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WhoLoDancE: Digital tools and the dance learning environment.

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WhoLoDancE: Digital tools and the dance learning environment.

The focus for this paper is on the WhoLoDancE EU Horizon 2020 project and the tensions between the technology and the potential impact on dancer education – the aspirations versus the realities. We explore how neuroscientific concepts can help to understand the embodied experience of working with digital tools in a mediated learning environment. The paper focuses on scoping the literature that contributes to our thinking about the use of avatars and learning in the dance studio. The authors draw on neuroscience and education theory, supported by experience from developing the tools to offer insight into what technology in the dance studio could offer. We explore the possible potential for WhoLoDancE to contribute to future technologies for dance education and creation, and what opportunities might arise for teachers, learners and choreographers.

Keywords: Digital tools, avatars, virtual reality, technology, learning environment, education, teaching.

Introduction

Dance is a diverse art form that is learnt and practiced for a number of reasons. Whilst some dancers train for a career as a performer or choreographer, others may want to learn and participate in dance for social, educational, recreational or therapeutic reasons. What is common to all dance learning and practice is time spent on developing and honing the technical, physical and expressive properties of the dance form. Each dance form will emphasise or prioritise these properties differently but the traditional method for learning is in a live body-to-body situation where the teacher/facilitator is working directly in contact with the learner (Chan et al 2011). This environment is one where information may be shared in multiple ways, through physical demonstration, touch, conversation, verbal cuing and instruction.

This paper aims to explore literature drawing from neuroscience, education and technology to build a context for the Horizon 2020-funded WhoLoDancE project and its potential impact within dance education environments. The reference to diverse

theoretical areas is necessary to be able to probe the implications for the digital tools that have been developed within the project. We discuss and explain how these tools could be used within the dance learning environment and their potential for allowing dance teachers and learners to reflect on and develop their understanding of what can be possible within a studio context. In order to begin to structure a framework for this discussion, we will look towards different theories, concepts and modes of thought (such as imagery and neuroaesthetics) to generate insights about what the project might offer to dance teachers, learners and dance makers, who may be new to digital tools, or already familiar with digital environments.

The WhoLoDancE project brings together 10 consortium partners based in the UK, Greece, Netherlands, Italy and Spain. The project, spanning three years from January 2015 to December 2018, is primarily focused on developing proof-of-concept digital tools that will assist with dance education and creation. Partners include dance researchers, professional dance companies, computer scientists, developers and motion capture experts. The partners thus span a range of experiences and expertise, providing a rich working environment wherein knowledge about dance practices and pedagogy has been shared, assumptions questioned and a common ground established.

Ideokinesis to Neuroscience to Avatar

Core to the project and the tools that are being developed is an exploration of how the corporeal dancing body interacts with digital avatars and responds to virtual environments. The act of creating an avatar of the dancer, and the dancer seeing herself as an avatar, and to mirror that dancing avatar, encourages the dancer to attend, and respond to the intricacies of the action and movement qualities. These responses have the potential to open up new modes of learning and new understandings about how

dancers relate to their own dancing image and to support autonomous learning. Exploring how an avatar can encourage the dancer to attend and respond to their idiosyncratic movement actions, we turn to ideokinesis and neuroscience to inform our understanding of movement perception and kinesthetic engagement. The roots of this research go back to the texts of practitioners who were working nearly a century ago, but are still a key reference for dance pedagogues today. For example, Mabel Ellsworth Todd's late 1930s work *The Thinking Body: A Study of the Balancing Forces of Dynamic Man* offers insight into the biomechanical forces behind the relationship between human movement and alignment. This was later followed by Lulu Sweigard's 1974 book, *Human Movement Potential: Its Ideokinetic Facilitation*, which is still studied as one of the primary texts on the use of imagery in dance (Overby and Dunn 2011). Sweigard developed this neuromuscular reeducation from her time spent as one of Todd's students and, fundamentally, used imagery to retrain the body to posturally align and move more efficiently. A guiding principle of the work was for the dancer to observe and be attentive to her own movement patterns.

