The Role of Musical Rhythm in Teaching Basic Concepts of Mechanics to Deaf Students

Dionisios Vavougios[1*], Panagiotis F. Papalexopoulos[2], Alkistis Verevi[3], Maria Michailou[4], Elisavet Likou[5] and Polytimi Patapi[6]

[1,2] Department of Special Education, University of Thessaly,
Argonafton & Filellinon Street, Volos GR-38221 Greece

[3] Academy of Athens,
Panepistimiou 28, 10679 Athens, Greece

[4] 1st Vocational School of Haidari,
2-4 Rimini & Ag Triados, Haidari, Greece

[5] Dance School Tsakalou Eleni,
8 Grigoriou Lambraki, Likovrisi, Greece

[6] Aion,
21Ag Lavras, Athens, Greece.

[*] Corresponding author's email: dvavou [AT] uth.gr

ABSTRACT– ***In the context of the integration of the students with special needs to the mainstream school we describe in this study the perspective to instruct basic concepts of mechanics to deaf students of Secondary Education using the rhythmic patterns of musical education in the motion elements of the art of dance. More specifically we analyze from the kinesiological viewpoint some basic dance movements using the laws of physics and physical quantities like angular acceleration, center of gravity, etc. and we underline the role of musical rhythm in the understanding and the execution of the above mentioned movements. Reviewing the relevant literature and presenting examples of specific physic concepts we support that the movements taught through dance -and their repetition with the assistance of musical rhythm in integrated dance groups- can improve the control of the posture of deaf children and therefore their psychomotor skills and the comprehension of the relative physic patterns.***

Keywords– deaf students, physics, mechanics, dance, musical rhythm.

1. INTRODUCTION

The literature review about students' with special needs integration to mainstream school (Author) and more specifically about the conditions and the development of a suitable learning environment for teaching physics to deaf students indicate, among others, that: a) deaf students' concepts about physical phenomena do not differ significantly from the concepts of hearing students, which is an encouraging finding for their education (Roald & Mikalsen, 2000, 2001, Molander, Pedersen, & Norell, 2001), b) there are several effective teaching approaches and instructional strategies that teachers could apply while teaching physics to deaf students (Lang, 1994; Wang, 2011) and several specially formulated activities that could be used both in the classroom and the physics lab (Miner, Nieman, Swanson, & Woods, 2001).

In this paper, taking into account the aforesaid suitable conditions for creating an effective learning environment, we discuss the use of music rhythm and dance moves in teaching basic concepts of mechanics to deaf students. The understanding and use of simple rhythmic patterns are important because rhythmic movement is one of the elements that exist in the natural and biological world and it is inborn in our first sense of breath. This justifies why combined rhythmic patterns in different speeds creating musical forms are used by music and movement teachers and by special education teachers (Alley, 1979; Walmsley, Crichton, & Droog, 1981); moreover, teaching tempo and music therapy, as flexible teaching strategies, were developed in the last years because they were applied in pathological and non-pathological

situations and, as part of integration programs, they promoted students' social inclusion. Therefore teaching tempo in groups of students could facilitate the teaching of physics concepts as well as their social inclusion.

In this context our paper refers to prelingual deaf students (i.e. students whose hearing loss occurred before language acquisition) of Secondary Education as people with special needs who are to be mainstreamed with other hearing children, ensuring equity of educational opportunities (UNESCO, 1994) and we explore how their training in tempo can contribute to a complete experiential learning of physics. More specifically the purpose of this paper is to describe the perspective of the instruction of basic concepts of mechanics to deaf students using motion elements of the art of dance and rhythmic patterns of musical education.

2. MUSICAL RHYTHMIC ELEMENTS

Several teaching methods, approaches and instructional strategies among which teaching deaf students through musical rhythmic patterns and movements have been used and evaluated, since understanding simple rhythmic patterns is fairly easy for most students (especially when small-group learning is employed as an instructional process).

