music-movement education in these grades can still help pupils increase their rhythmic ability and better learn sports skills. In this sense, music movement education should be integrated in the physical education lesson. A possible way to do this without interrupting the teaching of the other physical education subjects, but assisting them, would be to integrate music movement drills during the warm-up phase of the lesson. This approach is expected to have two benefits for the lesson, a) maintaining teaching rhythmic skills to pupils and b) providing an alternative, fun, enjoyable and interesting ways to initiate the lesson. Past evidence showed that music-movement programs include body activities in a low or medium intensity of aerobic exercise that can warm up pupils for a physical education lesson (Faigenbaum, Bellucci, Bernieri, Bakker, & Hoorens, 2005) and are perceived as energetic and enjoyable activities (Zachopoulou et al., 2003). However, so far there is no evidence that such an approach could be implemented in the school settings and whether it can be effective in increasing pupils rhythmic skills. Therefore, the aim of the present study was to develop a music-movement program suitable for the warm up phase of the physical education lesson and test its effectiveness in improving elementary school pupils' rhythmic ability.

2. Method

2.1 Sample and Procedure

The sample consisted of 245 elementary school pupils (122 boys, 123 girls) with an age range between 10 to 12 years-old (M = 10.5, SD = .52). All pupils were attending typical co-educational elementary schools in a large city of Northern Greece. Pupils were assigned into control (n = 122 pupils, M = , SD =) and intervention (n = 123 pupils, M = , SD =) groups.

Each participant was asked to perform the locomotor tests of hand clapping and walking in a specific space area to synchronize the corresponding motion with the 2/4, 9/8, and 7/8 beat rhythmic pattern at a tempo of 100 beats per minute (bpm). All participants performed six rhythmic ability tests (hand clapping 2/4, walking 2/4, hand clapping 9/8, walking 9/8, hand clapping 7/8, and walking 7/8). Each test required pupils to synchronize their motions with 36 acoustic beats and in the sequel to sustain the corresponding rhythmic motion with 12 non-acoustic beats. The score of each trial was recorded: a) The number of synchronized motions in total (48 perfect scores); b) The number of non-synchronized motions during the acoustic beats period; c) The number of non-synchronized motions during the non-acoustic beat period, and d) The total error of all motions (synchronized or not) expressed in milliseconds (ms). The threshold in which a motion is considered to be within limits was defined as 100ms, making adjustments for the age of the subjects; they were properly informed about the context of the test and were allowed some attempts without being recorded. In the beginning of the test, a set of four warning sounds accompanied the verbal instruction of the examiner "one, two, three, go", to start synchronizing their motions with the corresponding rhythmical pattern of 100bpm.

Three measurements were performed. A baseline pre-test measurement before the implementation of the intervention, a post-test measurement immediately after the intervention, and a follow up test two months after the post-test measurement. In the follow-up test, the 30% of the initial sample participated (33 pupils in the intervention group and 33 in the control group).

2.1 Rhythmic Ability

A Digital Rhythmic Ability Evaluation Tool (DRAET) was developed and validated by Authors (in press) to evaluate rhythmic ability with computer-assisted recording and analysis techniques and a set of accelerometer sensors. A compact device can be attached to any body part, using a belt or tape, and can communicate with a computer through a wireless Bluetooth interface, and then evaluates a subject's rhythmic ability in a defined space within a range of 5-100 square meters.

In Figure 1, a waveform consisting of 48 motions (hand claps) is illustrated. The 39 of the motions are identified as synchronized and 9 motions are out of limits. The beats are illustrated as vertical lines below the waveform (note that the x-axis of the waveform is the time expressed in seconds). Depending on the attributes of the test sample (such as the age) and the aim of the research, a threshold in ms is defined, in which a step is considered to be in rhythm when the time interval between it and the corresponding beat remains within a given threshold. As explained, the different types of steps are illustrated in various shapes and colours (a green circle for motions within limits, a red square for motions out of limits, green filling for single motions, and red filling for double motions). The error per motion and the total errors are also illustrated (expressed in ms), allowing for visual observation and evaluation of an individual's rhythmic ability with a high level of digital accuracy.

