

Conceptual and Experiential Dance Languages: Digital Representation and Interaction ^{*}

Katerina El Raheb

National and Kapodistrian University of Athens, Athens, Greece
kelraheb@di.uoa.gr

Abstract. While dance data that are related to movement are growing every day, the need for methodological frameworks and technological tools to represent movement and to manage such data is also growing rapidly. The objective is to make these data searchable, accessible and reusable. In parallel, the need for designing frameworks and workflows for the development of proper interfaces that are meaningful for the dance community is growing as well. We propose a formalisation for the modelling and enrichment of dance metadata and we suggest hierarchical vocabularies for annotating movement and its characteristics, aiming at searching archives using knowledge that is related to dance movement. The aforementioned framework is implemented and integrated in digital web-based interfaces, as well as embodied interactions that are evaluated by dance experts. In addition, the proposed model of representation can be implemented for the extraction of movement knowledge from motion capture datasets. Last but not least, the extensible nature of the framework, including all of the methodological, and technological tools can be investigated and applied in other use-cases for dance research, education and creative process, in the future.

Keywords: Semantic Technologies · Dance · Ontologies · Human Computer Interaction · Movement Computing · Embodied Interaction and Knowledge · Motion Capture · Labanotation

1 Introduction

As the title implies, we focus on giving an answer to two main research questions: a) What are the Conceptual Languages that we can use to represent dance and define its movement components in a way that make these subjects to semantic computation and management? b) What are the Experiential Languages that suggest meaningful digital interactions for dance that are directly targeting the dance practitioner or researcher? In other words, we suggest this separation between the conceptual and experiential aspects of dance, and we are discussing how we can transfer this to the digital.

Nowadays technologies can offer useful tools for recording, analysing, transforming and transmitting dance knowledge within a variety of contexts and purposes such as dance research, learning and education, supporting creativity and

^{*} supervised by professor Yannis Ioannidis

choreography. Such technologies can also support and enhance the preservation of intangible cultural heritage, and offer useful tools for the research of social, aesthetical, and anthropological aspects related to movement.

Contemporary technologies such as video, motion capture, computer vision, and experiences such as augmented and virtual reality, open new opportunities for experiencing dance content in a variety of contexts. In parallel, data related to movement and dance are increasing, demanding efficient and meaningful ways of online data management that facilitates findability, accessibility, reuse of existing digital movement segments for the community of dance practitioners. We argue that an interdisciplinary approach taking into account existing methodologies for dance analysis, is necessary for describing, analysing and enriching these data, as well as for organising the capture of data in future, and propose workflows for meaningful experiences.

Dance, integrating the universal human capacity for non-verbal communication and artistic expression, can be seen as a core activity that reflects the aspects of human societies, historical periods, cultures of specific regions, complex political and social dynamics, as well as human embodied identities [16]. While computer science can offer a useful tool for the transformation of the dance research, learning and creation, this can only be achieved successfully through a dialogue between the existing methodologies of the domain while, or even better before, applying technologies. Moreover, dance in comparison to other learning subjects or cultural domains present a variety of challenges due not only to the complexity of the human body and its movement, but also to the lack of standardized ways to describe movement in general, in a consistent, computational language, without presenting important limitations in terms of expressivity and capacity to describe the richness human movement. Of course, a variety of theoretical and computational attempts have been proposed the last decades and we discuss within this thesis. In fact, one of our main statements is that the computational analysis of human movement, especially if we are referring to dance, needs to take into account the theoretical background in movement analysis, Choreology and Anthropology of dance.

Our objective is to research the limitations of finding a general framework for dance and its digital transmission, while respecting its complexity and cultural diversity. To do so our use-cases range from transferring the semantics of formal notation to whole-body interaction experiences. We acknowledging the fact that one solution to fit all might be impossible and a universal upper-ontology to describe all kinds of dance would create a model that is far away from the reality of dance education, creation and practice. Thus our model suggests rather a modular, multi-layer and extensible approach, proposing a number of representational methodologies and workflows for design.

