# WhoLoDancE: Towards a methodology for selecting Motion Capture Data across different Dance Learning Practice

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# ProjectName: Towards a methodology for selecting Motion Capture Data across different Dance Learning Practices

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## ABSTRACT
In this paper we present the objectives and preliminary work of ProjectName, a European project, aiming at using new technologies for capturing and analyzing dance movement to facilitate whole-body interaction learning experiences for a variety of dance genres. Dance is a diverse and heterogeneous practice and ProjectName will develop a protocol for the creation and/or selection of dance sequences drawn from different dance styles for different teaching and learning modalities. As dance learning practice lacks standardization beyond dance genres and specific schools and techniques, one of the first project challenges is to bring together a variety of dance genres and teaching practices and work towards a methodology for selecting the appropriate shots for motion capturing, to acquire kinetic material which will provide a satisfying proof of concept for Learning scenarios of particular genres The four use cases we are investigating are 1) Classical Ballet, 2) Contemporary Dance, 3) Flamenco and 4) Greek Folk Dance.

## Author Keywords
Dance Learning; Motion Capture; Human Movement; Whole-Body interaction; Dance practices and genres.

## ACM Classification Keywords
H.5.5. Information interfaces and presentation (e.g., HCI): Sound and Music Computing—Systems. J.5. Arts and Humanities: Performing arts (e.g. dance, music).

## INTRODUCTION
ProjectName is a three years (January 2016-December 2018) Research and Innovation Action, under the framework of ICT2015 of H2020 aiming at designing and developing whole body interaction tools to support dance learning. The consortium of ProjectName consists of a) Technical Partners, b) Four Dance Experts partners from different countries (UK, Spain, France and Greece) with a mixed profile of Dance Education institutions and choreographing companies, covering four different dance genres (ballet, contemporary, flamenco, and Greek folk).

## RESEARCH OBJECTIVES
ProjectName will provide a common 'language' by which dance can articulate the principles that underpin the learning and performance of dance, which can be transferable to other expert movement practices e.g., martial arts, and create a digital environment that provides dance educators and students, as well as creators (choreographers), the opportunity for capacity building and networking, bringing together practitioners from different physical spaces (different studios, cities or countries). ProjectName will also allow them to communicate on line choreographical ideas and movement concepts and to collaboratively work beyond geographical or time limitations. ProjectName, applying Motion Capture Technology, Similarity Search tools, Movement Content Analysis and Complex Data Analytics to dance data, will allow the project team to uncover more about underlying principles, vocabularies, imagery, etc., and will support the development of novel methods for the teaching and learning as well as preserving cultural heritage through the documentation of diverse and specialized dance movement practices. In particular, ProjectName will create and deliver the proof-of-concept of a motion capture repository of dance motions built in a method allowing interpolations, extrapolations and synthesis through similarity search among different compositions.

ProjectName will investigate and apply methodologies of personalization to create personalized scenarios for learning. Learning dance is a timely, complex process which depends on the variety of techniques, context, student's needs etc. Several pedagogical approaches could be linked to this multimodal process, in order to deliver the needs of the particular (formal-informal) context and objectives of learning, the learning style of the student, and the preferences of the teacher, to achieve and assess the effectiveness of teaching. ProjectName aims to construct dynamic Learning Scenarios in the forms of "stories" or paths of teaching. Under this perspective ProjectName aims at analyzing the users' different profiles (age, gender, level of expertise, dance genre and technique). Application scenarios will include formal and informal education providing tools that will be available both for public institutions as learning materials and group training in class or for private use in the form of entertaining educational games. The learning environment, through a usable

multimodal interface, will provide the users with the ability to experiment with captured movement sequences and dance syllabi coming from a range of dance genres, through adaptive technologies and personalized paths of learning. The personalization will foresee the conceptual and practical design of multi level rule based ~~scenarii~~scenario as applied to a dynamic interaction between a dancer and an avatar (teacher-dancer himself) able to provide the user with a sense of inner feeling of movement (combined with other feed-back) and the design of the appropriate visualization and sonification of combined movement principles (with their varying degrees of difficulty to match or to move with accordingly).