The research of Todd (1937) and Sweigard (1974) has been crucial for the development of many other body work techniques such as Feldenkrais and Alexander Technique. It has fed somatic dance practitioners, influencing, amongst others, the work of and writing about experiential anatomy (Olsen and McHose 1998) and Body Mind Centering® (Bainbridge Cohen 1993). This work has served as the foundation for thinking about kinesthetic perception and has informed creative movement explorations. Parallel to these investigations, neurophysiologists; di Pellegrino and colleagues, discovered mirror neurons in macaque monkeys (1992). Over the next decade, mirror neurons became a widely studied neuroscientific concept and one where dancers became a popular choice to research (Calvo-Merino et al 2005). The work of Calvo-

Merino et al is now widely cited for their work with expert ballet dancers, and their findings that when expert ballet dancers watched ballet movements from their own motor repertoire, activity was seen in the brain areas known for mirror neuron activation (the sensory motor cortex). When the same ballet dancers watched movement performed by capoeira dancers that was similar to ballet vocabulary, activity was seen in the same area but activation was not as strong; this also happened vice-versa when the capoeira dancers watched ballet movements. The non-expert observers showed less activation when watching both forms of movement.

A conclusion from Calvo-Merino et al's study is that when we have movement in our own repertoire, there is greater activation in the human mirror system thus showing an entrainment effect. Entrainment effect is a technical term employed in neuroscience to describe the learning of locomotor action through sensory feedback (Rossignol, Rejean et al 2006). In addition, their research reveals the neurological functioning of observing and how we observe another person's movement or actions with greater activation if we have performed those movements previously. There is a close correspondence between the pattern of neural activity recorded while observing, imagining and performing the same action (Rizzolatti and Craighero 2004; Rizzolatti et al. 2001). Therefore, we have considered whether dancers interacting with dancing avatars, and visualisations created from data of dancers, is a form of entrainment and observation that may play a role in enhancing the role of imagery in the dancer's learning and performing process.

The theories that have emerged from the discovery of mirror neurons links to the process of 'mirroring', which is a familiar activity for dancers who may learn through mirroring, whether mirroring the teacher, another dancer, her own image (projected from a physical mirror) or in an immersive environment, which may allow the dance

learner to work in their own time and play with how they mirror what they see and experience (whether their own image, avatar, or that of another). Acharya and Shukla argue that the process of mirroring involves mirror neurons (2012). They further suggest that mirror neurons create a direct link between the sender of a message and its receiver and, through the mirror mechanism, actions done by one individual become messages that are understood by an observer without any cognitive mediation. If these mirror neurons activate both in the performance of actions and in the perception of actions, then the process of using an immersive digital dance environment could encourage the learner to imitate the bodily movements of others on screen in an immediate way. Moreover, mirror neurons may allow the dancer to perceive and understand intention in the projected image.

Mirroring and mapping also become increasingly important when learning and thinking about the acquisition of embodied, or tacit knowledge in dance. This has stimulated broader thinking in the project about the dance learning process and has raised two key questions: How is tacit knowledge communicated and transmitted in dance? Are there ways to use digital technology to help unearth, deepen or learn about tacit knowledge information? These have emerged as the project wrestled with the inevitable tensions between making the technology 'work' and be usable for the dance community whilst keeping the research open to finding out both the possibilities and limitations of the technology. To help unpack this further we turn to Stephen Turner (2014) and neuropsychologists who have studied dance and the body, and have shared views about how knowledge functions in dance learning.

Turner (2014) states that when implicit knowledge is made explicit, what is communicated is not implicit knowledge per se, but "functional substitutes for bits of

tacit knowledge for particular audiences and particular purposes, invented on the fly" (2014, 171). He offers:

> Explicit knowledge is transmitted through explicit means: speech, texts, and so forth. To the extent that tacit knowledge is transmitted, it requires, by definition, other means. The problem arises from the analogy between the "knowledge" that is tacit and the knowledge that is articulated when what is tacit is made explicit. If we think that these are the same thing, or more or less the same thing, the knowledge will come in the form of articulable assumptions and the like. And we will need an account of transmission that transmits these kinds of things tacitly. (Turner 2014, 170-171)

Turner further suggests that representations or concepts are the sorts of things we can "make explicit" (2014, 171). Links could be made here between the process of making tacit knowledge explicit and the acquisition of knowledge through experiential learning, which may influence the use of technology and learning environments within specific education settings, such as the dance studio.

