WHOLODANCE

Whole-Body Interaction Learning for Dance Education

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Usability and Learning Experience

Evaluation report

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1   Executive Summary

This deliverable includes the evaluation plan for the tasks of WP7, and reports on the methodologies to be used for the usability of user interfaces (UI), the user experience (UX) (T7.1), the learning impact (T7.2) and the personalization approach (T7.3). The presented plan is based on the concept of a -two- phase iterative evaluation, completing a formative (preliminary) and summative (final) evaluation, which will be documented in D7.2 and D7.3 respectively.

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2   Introduction

Evaluation activities are crucial to provide a constant feedback to the design and development teams regarding the appropriate approaches to be employed for the offered frameworks and tools. WhoLoDancE employs a user-centered design approach from the very beginning of the project. Especially for the evaluation of the general approach and framework and the tools themselves, the employed methodology foresees relevant and targeted formative and summative evaluation actions. This report outlines this methodology.

The section "Objectives" outlines the objectives of this document, the following one presents the targeted users and "Elements to be evaluated" a brief reference to the framework and tools to be evaluated. The next section presents the evaluation approach at large, followed by concrete planning of the foreseen evaluation activities.

3   Objectives

WP7 Evaluation and Validation of ICT-based Learning is responsible for the user testing and evaluation of the WhoLoDancE framework and produced algorithms and tools. It will take place throughout the duration of the project to inform the conceptual framework and development of learning tools with the feedback from the dance education community.

The task T7.1 "Usability and Learner's Experience Evaluation" in particular, will establish the framework for evaluating the usability and user/learner's experience, and testing of uptake and use, within the different dance genres, and learning scenarios. The validation and evaluation will focus on both the characteristics of the User Interface (ease of use, interactivity, response time, intersection validity, feedback validity, intuitiveness) as well as the Quality Assurance of the system within the different Learning scenarios. The task will define the methodology for user feedback including questions, recording and analysis, and forms of feedback (both standard, including questionnaires, interviews, focus groups) and observation of users and "thinking aloud" techniques. This task will check the meeting of the selected requirements with regard to Privacy, Data Protection, and IPR. This activity will inform the evaluation activities within the project as organized within Tasks T7.2 Evaluation of Learning process through the interfaces and T7.3 Personalization Evaluation.

4   Targeted users

In general, in WhoLoDancE, we focus on providing tools to support dance learning and education, taking into account the needs of intermediate to advanced and professional dancers. We target our outcomes to dance practitioners and professionals who have more than the basic knowledge of a specific dance genre and they seek innovative tools to enhance their learning experiences. Though

in some cases the tools might be useful for a wider range of users, such as less experienced dancers of specific genres. The user groups which we identify are the following:

1. Dance Student-Learner
   - Intermediate
   - Advanced
2. Dance artist-practitioner and professional
3. Dance Educator /teacher
4. Choreographer

Dance Student-learner (intermediated and advanced): this user group includes a wide range of dance practitioners ranging from less experienced amateur dancers to pre-professional dancers. As we have elaborated in previous deliverables (D1.1 State of the Art), dance learning is characterised with a wide range of diversity, depending on the dance genre, the technique, the context, etc. Another characteristic of learning in dance, and the concept of "taking a dance class" is a life-term process. To deal with this diversity, we focus on four different dance genres as use-cases: contemporary, ballet, Greek folk and Flamenco. In addition, we are proposing a conceptual framework which is based on Movement Principles that go beyond the limitations of one technique, but in contrary they summarize some of the most important skills and learning objectives that dancers of every dance style are dealing with (e.g., directionality, balance, musicality-rhythmicality, etc). For the evaluation, we consider as potential users, intermediate to pre-professional dance practitioners from each one of the dance genres. An important consideration is that each genre engages with different dance communities and for example the Greek folk dance genre involves recreational participants who may be learning folk dance for the first time and the tool could be a valuable support for their learning. For a more detailed description of the user groups see Deliverable D1.4 Needs Analysis. Depending on the dance genre, and the extent to which the corresponding techniques is demanding in terms of physical abilities, we expect the tools to be useful in a variety of educational levels.

Dance artist-practitioner and professional dancer: This user group targets professional dancers and dance artists as potential users who continuously seek ways to learn new ways of moving, improve skills, and enhance both their technique and improvisation ability. Dance is one of the fields in which professionals are completely aware of the need to practice, to improve their technique, and adapt to new styles and ways of moving for as long as they remain active. In this sense, our focus is on the educational potential of the tool. We recognise that there is a vital role for the tool in continuing professional development, not the least because of the tool's creative potential. A further potential of the tool is to be used for enhancing the creativity process. Creativity and ability to generate new material, and explore personal movement is not only a skill which is required from choreographers, but also from dance professional artists and practitioners, and is part of a complete education, especially in contemporary dance.