## DANCE LEARNING PRACTICES

Dance education is mainly an example of "learning by doing" and the development of embodied knowledge, whereas technological tools can support the analytical and conceptualizational abilities of dance students, and choreographers. Currently there is not one single repository of these teaching methods, neither is there a repository of dance actions that would support the development of the teaching of dance. Learning based on ICT, and whole-body-interaction in particular, can largely benefit from the outcomes of applying it in the field of Dance, as dancers are experts in embodied communication and dance is by its nature multimodal. ProjectName data-driven tools will be provided with a measurement of human-system interaction fostering non-linear approaches to adaptive learning and cognitive artifacts for effective human learning. Dance is traditionally a practice that is passed from body to body, and whilst there are established and codified dance 'techniques' that are genre specific (such as classical ballet, and some modern or contemporary techniques e.g., Graham, Limon, Cunningham, or Skinner Releasing Technique,) these techniques evolve through the teaching itself. Some techniques are therefore more prescriptive than others, and those that are more prescriptive tend to be guarded by a named innovator or developer of the technique. But aside from the specifics of named and codified techniques, there are teaching methods that connect all studio based teaching of dance and whilst these methods are moderated according to context (whether within a professional/vocational teaching context, or a recreational context, etc.) and according to genre, there are underlying principles that pertain to all good teaching of dance. The ProjectName multimodal repository will enable the usage of data analytics supporting the identification of effective teaching methods and practices showing commonalities and differences between them to support the future teaching of dance within a variety of contexts.

## DANCE LEARNING PRINCIPLES

As the aforementioned dance genres provide a huge diversity in both the kinetic vocabularies and the teaching methodologies, one of the big challenges is to find learning objectives that are common across genres. We aim for a systematic way of selecting shots beyond the differences of the kinetic material. A focus group, with the participation of dance teachers of all genres, agreed that the following *Learning Principles* summarize the different teaching styles applied in different practices:

1. *Mimesis*: imitation/copying (the teacher is teaching the student a specific movement or sequence of movements and the student follows the movement);
2. *Generative*: the teacher gives the student an exercise/phrase/sequence as a starting point to achieve technical and creative goals;
3. *Reflexive*: the student is given a movement task/image/to work with, improvising without trying to achieve a specific phrase/sequence and the teacher provides feedback. In this case the memorization ability of the student is challenged.
4. *Traditional*: (command style teaching), where the teacher makes all the decisions and the learner follows, while the teacher "commands" what the student must correct or change to achieve the good performance of the movement. The method requires precision and accuracy of performance.

According to the focus group, the aforementioned Learning Principles effectively cover the variety of teaching styles, which are indicated in literature for physical activity in general [4]. Common to all of these approaches, and to different levels, is information about imagery that may be auditory (sonic), visual or kinesthetic.

In consideration of the spatial and dynamic properties of dance techniques, the project is looking towards choreutics, which can be considered as a common vocabulary Spatial categories are: spatial progression, spatial tension, spatial projection, body design. The underlying theory is that different dance forms emphasize one or more of these categories. For example, the assumption is that ballet emphasizes 'body design' and contemporary dance 'spatial progression'. Categories of dynamics that emerge out of 'flow' in dance are: impulse, impact, swing, rebound, continuous. Similarly, different dance genres emphasize dynamic properties, and particularly interesting are the affinities or broken affinities between spatial and dynamic properties in identifying specific characteristics of a dance form/genre. Learning methodologies will vary, therefore, between dance genre, but common to all will be developing skills in performing variations of the following actions: step, run, jump, twist, stretch, swing, bend, balance, turn, extension, stillness, gesture.

For example, on one hand, in Contemporary Dance, the teaching may be focused more on teaching set exercises and phrases or may be more open to enable the student to develop their own response to instruction. In the latter, the teacher may focus on a body part (say 'spine'), providing information about where to be in the space, what visual image to use, what body parts to move, the 'internal' physiological processes in moving from stillness to activity.