Learning of tempo in a classroom facilitates the control of the posture while boosting self-esteem; we therefore assume that it may also contribute to deaf students' progressive integration in the school life of hearing and give them opportunities to improve physical skills; since deaf students, apart from vestibular deficits, do not seem to differentiate from normal students because they "seem to have compensated for their sensory loss by relying on either appropriate visual or surface information when available" (Horak, Shumway-Cook, Crowe, & Black, 1998). We argue that musical rhythmic and motor training and, more specifically, several kinds of dance form a framework which helps students to alleviate their mobility disabilities with regular practice (Sherrill, 1998; Auxter, Pyfer, & Huetting, 1997) in an experiential and social framework.

Alleviating mobility disabilities promotes acquisition of steadiness –for example, in terms of length of time that children can stand on one leg (Effgen, 1981)– and equilibrium, and eventually the control of posture which was lost due to hearing impairment. This is attributable to the immature function of the somatosensory system, i.e. vestibular, visual and proprioceptive system (Greffou, Bertone, Hanssens, & Faubert, 2008). Practicing dance regularly stimulates brain paths related to motor skills at a low firing rate, thus spending less energy in top down process of the stimuli to the motor neurons of the area of the body which will move. As a result thinking skills, such as right perception of space and time, correlation and memory representation of pieces of information and learning of concepts are organised at a natural pace.

The repetition of several rhythmic patterns creates a musical motif on which the movement is executed as a whole. The speed of the musical rhythm determines the speed of the movement, which should be slow for deaf people, and therefore kinesthetic function is developed with stability and control. (Faster rhythm leads to faster movement and it increases skill level and coordination. However, in a deaf students program this is not pursued, since at fast speeds the vestibular system might not respond properly and loss of balance may occur). Therefore, regular practicing within a specially designed dance training program the proper motor models (i.e. using tempo and repetition in certain simple musical rhythmic patterns) –through a self-correcting approach opposite a mirror– may reduce deficits of deafness to the rest of the body system and provide a kinesthetic perception of the physics concepts that underlie the moves of dance.

3. TEACHING APPROACHES FOR BASIC CONCEPTS OF MECHANICS

As it is already known, regular and appropriate physical exercise from early childhood help students with their overall cognitive development (Leppo & Davis, 2005; Schack & Mechsner, 2006). However, deaf children's perceptual and cognitive control schemes –depending on their growth and maturity stage (skeletal system develops between 16-19 years of age) (Greffou et al., 2008)– are practiced not only through a variety of specific exercises, but mainly through the repetitive patterns of the exercises that the different kinds of dance practice involves.

The exercises of the various kinds of dance can be described and explained using physics concepts (Laws & Sugano, 2008, Kuznetsova, 2003, Kunzig, 1999). For example, teaching angular acceleration, which usually takes place during the instruction of physics, can be completed during students' practicing in ballet and modern dance movements; deaf students may experientially approach the concept of angular acceleration while practicing outwards pirouettes (en dehors) and turns (fig. 1). A pirouette is divided in four phases; it starts partially with a moving pattern of one quarter which is equivalent to a rhythmic pattern of a half length note. The dancer pushes her/his leg against the floor so that the torque against his/her axis of rotation will evoke the angular acceleration to get the rotation started. After that, two rhythmic patterns are combined and the movement extends to two quarters, and it goes on until all four phases are completed.