2 Approach

We address this problem by using tools from the Semantic Web technologies, such as Web Ontology Language (OWL), and propose an ontological perspec-

tive for the semantic representation of movement and dance. We ground our framework on existing theoretical systems for analysing and describing movement such as Laban Movement Analysis and Labanotation, as well as Choreological approaches that suggest an analogy between Dance and Language. While this analogy provides the tools for the structural and morphological analysis of movement, we extend this framework, to include both the Conceptual as well as the Experiential aspects of dance. We apply an iterative approach, investigating a number of use-cases of different dance genres and interactions.

This iterative approach includes not only a continuous study of the theory and semantics underlying formal descriptions of movement but also a continuous dialogue with notators and dance experts to build tools through a user-centered perspective. The tools that we have designed, developed and studied, integrate and evaluate our framework and conceptual model, consist of two main categories: 1) web-based dance data management and enrichment existing dance content, and 2) visualisation and whole-body interaction experiences.

The web-based annotation tools integrate a complete data and user management system and implement functionalities of searching the library of content with movement descriptors and characteristics.

3 Dance Documentation: a Challenging Problem

Dance documentation is an open challenge that has been investigated by dance researchers, notators, historians, anthropologists, and archivists, long before the emergence of digital technologies for recording movement, such as motion capture, or even video.

Many dance analysts, anthropologists, or dance therapists [26] still prefer formal archiving methodologies expressed in standard languages like Laban Movement Analysis [17, 18] and Labanotation [14] which provide a common vocabulary that enables communication among researchers for comparative analysis or future use.

Such notational or formal systems for describing movement are not a common practice for dance practitioners such as performers, choreographers and educators. On the other hand, the technologies of video recording have definitely revolutionised the way both dance researchers and dancers record movement for teaching, learning, archiving, observing, analysing, recreating in their everyday life.

Motion capture technologies, although not yet accessible for the wide audience due to high cost and complexity can generate 3D animation with high accuracy and can capture the 3D dimensionality of the motion and thus is an approach followed by many research projects and teams recently such as the WhoLoDancE [23] and iTreasures [1] EU funded projects, and other efforts [25].

It is obvious that motion capture technologies and expertise provide a powerful know-how for capturing a particular movement of a performer. It is worth mentioning that these technologies are mainly and widely applied in gaming and entertainment industry. Nevertheless, the methodological and analytical tools

that are needed for dance documentation, analysis and transmission is a highly complex interdisciplinary challenge.

Contemporary technologies for motion capture allow the recording of human movement with precision. On the other hand, the level of description of these data falls far from describing the movement in a comprehensive way for humans and machines. In parallel, since decades, many dance digital libraries exist online providing photos, audio and video content as well, as textual descriptions and scores written in specialised notation systems.

Capturing a dance can either mean anything of the following:

- capturing the movement and steps of dance, to revisit later, in order to enhance the sequence, memorize, or leave for the next generations.
- capturing a specific performance at a particular time and place.
- disseminating and sharing a performance to students, collaborators or audience.
- creating datasets for analysing movement and study a particular dance genre, culture or type of gestures and expressions.
- recording a performer, as an artist or a living intangible heritage representative.
- preserving intangible cultural heritage, including movement, steps, performer, and expression.
- communicating choreographic practices and share strategies.
- creating material for teaching a dance.

These are only some examples on why one would like to capture, record or document a “dance”, and depending on the purpose the available means of representation or devices for recording might be appropriate or not. For example, one cannot expect to have a satisfactory documentation using scores and notation, if the objective is to capture a specific dancer, as a living archive. The conceptual and symbolic nature of notation might be appropriate to analyse her steps but would not capture her flesh and bone performance in its totality, including expressions of face, personality and energy.