Around the same time, Bläsing et al (2010) conducted research on cognitive and neural processes implicated in the generation, execution, expression, and observation of dance movements by the dancer and dance spectator. Their work suggests that dance training has the potential to influence basic functions underlying motor control, including posture and equilibrium control, facilitating the performance of complex movements via dancers' special skills in body alignment and balance tasks. Neuroscientists' work with dancers has contributed to the notion that watching motor actions that are perceived by a dance learner as *familiar* stimulates certain parts of the brain including motor neurons. The process of learning, copying and repeating dance phrases or sequences by a dance learner stimulates sensory and motor circuits; the interdisciplinary research of neuroscientists working with dancers offers insight into this relationship. The inclusion of this experimental and cross-disciplinary approach to

dance research opens up new ways of thinking about what happens when dancers work with digital technologies.

Education, dance and technology

The educational objective of the WhoLoDancE project, as listed on the project website, is to "disrupt the conventional mode of communication in teaching" through the use of technology. It is intended that this disruption could enhance the learning experience of the student, encouraging autonomy through reflection and encouraging both teacher and student to work interactively with the technology in order to construct new knowledge concerning technical, physical and creative processes. Fundamental to achieving this objective is the creation of an immersive environment, to emphasise the process of 'doing' as an educational learning method, fostering physical understanding through practical engagement and virtual experience. The concept of experiential learning was widely explored by the philosopher John Dewey (1969) and further developed more recently by learning theorist David Kolb (2015). Dewey's (1969) early work in developing a theory of learning through experience criticises 'traditional' teaching approaches and educational theory, arguing that learners should contribute to the construction of new knowledge, rather than having bodies of knowledge and information, which have been constructed from past generations, simply transmitted and reiterated as it was first, traditionally, taught. Kolb (2015) built upon Dewey's philosophy of experiential learning by developing a model for the learning process itself that, although focused on scientific inquiry, has been valuable for arts researchers, including those located in dance pedagogy (Risner & Barr 2015; Ross 2012; Stinson 2002).

While experiential learning may be misconstrued as pertaining only to apprenticeship education or ‘on the job’ learning environments, the concept of learning through experience is, according to Dewey, concerned more with advancing learning and education beyond ‘traditional’ modes of delivery (1969). As emphasised by Kolb (2015), tools required for the working environment are developed through experiential learning, and one of these tools is reflective practice. Experiential learning emphasises the link between educational learning and work practices, with the learner closely engaged with the realities of true working experience. Therefore, the experience of using the WhoLodancE tools within a learning environment will, it is hoped, encourage reflection whilst interrogating, and perhaps disrupting, traditional modes of dance education delivery, examining the ways in which technical ability is acquired as preparation for the demands on the working dancer and performer. Additionally, the use of technology within an experiential learning framework could aid the transition from dance study to dance employment.

Research regarding the use of technology within educational dance contexts is a relatively fresh area of study, but a growing one nevertheless, with a number of research studies (Huddy 2017; Doughty et al. 2008; Risner and Anderson 2008) being conducted in the past decade that have investigated the effect(s) of using technology within the dance studio as a learning environment. The theoretical debates concerning the use of technology within education are complex, with some academics (Selwyn 2013) encouraging the consideration of power relations and globalisation to be considered when exploring education and technology, considering who has access to technological teaching tools, where, how and why, something that is a consideration regarding the wider use of the WhoLoDancE tools. In higher education the use of E-Learning environments has been documented (Brenton in Fry, Ketteridge and Marshall 2015),

especially with the rise of distance learning courses and Universities' expectations regarding lowering paper consumption. However, some researchers suggest that the response by higher education institutions to the developments and technological advancements have been too slow (Bertrand 2010). Nonetheless, there has been more recent advancement regarding the type of technology used in learning environments or as a learning activity, such as Damewood's (2016) report on the utilisation of 'simulation' and its benefits in providing more active, realistic engagement with the subject being studied. This could be seen as an advancement of the experiential learning developed by Dewey and Kolb, but with emphasis on interaction with technological advancements to provide appropriate learning experiences for learners who are living in an age of technological saturation.

Looking specifically at the use of Virtual Reality (VR) in alternative educational environments can lead us to explore two significant areas of research: VR use in teacher education and the use of VR in medical education. For both of these disciplines (medicine and teaching) there is increasing evidence to suggest that VR technologies are being (and should be) used more in practical application environments (classrooms and hospitals) as well as within training scenarios for teachers and medical staff (Székely and Satava 1999; Hettinger and Haas 2008; Keskitalo 2011). Therefore, it could be suggested that engagement with VR technologies during training might be essential in order to develop the knowledge, understanding and skills to implement its use within practice, once qualified. When referring to the use of VR and virtual environments within medical spheres, there are multiple discussions raising common concerns. These include the ethical implications of VR use, the level of abstraction from a realistic environment for the learner and the cost of using this technology. However, as communication science academics Mantovani et al (2003) state, the use of VR in

medical training can provide an innovative and immersive learning experience, which enables learners to engage with scenarios that might be too costly or complicated to facilitate in the real world. Additionally, the elevated interaction level required for engaging with VR technologies can help develop motivation and improve engagement levels with the learning material.