Dance educator/teacher: The WhoLoDancE tools are designed to be also used by the dance teachers. They support a variety of activities before, during or after the dance class. For example, some of the tools such as the blending machine, can help the teacher to prepare the dance sequences of her/his class, use the tutorials and different visualizations to help the students understand some concepts, movement principles and qualities, show examples of similar dances, etc.

Choreographer: Last but not least, we expect that the WhoLoDancE tools are appropriate to inspire choreographers in finding new ways of moving, creating patterns and also convey choreographic concepts to their dancers. At this point, it is worth mentioning that choreography is also part of contemporary dance curricula, so we are also targeting these potential users. In addition, most of dance practitioners and professionals, usually interchange roles not only during their carriers but usually during a working day: many professional dancers work also as teachers or might create their own choreographies. A dance teacher, when she/he prepares a performance for the students, needs to choreograph and create new sequences, and professional dancers remain students even during and after the edge of their carriers.

5 Elements to be evaluated

The work towards an integrated personalized learning experience for dance within WhoLoDancE has been approached through a solid conceptual framework and the design and development of a set of functionalities that can also be used and tested individually and then made available to the users through specific learning scenarios.

More information on the envisioned learning scenarios can be found in Deliverable D1.4 Definition of Learning Scenarios-Needs Analysis.

Here we briefly describe these elements in order to describe in Section 8 the proposed evaluation approach for each one.

5.1 1. Conceptual framework

The WhoLoDancE conceptual framework, including the movement and learning principles, the movement qualities and various tags, is the cornerstone of the project learning approach and needs to be constantly validated and improved with dance experts.

5.2 2. Viewing and enriching content

The repository of movements will allow all user groups to search for content of interest and view it in different ways. For the dance experts, it will be possible to enrich the metadata of the content through an appropriate annotation tool.

5.2.1 Relevant Functionalities

a. Tutorial

The tutorial will allow users to familiarize themselves with the WhoLoDancE tools and framework.

b. Advanced search and browsing

The repository of movements interface will provide advanced search and exploration tools, including searching using the metadata tags, semantic annotations as well as using similarity search methods. An appropriately designed user interface will engage the user in browsing the content through an appealing user experience (Figure 1).
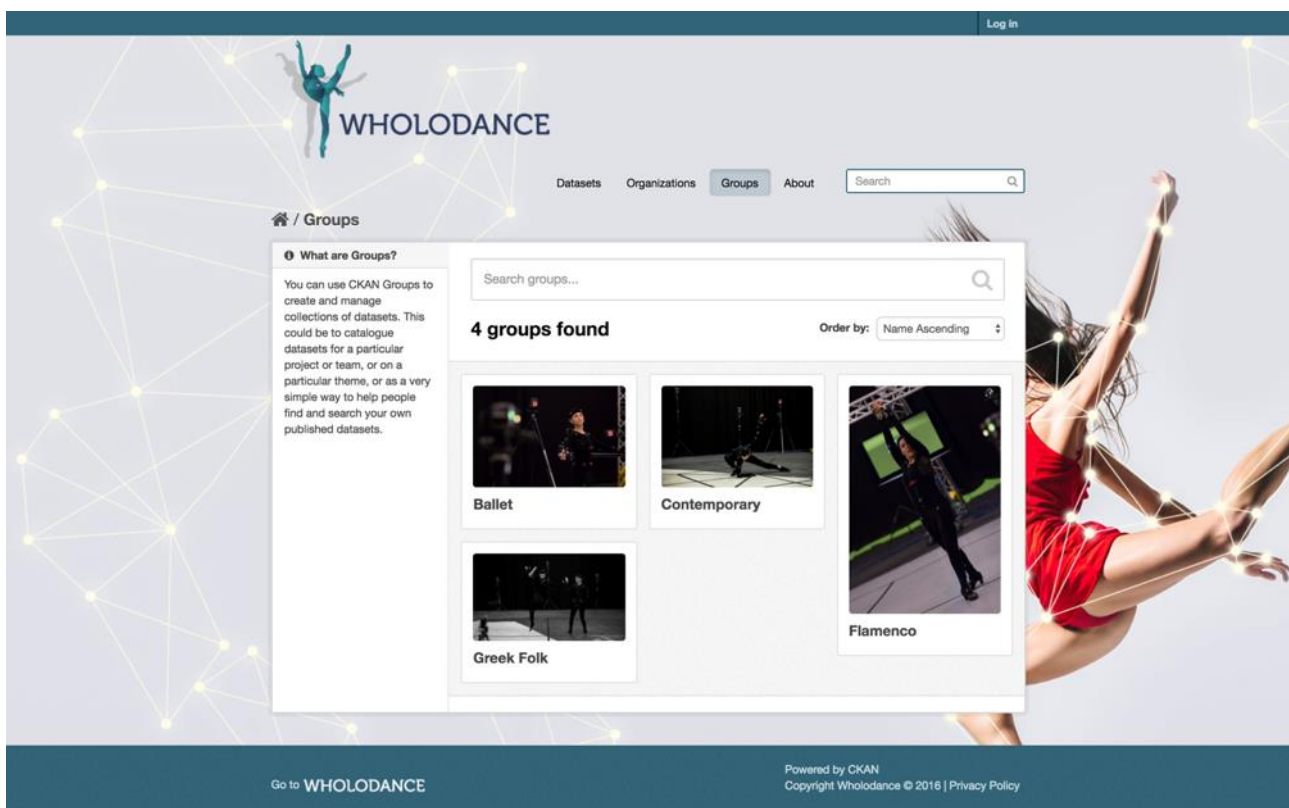