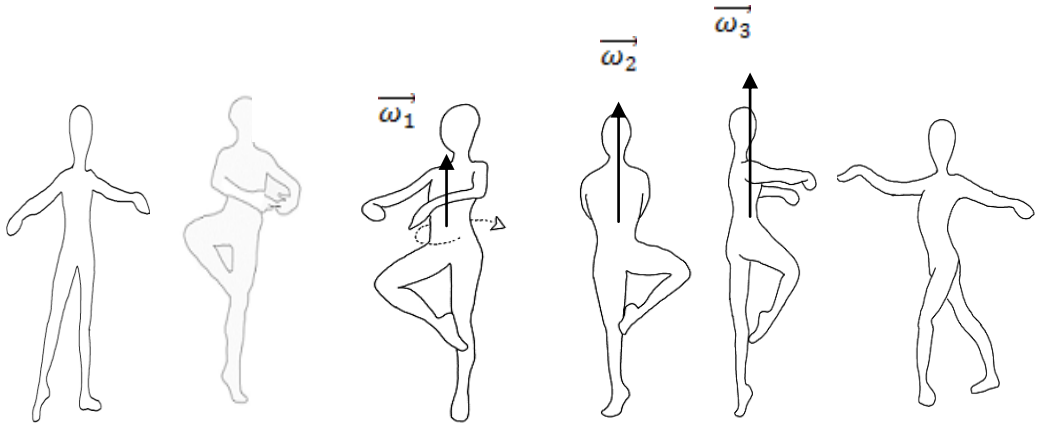
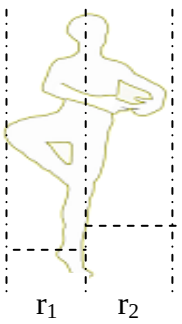


Figure 1: Deaf students may experientially approach the concept of angular acceleration (increase of the angular velocity) while practicing outwards pirouettes en dehors.

As for the instruction of the concept of moment of inertia, the teachers could take into consideration that it depends on the dancer's mass and its distribution to the axis of rotation. The relevant musical rhythm that accompanies the dance program determines the different position of the student from passé position (standing on one leg) to arabesque (the other leg is extended to the back) and therefore s/he could experience the different distribution of the mass round the axis of rotation. The dancer going over from passé position (fig.2) to arabesque (or back kick) (fig.3) could experientially approach the physical concept of the moment of inertia and kinaesthetically perceive that it is greater in arabesque position than in passé. This difference is due to the fact that in arabesque position, the dancers' mass is extended to a longer distance from the axis of rotation than in passé position. More specifically counting the move from passé/retire to arabesque position in 4/4 or 3/4 may help students realize the progressive differentiation of the distribution of the mass and its impact on steadiness.



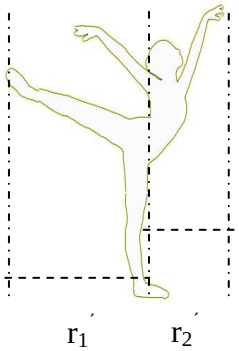


Figure 2: The passé position **Figure 3:** The arabesque

Figures 2 & 3: The dancer going over from passé position to arabesque could experientially approach the physical concept of the moment of inertia and kinaesthetically perceive that it is greater in arabesque position than in passé.

The concept of the center of gravity could be instructed when students have to balance over a small area of support on the floor (demi-point on one foot). Balance is achieved "only if the center of gravity lies on a vertical line passing the area of support at the floor. If the dancer is motionless, the sum of all the forces and torque acting on the body must be zero". For example when the dancer starts from a position where s/he stands straight with the heels together and the

entire sole of the foot, heels and toes are firm on the floor, (e.g. first position) (fig. 4) and gradually -following the counts of the music- transfers the weight sliding one foot away from the other until feet are about shoulders width, the dancer moves from first to second position (fig. 5). Through this movement the dancer can kineasthetically perceive the transition of the center of gravity. During this movement the dancer may kinesthetically experience the shift of the center of gravity of his body until the force of gravity is being placed opposite to the force of reaction from the ground, i.e. in the position where the dancer will balance on one foot (Newton's third law of motion).