The use of VR in teacher training, including classroom simulation, is relatively new and not currently common practice, perhaps due to similar concerns to those stated above regarding its use in medical training. However, there is growing support for its increased use in both teacher training courses and in education environments. It has been emphasised how training courses are places of learning, where high quality practice is not finite and the learning process can include learning from mistakes, and trial and error. Therefore, as teaching scholars Day and Macfarlane (2017) suggest, the time and space provided by VR use, enables teachers to learn, experience and reflect on their practice within a safe environment. Essentially they are allowed to take risks and make mistakes without "negatively affect[ing students] through a process of teacher trial and error." (39). Additionally, learners can experience scenarios within training that they may not experience whilst on placement, depending on their institution. For example, exploring the scope and spectrum of inclusion and diversity through virtual objects such as *Incluir,* a virtual learning object designed to assist in training teachers with a specialist focus on inclusion environments (Bisol, Valentini and Braun 2015).

Engaging with virtual environments within teacher education training is described by experts in Learning Technologies and STEM Education, Calandra and Puvirajah (2014), as a fourth space for developing knowledge and skills. The prior three spaces are: the learning that takes place in the mind through study, the mind-body interaction of micro-teaching and role play scenarios, and finally the body-environment

reality of classroom based experiences. The inclusion of this 'fourth space', Calandra and Puyiriah argue, provides social interaction as well as a sense of presence. This suggests that the virtual experience for learners goes beyond just interacting with elements in the virtual realm, but also allows space for "exploring certain aspects of their identities in ways not necessarily feasible in the real world" (Calandra and Puyiriah 2014, 32). Therefore, the process of engaging with VR in training environments can provide important reflective opportunities as well as social engagement that might not be achieved otherwise. In a dance context, this could be especially important for practitioners who are isolated from other dance practitioners and often have to work in solitude. The use of VR in medical and teacher training shows the broad value for encouraging autonomy in the learner and it is this aspect that links with how we anticipate the WhoLoDancE VR environment to work for the dance learner.

The emphasis in WhoLoDancE is on allowing the learner to better understand both their practice and particular dance style(s) through providing alternative modes of viewing, and thus to support engagement in new reflective experiences. Reflective practice, a theory integral to Kolb's (2015) concept of experiential learning, can be seen as a political and social responsibility, as education academic Bolton (2014) suggests, whereby learners reflect on experiences, interrogating them in order to reveal new knowledge about and understanding of these experiences. The tools developed in WhoLoDancE are not intended to be limited to learners in an HE context but a greater emphasis on reflective practice in HE could suggest its value here, although these practices can be transferred to other learner experiences. While the practice of reflection within higher education is highly encouraged, it is not always achieved without its challenges (Davis 2003). However, educational scholars Fry, Ketteridge and Marshall

(2015) put forward a more positive and proactive approach to the concept and the role of reflective practice within higher education, stressing how it can be viewed as developing professional and employability skills needed to interrogate experiences and uncover new understanding.

Traditional forms of reflection in an educational context tend to be grounded in reflective writing rather than encouraging more embodied forms of reflection. For the dance learner, reflection can be developed through a range of modes, including writing, but deep reflection can be developed through observation and through self-analysis of the body moving. Technology can participate in increasing engagement with reflective processes and reflective learning practices, not to undermine the place of embodied reflection but to provide additional ways to access reflexivity. Additionally, a study by Dutch educational researchers Leijen et al (2008) found that that a key priority of dance teachers in creative and technique classes is the reflective process and they emphasise that any ICT interventions in these scenarios should "assist defining and achieving students' individual learning goals, facilitate connecting methodological concepts to students' dance style or choreography, and aid developing awareness over their learning process" (Leijen et al 2008, 229).