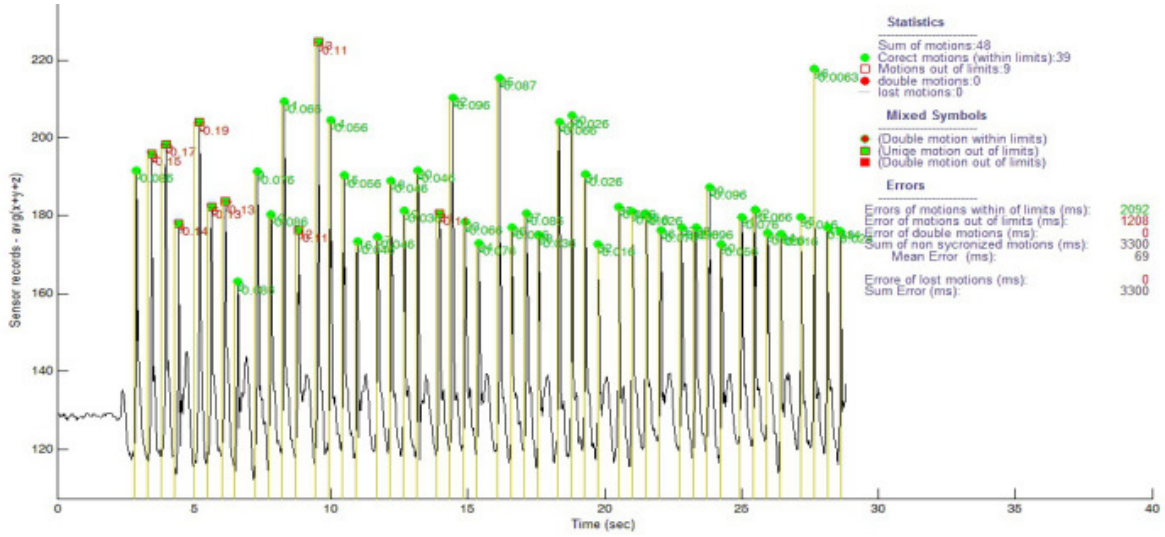

Figure 1. The measurement data of rhythmic ability parameters via DRAET

2.2 The Intervention Program

The intervention program was designed to last the same time with the warm-up phase of a regular physical education lesson, i.e., 8 to 10 min. Pupils in the intervention group performed the program twice a week for 13 consecutive weeks. The program consisted of four independent thematic activities including locomotor activities accompanied by traditional and modern music. The thematic activities included: 1) The motorcycle rider: The pupils impersonated travelers who make a trip with motorcycles, meeting different cultures and various incidents in the towns they come through; 2) Old Greek cinematography: the following scenario was connected to popular movie themes of old Greek cinematography; 3) World Music: pupils traveled around the world impersonating national dancers with corresponding rhythms; and 4) The Rhythm of Sports: pupils impersonated sports activities with suitable accompanying music. Each thematic activity consisted of an audio file which included the music and additional instructions in a storytelling form. Storytelling provides students with an opportunity to become more actively involved (Davidson, 2004) and was used to help pupils prepare for the corresponding scenario.

During the activities, pupils tried to synchronize their motions (running, clapping, jumping, etc.) with the changes of the mixed rhythmic patterns (2/4, 7/8, 9/8, 3/4) and tempos (moderato, allegro, presto, andante, etc). These rhythmic patterns and music themes were chosen as the more appropriate for this age group. A combination of traditional and modern music was selected in order to create an enjoyable atmosphere with several rhythmic and tempo alternations. Also, this variety of rhythms facilitated the application of many different locomotor activities, relevant to the corresponding beat and providing the opportunity for expression in the thematic scenario.

Each activity lasted 9-10 min, including a 1-2 min stretching period with relaxing music and only one of the four scenarios was applied each time. The activities were performed in the introduction phase of the physical education lesson (warming up) starting the audio file of the corresponding scenario via audio player. The physical education teacher participated in the program acting as a model providing additional guidance. Thus the acoustic scenario with music called the pupils to act through running jumping, dancing, clapping e.t.c following also the physical educators' instructions. Pupils in the control group performed the regular warming up described in the national curriculum. This warming up includes running or a running-related game and stretching exercises for 8 to 10 min.