One of the challenges for designing meaningful tools for dance stem from the fact that dance is primarily an experiential, embodied activity, therefore the intention of the performer in terms of experience, what is actually done on a physical level and can be captured or measured, and what the observer can perceive or see. Loke [19] mentions the “The three perspectives in the design methodology” that occur in a movement based interaction experience. In fact, a similar triangle exists when it comes to capturing, recording as well as representing movement through notation or scores. The perspective of the performer, observer and machine or medium can never be aligned, however, a number of relationships are possible, as follows:

- The (human) performer acts and experiences the movement in a first person experience

- The (human) observer describes what the performer does, always limited by their own perception and priorities of focus. They have a third person experience as they create a representation using a machine/medium.
- The human (observer) reads the representation of movement as it is captured by the medium /machine, or creates a new representation (e.g., in case of descriptive notation).
- The machine (or medium) captures aspects of movement of the Performer, depending on its technical and expressional limitations
- The (human) performer reads the representation that is created either by the machine/medium alone or through the human observer to re-create a movement. (e.g., In the case of prescriptive notation or learning).

Another challenge stems from the fact that when we talk about dance it is important to take into account that although the capacity of humans to express through their bodies and dancing and is universal, there is a huge amount of dance languages, practices, techniques and approaches. This work deals with the representation and analysis of movement, focusing on the transmitting and processing of dance genres that rely on particular forms with the intention to describe, search and re-use in digital environments mainly from the perspectives of intangible cultural heritage and education.

When it comes to describing movement another duality that has been introduced by cultural anthropologists is important: the difference between Etic and Emic [13] perspective on analysing and documenting the structural elements of a language. While in the Etic approach the identification of the important components is done by the observer, the outsider or the scientist, in the Emic approach the distinction is based on the perspective of the community that uses the language. Kaeppler's definition of structural components of dance morphology is based on an Emic approach [15].

4 Movement Semantic Representation

The semantic representation of movement includes many challenges, due to a variety of reasons such as the following:

- No unique framework on dance description or standard definition of dance data, format or management technique
- Gap between research and practice, no written language is actually used by practitioners
- Syntactic and semantic heterogeneity of movement data
- Labanotation provides a rich but complex language, that expressive but resembles physical language (it is symbolic and in some cases ambiguous)
- Dance Representation, implies Space/Time Representation
- Segmenting the continuous movement and defining the *Movement Entities*, i.e., the parts that are separable or important
- Diverse provenance of information: e.g., part of Intangible Cultural Heritage, artistic creation, social expression and part of syllabus or educational subject

Potential uses of semantic representation for data heterogeneity on the level of connecting information can contribute to the following

- Synchronisation of files.
- Naming and organizing the files (metadata standards).
- Syntactic and semantic Interoperability.

In this context, semantic representations of movement based on existing Choreological, notational, and educational approaches for expressing and describing dance movement can contribute to narrowing this gap, to provide a language for movement annotation search, analysis, segmentation and composition.

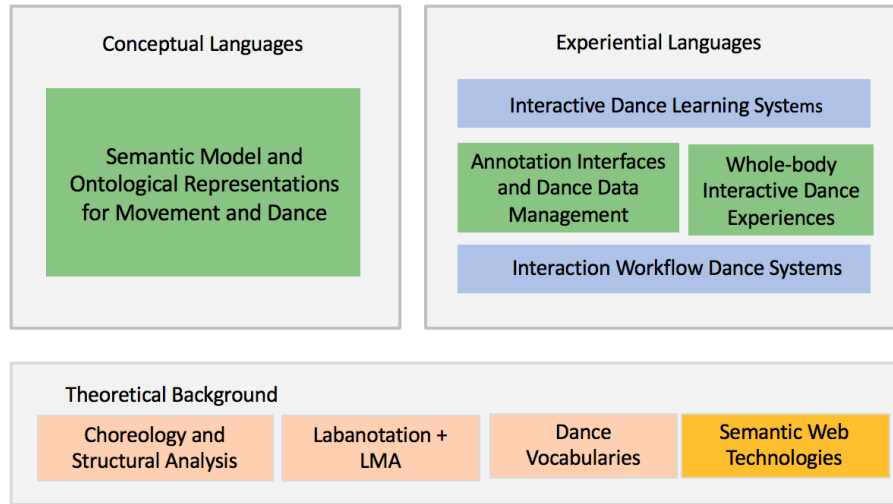


Fig. 1. Overview of the thesis theoretical background, methodology and contribution

5 Main Outcomes and Results

The detailed theoretical background, methodologies, results and outcomes, for identifying and targeting the research questions can be found in the dissertation manuscript [2], as well as in the related published journal and conference articles.