While the education-based literature thus far has highlighted the potential benefits of increased use of technology for Dance courses in Higher Education, there is also the potential for its significant use within professional dance training environments. While technology can offer opportunities for reflective practice as well as methods to elicit innovative creative responses, there is also the potential for its use and impact for the learning of repertoire and perfecting of dance techniques. Depending on the specifics of the technology, the different viewing angles, ease of repetition, ability to

concentrate on single or multiple movements and close viewing strategies, can offer a unique way of encouraging technical understanding, whilst allowing the learner to have agency and autonomy in their learning. The aim is for the WhoLoDancE experiences to support this process, providing novel approaches to learning dance, to reflecting on dance technique and providing a new way of observing that encourages reflective reviewing.

WhoLoDancE Project

To focus now on the specific activities within the project, we are exploring ways in which the virtual environment can augment and extend the "live" space of dance learning using four dance genres - contemporary, ballet, flamenco and Greek folk dance. There are a number of tools that have been built for the project. What follows is a brief description of the six main tools that have been developed. The WhoLoDancE Movement Library (WML) represents a web-based interface designed to store the large collection of dance movements recorded during motion capture sessions. The system allows users to browse recordings by genre, search for specific performances by movement descriptors, interact with recordings and annotate movement segments. The WML therefore also serves as an annotation tool. With hundreds of motion capture recordings, the WML is a resource for dancers and choreographers, but highlights the need for a tool which allows for easy navigation. The similarity search engine tool is an interface for querying a movement segment in the library and automatically retrieving similar ones, and was designed to allow for different criteria, from physical aspects to qualities expressed in the dance, to be retrieved. The choreomorphy tool provides an interactive experience for the dancer who, when wearing a motion capture suit and improvising, can see the movement visualised on screen in real-time, rendered through a variety of different avatars and settings, so as to enhance the user’s self-reflection and

experimentation. The movement sketching tool is designed as a lower-cost option, allowing dancers to record, display and analyse their dance movements using devices such as Notches or mobile devices. The motion blending engine is a tool for composing new kinds of movement sequences. It enables the user to experiment with composing sequences that can draw from any dance genre in the repository to create new blends and even assemble full choreographies, and save results. Finally, the segmentation tool enables the user to study a dance performance and annotate at a detailed level. For this paper, the tools we will mainly be referencing are the WML, with its additional function as an annotation tool, and the choreomorphy.

The tools, which together produce a suite of options for the dance teacher and practitioner, are the result of the project team exploring different ways to advance from the use of video within the studio to using both high-end and low-end motion capture devices. These include devices whereby sensors are attached to the body to collect basic motion data, for example, wearable sensors such as Notches (low-end). The project has also collected a considerable bank of data using higher end motion capture equipment (using a dedicated motion capture studio that requires the dancer to wear a suit with optical markers) to produce a range of avatars of the dancer, which are then viewed through using a VR headset, such as the Microsoft Hololens, as one example. The VR experience is provided by means of devices for Cross Reality (XR), which includes any combination of hardware that has aspects of Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (MR). Whilst VR is thus proving to be a valuable tool for dance learning and teaching, questions arise about the accessibility and portability of the technology, concerns which have previously been discussed as issues faced by educational institutions regarding the increased use of technology for learning. Those in the dance community may have access to different VR devices, depending on the needs:

a choreographer may be interested in testing VR for their work with a low-end device, before investing in higher-end support, whereas a student may just need a low-end device in the practicing sessions at home.

Project Tools and Avatars

As noted above, the project is interdisciplinary, bringing together technologists, dancers and researchers to find the balance between what is possible to achieve and what potential users have requested. For avatar creation, the consortium has relied on the industry partner MOTEK Entertainment for support with developing the variety of avatars used within the project. One of the aims of the project is to achieve a dance teaching paradigm where a dance student is immersed inside the 3D avatar, and the teacher or choreographer can see both the dancer and the avatar engulfing the dancer. To achieve this, the ultimate goal is to use life-size volumetric holography. However, this technology is yet to be fully realised and alternative ways of achieving this experience are being explored, using different AR and VR techniques.

The avatars within the project have been designed to exhibit different principles of movement in dance. The movement principles that were defined at the start of the project served as the primary guideline for their creation. We decided to develop three different avatars: Directional guidance (The Arrowman avatar), Time based motion volume (The Blob avatar) and Articulated visual (The Robot avatar). The following images and descriptors are provided by MOTEK.