2.3 Data Analysis

The SPSS 22.0 was used for the analyses of the present study. Descriptive analyses were performed. The study hypotheses were tested via analyses of variance with repeated measures on time. The level of significance was set at p=.05.

3. Findings

Fourteen participants were excluded from the analysis as they didn't provide complete data in the pre- and post-test measurements. Therefore, the data from 109 pupils attending the intervention group and 122 pupils in the control group were used in the analyses. Participants in both groups did not differ in demographics and rhythmic ability in the baseline measurement. The mean values and standard deviations obtained by DRAET, are summarized in Table 1.

Table 1. Mean values and the standard deviation of the rhythmic ability variables

		Pre				Post				Follow Up			
		Intervention group (n=109)		Control group (n=122)		Intervention group (n=109)		Control group (n=122)		Intervention group (n=33)		Control group (n=33)	
		MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
Handclap 2/4	a. total synchronization	38.68	7.446	40.24	6.142	44.39	3.477	40.35	5.901	45.52	2.373	39.52	2.863
	b. total ms error	3225.07	1417.193	2907.27	1276.820	2026.86	675.880	2900.15	1268.051	1742.33	616.110	2984.24	709.254
	c. beat period errors	3.55	5.468	2.50	5.023	.96	1.805	2.60	4.670	.85	1.326	1.88	1.949
	d. no beat period errors	5.77	3.713	5.68	3.434	2.83	2.869	5.15	3.334	1.58	2.062	6.61	2.487
Walking 2/4	a. total synchronization	36.02	10.946	37.80	9.499	43.18	4.922	37.76	9.069	45.42	2.728	38.97	6.748
	b. total ms error	3779,90	2263,043	3486,95	2091,258	2234,61	988.501	3413.31	1934.474	1837.33	680.169	3192.18	1395.669
	c. beat period errors	7.41	9.860	5.97	8.764	1.65	2.682	5.37	8.160	1.12	1.516	4.15	4.535
	d. no beat period errors	5.23	3.460	5.18	3.766	3.10	3.437	5.44	3.686	1.48	1.938	5.55	4.360
Handclap 9/8	a. total synchronization	37.89	6.646	39.23	4.748	42.41	3.408	39.70	4.496	45.45	2.948	38.61	4.015
	b. total ms error	3313.14	1307.194	3138.45	908.380	2417.15	679.356	3028.09	901.251	1923.33	629.962	3296.97	875.981
	c. beat period errors	4.90*	4.684	3.30	3.715	1.06	1.635	3.06	3.375	.76	1.001	2.48	2.476
	d. no beat period errors	5.23	3.075	5.34	2.827	4.38	2.765	5.07	2.697	1.79	2.547	6.64	2.870
Walking 9/8	a. total synchronization	36.96	8.230	38.70	7.609	42.77	4.837	38.30	7.602	43.27	4.193	36.94	6.731
	b. total ms error	3585.78	1740.757	3171.93	1621.516	2422.86	890.744	3279.11	1509.971	2317.48	820.535	3364.00	980.485
	c. beat period errors	6.13	6.221	4.92	6.347	2.09	3.014	5.04	6.654	1.70	2.506	5.55	5.985
	d. no beat period errors	4.91	3.865	4.57	3.547	3.07	3.039	4.72	3.426	2.85	2.774	5.42	3.700
Handclap 7/8	a. total synchronization	38.06	5.955	39.02	5.616	42.72	5.199	39.14	4.893	44.03	3.661	39.91	3.827
	b. total ms error	3515.45	1291.699	3220.25	1262.362	2327.18	687.540	3206.25	1030.177	1989.55	703.803	3000.97	735.770
	c. beat period errors	4.86	5.995	3.78	4.479	1.35	2.065	3.64	4.051	1.24	1.888	2.06	1.784
	d. no beat period errors	5.43	3.125	5.07	3.175	3.57	2.945	4.97	2.757	2.58	2.762	5.79	2.902
Walking 7/8	a. total synchronization	35.83	7.898	37.58	7.684	42.78	5.365	37.79	7.841	43.61	4.636	39.48	6.413
	b. total ms error	3821.09	1807.738	3755.75	4063.877	2318.15	950.208	3350.89	1637.282	2188.64	1081.341	3162.86	1418.464
	c. beat period errors	6.62	6.902	5.40	6.650	1.78	2.967	5.38	7.006	1.73	3.085	3.42	4.486
	d. no beat period errors	5.38	3.490	5.48	3.885	3.68	3.153	4.80	3.439	2.48	2.451	4.97	3.137