Based on our motivation to address issues of digital dance documentation and movement semantic representation, this research extends in the field of designing and developing technological approaches to dance preservation, search and interaction through a number of use cases.

In our articles [3, 4, 6, 5], we present the theoretical background and methodology, which consists of the notation system of Labanotation and Choreological

methodologies that suggest an analogy between Dance and Language in different levels. In the same subset of work we explain how we use this analogy for defining movement entities and formalizing structures of dance.

In the aforementioned work set, we present our first contribution which consists of the semantic model and ontological representation for describing the Conceptual aspects of Dance (Fig. 1). We have explored existing notation system, and Labanotation in particular, and created an ontology that uses the Semantic Web technologies for representing movement and dance. We describe the multi-layer approach that resulted for the transferring of semantics (from Laban to OWL) and the iterative approach of extending and enhancing the ontological representation.

The initial ontologies and framework have been extended to formulate different versions of the ontologies (MoveOnto, and DanceOWL) [4–6] and to extend an analogy between dance with language, and with music scores [6, 20]. We also examine the relationship of our model with conceptual models for CH, and define the role of the Recording, Score, Dance Entities, and Movement Entities and their relationship [4]. Finally, we formalize the most challenging parts of movement representation and discretisation, such as body and temporal aspects. The use-case for creating the knowledge base deal with examples for Greek traditional and folk dances.

Based on the aforementioned models, our next target focuses on how to use such models in web-based environments and creating tools for manual and semi-automated annotation [10, 9, 7]. We introduce the potential and challenges of manual annotation for dance and its application in various context of use (education, practice, choreography, research, analysis). We present concrete use cases, of designing, developing and evaluating annotations tools. The first of this tool is the BalOnSe, a tool for semantic annotation and search of ballet movement and vocabulary. We present two versions of its development. In the first version, we created an extension to our ontology presented in [3] for representing Ballet syllabus, which we incorporated in web-based system and interface [10]. In the second version of the system [9], we extended the rules expressed in the ontology and used DatalogMTL to deal with the challenge of temporal representation and reasoning.

Finally, the Web-Movement Library, is a use case where we have used and extended the semantic model to manage and annotate a large number of both videos and motion capture archives coming from four different dance genres (Greek folk, Ballet, Contemporary and Flamenco). In this use case [7], we present not only the semantic issues that related with movement representation and dance vocabularies but also with the Human Computer Interaction (HCI) challenges [8] that emerge in co-designing such annotation tools with dance experts. Such challenges are not only conceptual and semantic challenges related to segmenting and naming movement, but extend to the experiential domain posing design questions such: how the user selects annotations, how the body is visualised, and how to deal with annotations subjectivity.

The third set of use cases are targeting the Experiential and HCI challenges that are related to the design of digital interactions for dance. Our work in this use case, consists of a Survey on existing Digital Interactive Learning Systems, that use motion capture and virtual experience [22]. We also present one of such applications, Choreomorphy that is used as body and movement visualisation tool in real time, and we present the results of user study with dance experts [11, 27]. Finally, we present a workflow that can be used as a guide for designing and evaluating embodied experiences for dance [22].

6 Future work and Open Issues

In terms of extending the ontological representation of movement and dance, and since our proposed model and methodologies are extensible one of the future works includes the inclusion of other dance genres, than the ones examined. This extension is also possible to other contexts such as education, including information about the process of learning, interrelations that are meaningful for teaching particular dance genres and syllabi.

In addition, the conceptual framework, in combination with the workflow can be used as way to inform interactive virtual experiences based on particular categories of dance. Such ontological perspective applied to the actual digital experience that can implemented using motion sensing camera, and or VR/AR experiences. Technology and digital representation can reshape the form and take apart the morphology of the human body. This enables a huge amount of possibilities in terms of transformation not only of forms, and shapes but also of the qualities, amplify or diminish particular aspect and their transmission.