1: Arrowman avatar:

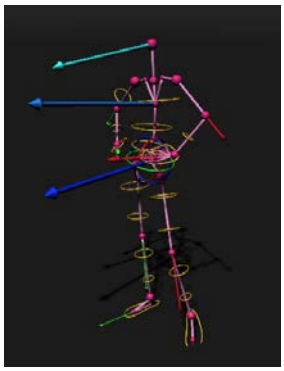

Fig 1: Arrowman avatar

This avatar was designed with the following functionalities in mind:

- To give real-time visual guidance to the dancer about the direction in space of each body part (Head, Torso, Pelvis, Elbows, Hands, Knees and Feet). This was achieved by implementing the arrows emanating from the center rotational pivot of the respective body parts.
- To give visual cues of the perpendicular place of rotation of each body part. This was achieved by modeling circular objects around the limbs, where the radius of the torus mimicked the actual limb thickness. This assists in intuitive understanding of the segment (body part) rotations in real-time.
- Creating a rotational manipulator around the hips to assist in the visualization of the global direction of the dancer in space.

2: The Blob avatar:

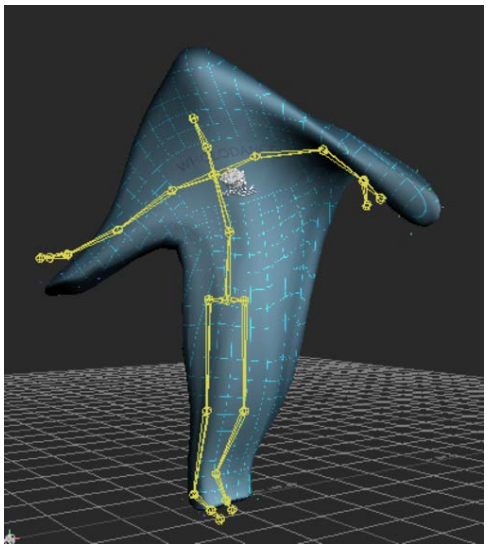

Fig 2: The Blob avatar

This avatar was designed with the following functionality in mind:

- To create clear and intuitive time-based feedback of the volume that the dancer occupies in space while moving. A main target of the WhoLodancE project is to let a dance learner be immersed inside an avatar that is driven by the motion of the dance expert (teacher, etc.). For this purpose, we created five different variations of this avatar. Those different variants present different levels of difficulty to the learner who tries to ‘stay inside’ the virtual body represented by the avatar.

The levels of difficulty for staying ‘inside’ the image were based on allowing lesser or greater volume around the physical dancer. We are experimenting with different parameters for the dancer to work 'with' the blob, including temporal aspects (varying sequence length and variations in speed) and synchronisation options (whether the dancer is syncing with her own avatar's movement or with her teacher, or the avatar of another dancer). There is more to explore in the final stages of the project, including whether providing more or less volume encourages more 'accuracy' in terms of action content, or permits more freedom for the dancer.

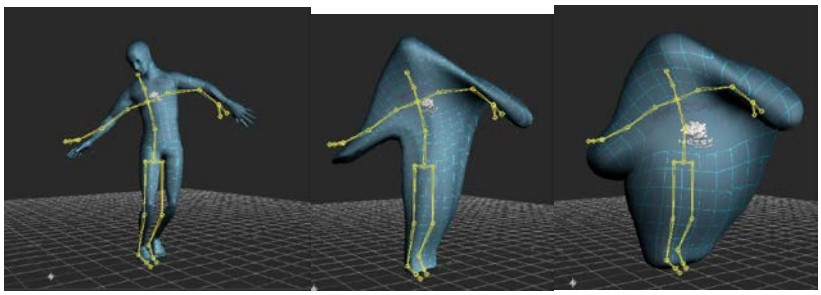

Fig 3-5: The Blob avatar’s levels of difficulty

3: The Robot avatar

Fig 6-7: The Robot avatar - Female /Male

This avatar was designed with the following functionalities in mind:

- To create an avatar in a way that will appear to be more figurative and will bring out the articulation in the joints of every part of the body.
- To make a figure that is primarily gender agnostic but if users are interested in selecting a gender specific avatar, then this provides some distinction with very slight modifications to the avatar.

What has emerged through the development of the avatars is a bank of avatars, a visual imagery collection, which could support the dancer's process of learning new movement and further deepening their creative knowledge. As we alluded to earlier, in dance training and performance, imagery, including visual and mental imagery, is frequently used as a tool for learning and optimizing movements (Bläsing 2010). The avatars thus seem to be most effective in supporting the way in which imagery operates in dance; as an image that reflects back on the dancer and her sense of her own occupation of time and space, as well as communicating feeling states and information that is more sensorial in nature.