a. The total synchronized motionsb. the total ms error, c. the non-synchronized motions during the beat period andd. the non-synchronized motions during the no beat period

The analysis of variance with repeated measures on time revealed significant group by time interactions for the majority of the tests (see Table 2). The analyses demonstrated a statistically significant increase in the performance of pupils in the intervention group in all tested variables compared to the pupils in the control group whom scores remained rather stable. Importantly, the effect of the intervention remained significant in the follow-up measurement two months later. No significant group by time interactions emerged for “no beat period errors” for handclap 9/8 and walking 7/8 (see Table 2).

Table 2. Interactions between measurements and groups

		Between groups pre and post measurements Interaction		Between groups post and fu measurements Interaction	
	Variables	F	η^2	F	η^2
Handclap 2/4	a. total synchronization	54.616**	.193	5.505*	.080
	b. total ms error	68.876**	.232	2.289	.035
	c. beat period errors	20.399**	.082	.999	.16
	d. no beat period errors	22.202**	.089	2.375	.36
Walking 2/4	a. total synchronization	52.200**	.186	4.995*	.073
	b. total ms error	54.049**	.192	3.245	.049
	c. beat period errors	28.221**	.110	2.029	.031
	d. no beat period errors	26.519**	.104	2.752	.042
Handclap 9/8	a. total synchronization	37.274**	.141	27.094**	.301
	b. total ms error	43.233**	.159	16.449**	.207
	c. beat period errors	45.873**	.167	1.530	.024
	d. no beat period errors	1.805	.008	29.985**	.322
Walking 9/8	a. total synchronization	60.203**	.209	4.373*	.065
	b. total ms error	71.197**	.238	2.621	.040
	c. beat period errors	43.815**	.161	2.958	.045
	d. no beat period errors	14.011**	.058	1.548	.024
Handclap 7/8	a. total synchronization	37.059**	.140	.678	.011
	b. total ms error	70.791**	.237	2.193	.033
	c. beat period errors	24.779**	.098	.447	.007
	d. no beat period errors	11.735**	.049	3.291	.050
Walking 7/8	a. total synchronization	52.089**	.186	.007	.000
	b. total ms error	8.007*	.034	.348	.005
	c. beat period errors	40.260**	.150	.239	.004
	d. no beat period errors	3.758	.058	.413	.007

*p< .05 **p< .01. a. The total synchronized motions b. the total ms error, c. the non-synchronized motions during the beat period and d. the non-synchronized motions during the no beat period.

4. Discussion, Conclusions and Recommendations

The aim of this study was to examine the effect of a music movement intervention program during the warm-up phase of the physical education lesson on the rhythmic ability of elementary school pupils. Both simple and complex rhythmic patterns (2/4, 7/8, and 9/8) were taught to pupils. The results of the analyses indicated that a music movement program used in the warm-up phase was effective in increasing pupils' rhythmic ability as compared to the regular warming up.