Many open challenges both on manual and automatic annotations of movement can be discovered. On one hand there is the open challenge of automatically annotated movement and apply machine learning techniques or computer vision to discover patters and similarities. On the other hand, designing tools that can gather reliable datasets of annotations that can work as ground-truth data to train algorithms is a complex HCI and semantic challenge on its own. These challenges are due again to the fact that there are no agreed vocabularies for describing and analysing movement, and even if systems like Laban Movement Analysis are used and experts are involved [12], these subjectivity of describing movement cannot be erased. This is also due to the triangular relationship that we mentioned between the Performer, Observer and Medium/Machine above in this paper.

Finally, one of our future works in includes the application of the semantic representation and hierarchies as decision trees, to define the states in Machine Learning algorithms in order to discover movement motifs and patterns in higher level from big motion capture datasets.

7 Conclusions

In the core of this thesis in the analogy of Dance and Language, as a methodological tool for analysing, managing, representing and transmitting movement knowledge using information and communications technologies.

This analogy, extends the methodological tools of Choreology and Dance Anthropology that has been applied for studying the morphology and structure of dance. This analogy suggests handling the different dance practices and genres as different languages that they have their own syntax, semantics, grammar and vocabulary.

Different methodological tools originating from Choreology and Dance Anthropology integrate this analogy of language and dance to define the structural movement units of dance. What is characteristic of Kaeppler's model that we focused on is that the structural analysis, is Anthropological rather than Choreological. One of the reasons why we focused on this particular perspective is that it aims at creating an inventory of Movement Entities. So in this approach, the Movement Entities are defined first, and the the characterisation of them as structural elements of the Dance Genre into Kinemes, Morphokines, Motifs, etc, comes at a second stage. This is very interesting for us for two reasons: 1) this methodology starts by identifying these entities with the consideration that these entities have an existence and life on their own. These methodology suggest that movements exist firth then they can then be furthered organised to form the dance, rather than start with a particular dance and analyse it or segmenting it. This way, each of the recognisable movement entities has its own existence within the language system, and can be re-used, or even belong to other movement and gestural languages, besides dance. 2) The definition of these movement entities relies on an *Emic* approach, which means that the identification of a movement as a meaningful entity, its categorisation into the structural hierachy and distinction from other entities, is done by the community of those who speak or dance this language, rather than the observer or the researcher (*Etic* approach).

Both characteristics are very important when it comes to translating this methodology into a model for digital representation and analysis of movement, as the first puts in the center the idea of an inventory of movement entities that can be re-used, composed, tranformed or come together to form a bigger sequence. The second characteristic of Kaeppler's methodology, related to Emic approach, highlights the importance of the community's perspective and understanding of movement elements not only when it comes to designing the final interface, but from the very begining of representing movement. In other words, it answers to the question of what are the movement entities that we can find within a movement language based on the practitioners perspective, the people who use and develop the language.

The focus on language has also been introduced on another level. When defining a Movement Entity as a smaller or bigger unit of a dance practice, there are many (Conceptual) languages that one can use to describe the exact same motion or position. These Conceptual Languages can include verbal descriptions, terminology of the specific dance vocabulary, idiosyncratic key words, or formal

notational languages such as Labanotation, as well as symbolic, abstract or specific scores. In this thesis, we proposed a multilayer approach for distinguishing these languages, formalizing them using Semantic Web Technologies (OWL) and other computational languages (DatalogMTL).

On the other hand, the exact same Movement Entity, not only can be described and represented using different Conceptual Languages, but can be implemented and embodied creating different Experiential Languages. Within an interactive learning or creative experience the exact same Movement Entity can change its Experiential characteristics, expression, meaning and functionality depending on the purpose, context, visualisation, body representation, mode of interaction.

Although in practice the Conceptual and Experiential aspects are inseparable, this dualism allows to handle the challenge of documenting, recording and digitally transmitting dance information related to movement. Taking advantage of the Conceptual Languages we can organise the explicit knowledge that exists within any dance practice, while the Experiential Languages can guide the creation of new digital experiences acting as an analogy of human-human interaction to human-computer-interaction.