Evaluative Workshop Sessions

As with any project that is primarily focused on the development of new tools for the working environment, user testing is conducted to evaluate the likely take-up and potential value to the user-community. Here, we describe and reflect on two user-testing sessions conducted in the first few months of 2018, to show how different groups responded to the tools and how those responses are helping us to further reflect on the perceived value of the tools and their potential contribution to the dance learning environment.

In March 2018, the whole suite of tools were shared with dance students in conservatoire training in Madrid, Spain. In March and April 2018 the Annotation tool was shared with students from two different universities in the U.K. The conservatoire students experienced seeing the tools being demonstrated and using the the tools over a two hour session, we then interviewed nine students to ask them about their experience immediately after this session. The U.K. students were shown the Annotation tool and then used it. There were seven U.K. students in total. The Annotation tool uses pre-recorded video sequences aligned next to an avatar of the same sequence motion

captured, drawn from the four different dance genres. The user can annotate the sequences, on a timeline, drawing from a set of movement principles, movement qualities and actions defined by the project team. The tool is designed to support an in-depth analysis of dance movement, to identify style features, and to tune the user's perception by drawing attention to the complex interrelationships between the component parts of dance.

Fig 8- 10: Evaluation sessions using the choreomorphy tool in Naves Matadero (Madrid, Spain)

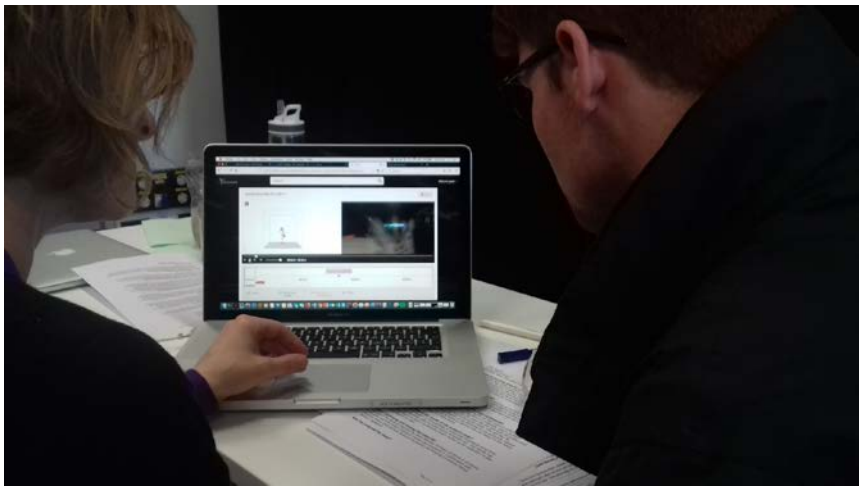

Fig 11: Student evaluating the WML Annotation tool (Wolverhampton, UK)

We used qualitative research methods, including interviews and observations, in this phase, to gather evaluative data about the tools. We wanted to find out about how a new approach to dance annotation may be useful in the dance learning environment. We also used observation as the method to study the students using the tools and then interviewed the conservatoire students to gain a better understanding of their experience. The interviews were transcribed in conjunction with the observation notes, and a primary analysis of the data was undertaken. The findings of this phase of the research are now contributing to the last stages of the design of the WhoLoDancE tools, which will then be finally evaluated towards the end of the project.

User Experience

The analysis of the interviews revealed a positive response to the demonstration of the tools and an enthusiasm to use and play with the technology. Some commented on the need for portability and ease of access to the software, which includes cost consideration. Most of the students could see the potential for learning and complementing what the teacher offers in the dance studio. It was highlighted how the technology could be viewed as a form of bridge between the dance studio and the

technological atmosphere. The WhoLoDancE tools appear, from the feedback, to be pushing boundaries whilst advancing knowledge, in an easeful way, for both the novice as well as the more experienced dancer. In addition, the potential for choreographic opportunity was noted by most. The students were also thinking about 'what next' in terms of the future for dance and what technology can contribute to the artform and their own practice.

In particular, feedback revealed the need for an accessible and easy to navigate interface to the tools, easy-to-follow guidance for how to use the tools (in the form of video tutorials) and we gained useful information about avatar preference according to dance genre, which we discuss further below. It also highlighted the gaps and some of the challenges that dance learners may face when trying to integrate technology into their practice, such as dealing with the complexity of setting up and processing technology, which can require a splitting of attention and energy between the tool and the 'live' experience of body-to-body interaction.