The teacher responds to what the student does by feeding in more imagery (kinesthetic), and spatial or dynamic information – this may be both metaphorical and biomechanical. The improvisation for the spine forms itself into a repeatable sequence of movement, where the teacher can demonstrate or induce verbally a phrase of movement that is based on the same emphasis on the 'spine' and the same imagery. ~~The student responds through conscious embodiment to expand and hone movement that combines awareness of imagery, anatomical~~ The student responds through conscious embodiment, anatomical and mechanical structures and constraints, and physiological processes. They learn to manipulate abstract forms of kinesthetic imagery. In Ballet Dance, on the other hand, the student will move through a series of structured exercises and combinations of movements that focus primarily on: Balance, Coordination, Alignment, Musicality, etc. The teacher will usually demonstrate a sequence of movements and ask for a particular quality or effort, again using imagery.  The student responds and the teacher provides feedback to help the student enhance her/his response. Imagery is to support the biomechanical performance, for example 'imagine small fireworks under the toes' or may be more metaphoric 'imagine moving through treacle' or 'imagine moving like water tumbling over rocks' etc.

## MOVEMENT PRINCIPLES

The aim of the ProjectName is to develop learning tools which will be designed upon the principles of contemporary models of dance learning and teaching. The research will focus not only on teaching steps by mimicking, but also on enhancing the student's movement literacy, increasing the learners'ability to analyze her/his own movement, and enhancing movement skills that will feed into the development of the student's creativity, musicality and broader dance experience.
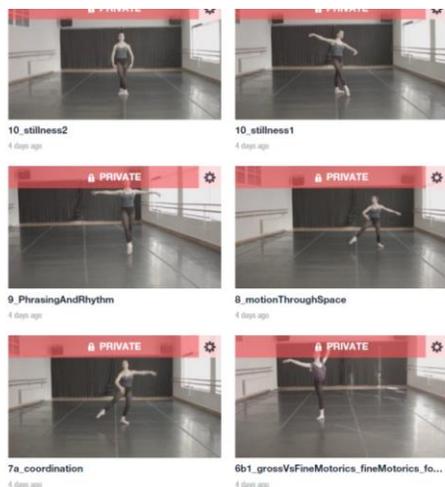


**Figure 1-Screenshots from the videos produced to demonstrate some of the Movement Principles for classical ballet**

Following the approach of the interdisciplinary focus group, we proposed ten essential *Movement Principles,* that can summarize the embodied skills which are to be improved in each dance learning process, independent of the dance genre and style. The *Movement Principles* are the following:

1. Symmetry: The use of the two sides of the body (right vs. left side, arm, leg) etc., both in position and while moving. The ability to do the same thing simultaneously or sequentially using both sides. Each Movement Principle includes also the opposite. Playing with asymmetry and isometry is included in this principle.

2. Directionality: The awareness of body orientation in space. Usually this is derived from the position of hips and torso, but interesting postures might derive from the various directions of each body part in relation to a space, e.g., the audience, the camera, the studio.

3. Balance: The ability to stand and move in balance, but also out of balance, depending on whether the line of gravity falls within the line of your supporting limb(s) or not. The awareness of the different vector forces on your body.

4. Alignment – Posture Stability: The awareness of the geometry of the body (e.g., the axes (sagittal, horizontal, vertical) and planes, and how the relations of different body parts and joint create "lines" in the body shape.

5. Weight bearing vs. Gesturing: This principle is about the difference between movement that is concerned with bearing weight (weight transference, stepping, hand stands, etc.) and movement (gesture) that is not bearing weight but which has intention/expression

6. Gross vs. Fine Motorics/Isolation/Articulation: The ability to distinguish small movements done by specific body parts e.g., hand or one hip, or one shoulder, without moving the rest of the body, vs. moving larger parts of the body as a whole.

7. Coordination: One of the most important skills practiced in every kind of dancing, which is about the ability to synchronize or not different parts of the body that can move in the same or separate tempos.

8. Motion Through Space: Progressing through space or towards particular directions, paths etc. "Moving through space vs. dancing on the spot.  Also the body as moving point in space, or as continuously changing moving volume.

9. Rhythm and phrasing. The ability to move in particular (predefined or improvised) rhythms. This principle is also about how the dancer's movement is related or not to the music and its rhythmical aspects (tempo, time signature, rhythmic patterns etc.).