Dance is usually seen as the ephemeral art, and its lifecycle starts and ends with the event of the human performer embodying the dance. Motion capture and video can record the performance in a digital form but this is not an extension of this lifecycle, but rather a transformation of it. Conceptual Languages such as scripts, notations, verbal descriptions terminologies, abstract scores, or grammar and syntax of the language can provide the description, prescription or in the best way a kind of transcription of the dance. Experiential Languages, i.e., all the embodied knowledge that is developing on the dance floor, in the studio, or dance classroom can be used as a guide to evaluate all the fragments of the actual dance have remained in the aforementioned transformations and descriptions of dance. If organised appropriately they can create a new meaningful experiences for observing, analysing, or learning dance through the digital medium.

This interrelation between the actual dance, its representation, recording and transmission through the digital, although will never recreate the original, embodied experience of dancing can open a numerous options for re-experiencing dance in its digital environments. One of the main conclusions of this thesis is that semantic representation for dance, as well as the design of dance applications, is a challenging interdisciplinary domain, that requires collaboration between computer scientists, dance experts, as well as other domains.

While the need of applying technologies for recording, analysing and transmitting dances that are considered cultural heritage that requires research and preservation, is obvious, the integration of state-of the art technologies in the embodied practice, poses many HCI challenges.

The lack of a universal written language or system that is applied for the conceptualisation of dance in general, as it is the case with the western music notation/theory, makes digital dance research a very challenging domain. This

lack of standards, and written languages, combined with the diversity of dance practices and genres can largely benefit from prototyping, iterative user-centric approaches, as well as participatory and co-design methodologies for drafting requirements and specifications. In addition, dance practitioners can play the role of movement experts, contributing to the field of HCI and especially the field of embodied interaction in very fruitful manner.

As Schacher [24] describes, the analysis of movement with computing tools is a paradox that can be turned into a productive dilemma only under an interdisciplinary lens. Not surprisingly, McBride [21], argues that dance research is the sister discipline of information system not only for its practice-based nature compared to other scientific fields, but also for its deep connection with cultural aspects. Therefore, the dialogue between computer science and dance can be either considered as a strange dichotomy, or it can be seen as an opportunity cross fertilisation in many ways.

References

1. Dimitropoulos, K., Manitsaris, S., Tsalakanidou, F., Nikolopoulos, S., Denby, B., Al Kork, S., Crevier-Buchman, L., Pillot-Loiseau, C., Adda-Decker, M., Dupont, S., et al.: Capturing the intangible an introduction to the i-treasures project. In: 2014 International conference on computer vision theory and applications (VISAPP). vol. 2, pp. 773–781. IEEE (2014)
2. El Raheb, A.: Conceptual and experiential dance languages: digital representation and interaction. Ph.D. thesis, *Εθνικό και Καποδιστριακό Πανεπιστήμιο Αθηνών (ΕΚΠΑ)*. *Σχολή Θετικών Επιστημών* (2019)
3. El Raheb, K., Ioannidis, Y.: A labanotation based ontology for representing dance movement. In: International Gesture Workshop. pp. 106–117. Springer (2011)
4. El Raheb, K., Ioannidis, Y.: Dance in the world of data and objects. In: International Conference on Information Technologies for Performing Arts, Media Access, and Entertainment. pp. 192–204. Springer (2013)
5. El Raheb, K., Ioannidis, Y.: From dance notation to conceptual models: a multi-layer approach. In: Proceedings of the 2014 International Workshop on Movement and Computing. pp. 25–30 (2014)
6. El Raheb, K., Ioannidis, Y.: Modeling abstractions for dance digital libraries. In: IEEE/ACM Joint Conference on Digital Libraries. pp. 431–432. IEEE (2014)
7. El Raheb, K., Kasomoulis, A., Katifori, A., Rezkalla, M., Ioannidis, Y.: A web-based system for annotation of dance multimodal recordings by dance practitioners and experts. In: Proceedings of the 5th International Conference on Movement and Computing. pp. 1–8 (2018)
8. El Raheb, K., Katifori, A., Ioannidis, Y.E.: Hci challenges in dance education. *EAI Endorsed Trans. Ambient Syst.* **3**(9), e7 (2016)
9. El Raheb, K., Mailis, T., Ryzhikov, V., Papapetrou, N., Ioannidis, Y.: Balonse: Temporal aspects of dance movement and its ontological representation. In: European Semantic Web Conference. pp. 49–64. Springer (2017)
10. El Raheb, K., Papapetrou, N., Katifori, V., Ioannidis, Y.: Balonse: Ballet ontology for annotating and searching video performances. In: Proceedings of the 3rd International Symposium on Movement and Computing. pp. 1–8 (2016)