More detail came from observing the students using the tools and in particular, the Annotation tool. This highlighted to the students the anatomical structure of the skeleton and the detail that can be seen in watching an avatar of the dancer from a clip in the movement library. This brought comments such as, 'when learning rep[ertoire], I can see the joints move' and 'I can see the quality of the movement'. Some students commented on the usefulness of seeing this detail to complement what was learnt in the studio. Another student said that by watching the avatar they were, 'noticing own habits and ways of moving'. They were getting real-time information about the way they move that they may not have received before, indicating that a new way of looking and experiencing may be taking place, whereby they were thinking about their own dancing from a new perspective.

One student commented on how it could make studying easier, ‘we can study better with the avatar – we can work in our own house etc. so it makes it easier to study. This can improve my dancing’. However, discussion also focused on portability and the kind of platform that they would like for accessing the tools. There were mixed views on whether they would prefer to have an app on their mobile phones with the software available or whether the change in screen size would mean losing detail. While portability and ease of access was an important consideration, they did not want to lose the detail of the skeleton that can been seen from the avatar representation on a larger screen. They could also see the creative potential of the tools especially for long distance collaborations, showing that these students were also thinking about life after their study years.

Conclusion

What appears to have emerged from both the project design and the user sessions is the two-way impact potential for the WhoLoDancE tools; for both learners and for teachers. The intention is not for the tools to replace teachers, but rather to provide supplementary opportunities to engage with technology to enhance learning that has already taken place. The inclusion of technology within dance learning environments seems to be able to offer, from both the examination of literature and WhoLoDancE evaluation comments, alternative ways of understanding the body, different cognitive engagement with dance content and new ways of responding creatively.

The virtual environment is void of corporeal human-to-human and/or peer-to-peer interaction, but we are interested in finding out whether the tools elicit a different mode of learning that is not dependent on the kind of human interaction that is characteristic of the typical dance studio. The potential impact for students with the web based online tools, such as the Annotation tool or the Segmentation tool, is that the

learner is encouraged to communicate their understanding and engage at a deep level with the dance content. The Annotation tool provides a platform where terms for movement qualities and principles are already provided, thus encouraging the learner to analyse dance technique with a prescribed vocabulary, whilst providing additional space for free-text analyses. The online tools also allow the student to analyse their learning styles, while also better understand their own strengths and weaknesses in observing, analysing and interpreting dance. An active process of engagement is encouraged, whereby the user has a different type of relationship with the dance teacher and materials, supporting the student developing a greater sense of ownership in their learning. The WhoLoDancE avatars can serve as primers for students to access their own tacit embodied knowledge. The use of the WML encourages what is tacitly understood by the dance learner to be communicated to others explicitly.

To conclude, we have looked towards neuroscience and educational theory to consider the impact of introducing digital technologies into the dance studio. When the WhoLoDancE project closes we will continue to monitor the tools and and their influence on the role of technology in the education and training of dancers. Further research is needed to find out whether the tools developed within the project will have longer-term impact, and whether there will be a wider uptake of digital technologies more generally to support the teaching and learning of dance. Thus far, there has been no widespread integration in the sector, due to a number of factors, including the cost of technology, the need for appropriate technological expertise and perhaps an understandable resistance to changing traditional methods of body-to-body interaction. The WhoLoDance tools are yet to be fully tested but we hope that they will be part of a wider movement to expand the possibilities offered by new technologies, not to replace the teacher but to support and augment the teaching and learning of dance. For example,

the blending engine and choreomorphy tools encourage the learner to 'play' with building a new dance sequence, or create new visualisations of their own dancing. Exploring possibilities in the virtual environment, by creating an anthropomorphic avatar, or constructing dance sequences that may be beyond what a ‘real’ dancing body can do, can then extend a dancer’s imagination and feedback into their technical and creative development.

Dancers are generally familiar with studio-based learning, which involves the development of a range of technical skills, according to the specific requirements of the dance genre. Dancers integrate thought, emotions, movement and, as Vahri McKenzie (2017) reminds us, dance is a cultural phenomenon that operates within social environments. These social environments are traditionally seen as (live) person to person but in WhoLoDancE we are exploring the extent to which digital immersive environments could be another context for dance training and learning. The human, working and dancing with a digital avatar, creates a new kind of social environment that can also encourage dance knowledge acquisition. This could be especially beneficial for remote dance practitioners, those who work in areas without established dance programmes or low numbers of practitioner peers.

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