10. Stillness. While movement seems to be the essence of dance, a dancer needs to improve her/his ability to remain still, whether this is a part of a choreography or

interpretation of rhythmical pauses, and exercise for balance and isolation of body parts. Stillness is usually connected to the notion of being present and has been investigated in previous interdisciplinary work. [2]

## PRELIMINARY OUTCOMES

A short questionnaire has been distributed among both technical representatives and dance experts in order to provide feedback on the following key questions:

a. Define a set of movements/movement sequences that are connected with the movement principle. (Dance Partners)

b. How important is this principle for your dance genre-style? (Dance Partners)

c. Give two examples-learning scenarios of teaching the particular principle. Which of the Learning Principles you would chose? (Dance Partners)

d. Do you see the connection between the movement principle, and the low level features we should capture analyze? Is there a challenge/obstacle? (Technical Partners)

e. Is there any related work in your institution in capturing-analyzing this particular movement principle?

For questions and c, the dance partners, were asked to provide video shots along with their answers for each Movement Principle. The main objectives of the questionnaire were the following: 1) to validate if the Movement Principles decided during the Focus Group are appropriate for the different dance genres and learning practices. 2) to identify any relation between the Movement Principles and the Learning Principles. 3) to collect an initial number of kinetic material described verbally and captured in videos, allowing the motion capture experts to create a relevant shot list. 4) to provide an initial reflection of how basic Movement Principles, which are dance genre and learning practices independent, can be mapped into low or middle level features i.e., objective measurable features that can be derived by a minimum data processing on signals coming from sensors or other input. While listing the movement principles we determined to exclude their qualities, as they are considered a higher layer of movement representation [1]. It is also predictable that many of the Movement Principles in practice, due to their holistic nature, show some form of overlap e.g. Alignment/Posture Stability and Balance. Also most Movement Principles can be found in systems of Movement Analysis like Laban Movement Analysis, e.g., Symmetry is one of the main aspects in Labanotation as the whole score is devised in two sides. Directionality can be easily interpreted to Laban's cube with the 27 directions (9 directions (Forward, Backward, Right, Left, Place, Diagonal FR, Diagonal BR, Diagonal FL, Diagonal B) and 3 levels (low, middle, high). In Labanotation [3] also the difference between the support and the gestures is very clear, as one column is dedicated for each case. Finally an initial categorization of the Movement Principles has been done depending on the static or dynamic nature of the principle. *Symmetry, Balance, Directionality, Alignment-Posture Stability* and *Weight bearing vs. Gesturing* can be indicated from both static and moving images (or captures), whereas *Coordination, Motion Through Space*, *Rhythm and phrasing, Gross vs. Fine Motorics and Stillness,* can be indicated only through motion tracking. Interestingly no patterns identified on the relation of Learning Principles and Movement Principles, as the Learning Principles seem to be more related to the Learning practice of the dance genre, e.g., in Greek Folk and Ballet there is a dominant preference on Mimesis and Traditional principle, whereas in Contemporary there is a higher preference for the Reflexive and Generative learning principle.

## CONCLUSION AND FUTURE WORK

In this paper we described the main objectives of ProjectName and preliminary work towards a methodology to find commonalities in different learning practices and dance genres and deciding and collecting the appropriate kinetic material in the form of shots to be tracked through motion capture. This preliminary theoretical framework will be further validated through semi-formal interviews and questionnaires, workshops, and focus-groups. For the data acquisition an iterative approach is foreseen, in order to take into account the actual needs identified both from previous stages of the capturing process, but also from involving the wider community through the questionnaires and the interviews.

## ACKNOWLEDGMENTS

## REFERENCES

1. Camurri, Antonio, Ingrid Lagerlöf, and Gualtiero Volpe. "Recognizing emotion from dance movement: comparison of spectator recognition and automated techniques." International journal of human-computer studies 59.1 (2003): 213-225

2. Gibson, Ruth. "Capturing stillness: visualisations of dance through motion/performance capture." Proceedings of the 2011 international conference on Electronic Visualisation and the Arts. British Computer Society, 2011.

3. Guest, Ann Hutchinson. Labanotation: the system of analyzing and recording movement. Routledge, 2014.

4. Mosston, Muska, and Sara Ashworth. "Teaching physical education." 2002.

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[1] The names are removed for the blind review.