11. El Raheb, K., Tsampounaris, G., Katifori, A., Ioannidis, Y.E.: Choreomorphy: a whole-body interaction experience for dance improvisation and visual experimentation. In: AVI. pp. 27–1 (2018)
12. Fdili Alaoui, S., Carlson, K., Cuykendall, S., Bradley, K., Studd, K., Schiphorst, T.: How do experts observe movement? In: Proceedings of the 2nd International Workshop on Movement and Computing. pp. 84–91. ACM (2015)
13. Harris, M.: History and significance of the emic/etic distinction. *Annual review of anthropology* **5**(1), 329–350 (1976)
14. Hutchinson, A., Guest, A.H.: *Labanotation: Or, Kinetography Laban: the System of Analyzing and Recording Movement*. No. 27, Taylor & Francis (1970)
15. Kaeppler, A.L.: Method and theory in analyzing dance structure with an analysis of tongan dance. *Ethnomusicology* **16**(2), 173–217 (1972)
16. Koutsouba, M.: Dance dynamic in post formed procedures in the formation of local cultural identity. In: Proceedings of the 1st Greek Conference for the Culture. pp. 205–210 (1999)
17. von Laban, R.: *The language of movement: A guidebook to choreutics*. Plays, inc. (1966)
18. Laban, R., Ullmann, L.: *The mastery of movement*. (1971)
19. Loke, L., Robertson, T.: Moving and making strange: An embodied approach to movement-based interaction design. *ACM Transactions on Computer-Human Interaction (TOCHI)* **20**(1), 7 (2013)
20. Ludovico, L.A., El Raheb, K., Ioannidis, Y.: An xml-based web interface to present and analyze the music aspect of dance. In: International Symposium on Computer Music Multidisciplinary Research (CMMR). pp. 631–639 (2013)
21. McBride, N.: Is information systems a science? *Commun. Assoc. Inf. Syst.* **43**(1), 163–174 (2018). <https://doi.org/10.17705/1CAIS.04309>
22. Raheb, K.E., Stergiou, M., Katifori, A., Ioannidis, Y.: Dance interactive learning systems: A study on interaction workflow and teaching approaches. *ACM Computing Surveys (CSUR)* **52**(3), 1–37 (2019)
23. Rizzo, A., El Raheb, K., Whatley, S., Cisneros, R.M., Zaroni, M., Camurri, A., Viro, V., Matos, J.M., Piana, S., Buccoli, M., et al.: Wholodance: Whole-body interaction learning for dance education. In: CIRA@ EuroMed. pp. 41–50 (2018)
24. Schacher, J.: What quality?: Performing research on movement and computing. In Proceedings of the 5th International Conference on Movement and Computing (MOCO '18) pp. 1–9 (2018). <https://doi.org/https://doi.org/10.1145/3212721.3212834>
25. Stavrakis, E., Aristidou, A., Savva, M., Himona, S.L., Chrysanthou, Y.: Digitization of cypriot folk dances. In: Euro-Mediterranean Conference. pp. 404–413. Springer (2012)
26. Tsachor, R.P., Shafir, T.: How shall i count the ways? a method for quantifying the qualitative aspects of unscripted movement with laban movement analysis. *Frontiers in psychology* **10**, 572 (2019)
27. Tsampounaris, G., El Raheb, K., Katifori, V., Ioannidis, Y.: Exploring Visualizations in Real-time Motion Capture for Dance Education. Proc. 20th Pan-Hellenic Conf. Informatics pp. 76:1—76:6 (2016). <https://doi.org/10.1145/3003733.3003811>, <http://doi.acm.org/10.1145/3003733.3003811>