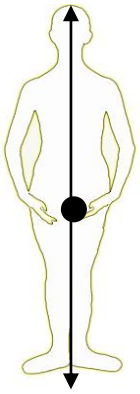


Figure 4: The first position

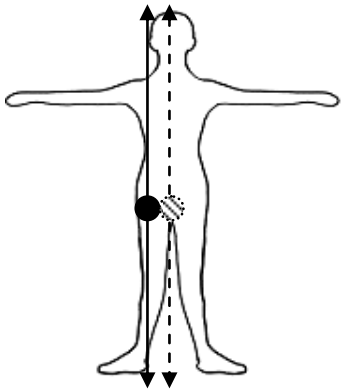


Figure 5: The second position

Figures 4 & 5: When going from first to second position the dancer may kinesthetically experience the shift of the center of gravity of his body until the force of gravity is being placed opposite to the force of reaction from the ground.

The aforesaid concepts of mechanics are usually taught to hearing students at Secondary Education. Therefore they can be equally taught to deaf students, since at this age deaf students "seem to have compensated for their sensory loss by relying on either appropriate visual or surface information when available" (Horak et al., 1998, p.74). The above mentioned dance exercises should be practised in a rehearsal studio that is properly organised for deaf students. The rehearsal studio should, among others, have: a) a specially constructed floor with plastic surface, so that sound impulses produced by the music or the teacher are sensory used via stimulation of the receptors of the foot (Auxter et al., 1997, Bernari, 1995), b) bright colorful spotlights of certain colors placed in several parts of the studio, that flicker in turns and at different speeds following the rhythm of music, which will provide the students with feedback pointing to the right direction for every movement. Such equipment may activate the visual and proprioceptive system that transmits at the proper frequency stimuli to the brain, and a co-ordinate and accurate movement is executed (Grasso, Ivanenko, & Lacquaniti, 1999; Greffou et al., 2008) and c) mirrors placed opposite the students, so that they are able to identify the accurate movement and correct faulty physical stereotypes via imitation and visual feedback (looking at themselves or their teacher).

4. DISCUSSION

The advances in education during the last decades saw the emergence of versatile teaching strategies for deaf students (Ingvild, 2002; Lang, 1994). The teaching of concepts of physics to deaf students via simple and specifically designed physical exercises not only enhances some of their motor skills but it may also raise their interest in the explanation of the different phenomena in physics that cannot be conceptualized otherwise. Research has shown that special exercises have an impact on the motor skills of deaf students. However, there is a great field for research when it comes to experimental study of the exercises which will be adapted so that they combine the teaching of a specific concept of physics with a specific movement malfunction or an advantage deriving from the deafness of the particular students.

Following the teaching approach described in this paper we consider that students' practice in musical rhythm through dance exercises may help them understand basic concepts of mechanics. According to our approach the different kinds of dance engage deaf students in a group activity that helps them explore a physical concept from a different perspective than the traditional one that has been taught in the school lab or in the classroom. However we do not argue that practice in musical rhythm and dance movements can replace the advantages of the experimental procedure that takes place in the school lab (Hofstein & Lunetta 2004, 1982) or the elaboration of the theoretical problems during the instruction of physics in the courses.

As far as the restrictions of our teaching approach are concerned we support that it can be improved by studying and constructing the equivalent sign language; signs of sign language that will connect concepts of physics to musical rhythm and dance movements. In the development of such signs we should consider deficiencies of sign language as far as signs of scientific terminology are concerned -though we acknowledge the importance of sign language in the teaching of physics (Wang 2011, Lang et al., 2007).

Moreover, field and empirical research and evaluation of its results concerning deaf students' understanding of concepts of mechanics and other concepts of physics is essential for the effective integration of deaf students to physics and science school class. The results of an empirical research may also contribute to the improvement of deaf students' integration to mainstream education from the teacher's perspective. Besides, the teacher is the one who can adapt the suggested teaching strategies taking into account the specific needs of his/her class deaf students and according to his/her own critical approach towards educational practice so that deaf students will be successfully mainstreamed with other hearing children in a science class (Carr & Kemmis, 1986; Argyropoulos & Nikolaraizi, 2009).

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