These findings are in line with those reported in previous studies with preschoolers demonstrating that such music movement intervention programs can positively influence rhythmic ability (Bailey & Penhune, 2010; High, 1994; Moor, 1984; Pollatou et al., 2012; Venetsanou et al., 2014; Zachopoulou etal., 2003) and locomotor and cognitive development (Blasi & Foley, 2006; Derri et al., 2001; Freshwater et al., 2008; Gillespie & Glider, 2010; Salmon, 2010; Winsler et al., 2009; Zachopoulou et al., 2004). Additionally, they support previous evidence with elementary school pupils demonstrating that a music movement program can effectively improve rhythmic ability in older elementary and secondary school pupils too (Chatzipandeli et al., 2007; Likesas & Zachopoulou, 2006; Lykesas et al., 2009).

Past evidence has largely relied on improving rhythmic ability on preschoolers neglecting elementary school pupils. Importantly, the results of the present study indicate that music movement programs are similarly effective in increasing rhythmic ability of higher grade elementary school pupils as well. Also, it is important to note that this increase was achieved by incorporating rhythmic activities in the warm-up phase of the lesson. This has important implications for physical education practice as it implies that a short period of implementation is adequate to maintain and improve the rhythmic ability of 10 to 12 years old pupils. Physical education teachers can incorporate such activities in the warm-up phase without costs on teaching other subjects (i.e., games etc) and assist in the multifaceted motor development of their pupils. Interestingly, past evidence has shown that such rhythmic activities increase enjoyment from the lesson (Zachopoulou et al., 2003). Therefore,

they may provide an important alternative for warming up activities as they are enjoyable and promote pupils motor development.

With respect to the activities tested, the results indicated that the most notable improvements were achieved in the walking tests as compared to the corresponding handclaps for all rhythmic patterns. This evidence suggests an increased effectiveness of the music movement program on rhythmic synchronization in walking or running exercises. This of great practical importance as walking and running activities are mainly used in physical education lessons. The improvement was larger in the rhythmic patterns of 2/4 and 7/8 as compared to 9/8 pattern, although pupils' performance improved in this pattern too. The improvement on the 2/4 rhythmic pattern was in the expected direction, as it is a rhythm with a simple structure and is suitable for music movement programs.

Improved performance on the 7/8 rhythmic pattern could be ascribed to the fact that this pattern is typically used in Greek traditional music and dances, and pupils' might have been familiarized with this pattern. Also, the age of the participants might have been responsible for the improvement in the 7/8 rhythmic pattern. Past evidence has shown that children begin to synchronize their moves with complex rhythms at ages of 9 to 11 (Grahn & Brett, 2007; Patel, et al., 2005; Serbezis & Panagopoulou, 2008). Therefore, this is the suitable age to teach this rhythmic pattern and the findings of the present study demonstrated that this can be achieved even with short rhythmic activities in the warm-up phase of the lesson.

No significant effects of the intervention were found in the "no beat period errors in Handclaps 9/8". This finding may be attributed to the difficulty of this rhythmic pattern and the inability of the pupils to endorse this pattern in the time provided in the current intervention. However, the follow-up measurement revealed a lower number of unsynchronized motions in this variable suggesting an improvement. The present program introduced innovative elements such as the variety of music rhythms which might have produced long-term effects on this rhythmic pattern.

The scores of the control group remained stable in all tested parameters of rhythmic ability across all measurement points. This finding, combined with the improved scores of the intervention group, indicated that of the music movement program implemented in the intervention group resulted in the increase of pupils' rhythmic ability.

In the present study a wide range of parameters measuring rhythmic ability was tested, including the total synchronization calculating the synchronized and non-synchronized motions, the record of the total ms error of all motions providing digital accuracy, and the evaluation of the ability to preserve the synchronized motion with the corresponding rhythmic pattern without the acoustic beats. These are variables that provide a high level of consistency and a comprehensive view of the rhythmic ability parameters assessment. Furthermore, the rhythmic ability was measured with a new and validated approach (DRAET; Authors, in press) that provides objective assessments of rhythmic ability.

Overall, the present study demonstrated that a short music movement program implemented in the warm-up phase of the physical education lesson for 13 weeks can significantly improve 5th and 6th-grade elementary school pupils' rhythmic ability in handclapping and walking in both simple (2/4) and complex (7/8, 9/8) rhythmic patterns. This program could be effectively used to promote motor and psychological development in elementary school and complement regular teaching activities.

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