Figure 1. Prototype interface for accessing the movement library

c. Movement sketching to access the repository

Users will be able to perform a movement and/or dance sequence, record it through simple low-end motion capture devices such as accelerometers, RGB-D cameras, and query the system to get similar movements in terms of movement and movement qualities. This allows dance students and dance experts to compare their movement with the ones of professional dancers stored in the repository and reflect on the various aspects of movement.

d. Blending Machine

Users (dancers, dance teachers and choreographers) will be able, through a custom user interface, to create motion sequences as blends between any of the recorded sequences present in the software's library. Moreover, they will be able to create new sequences, assemble and mix longer choreographies and dance sets using a timeline module inside the interface (Figure 2).
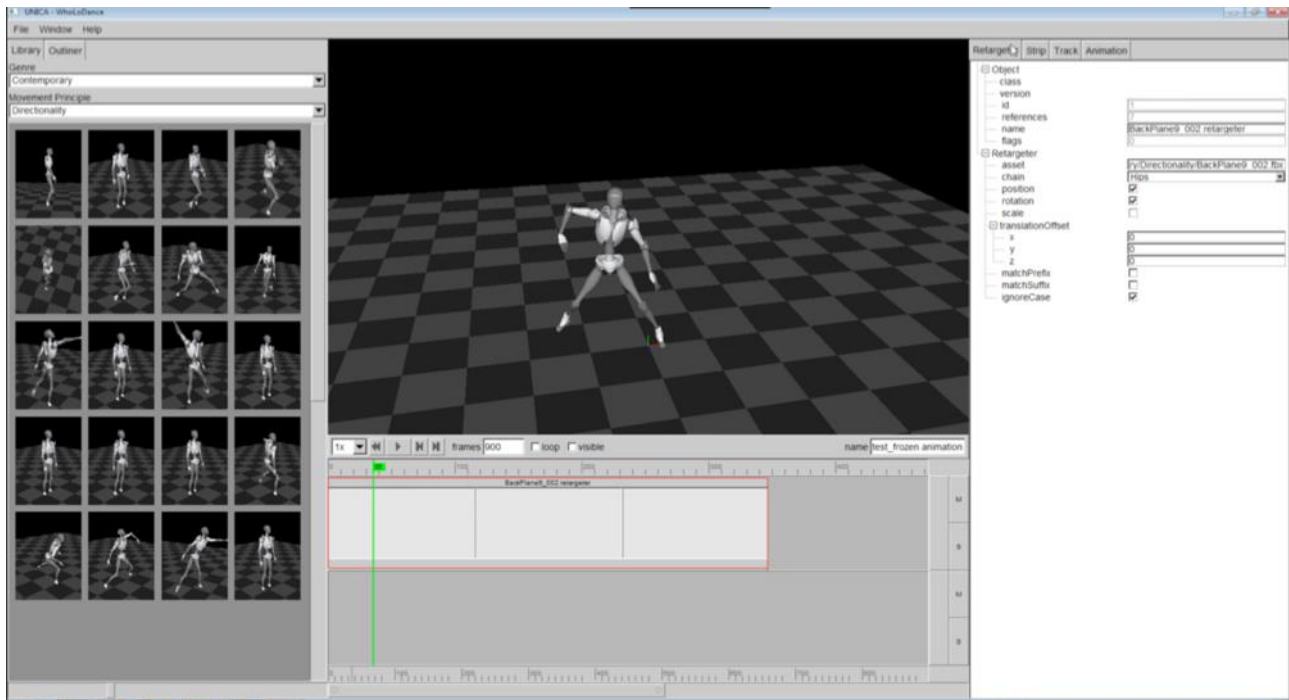

Figure 2. Screenshot from the early version of the blending machine prototype

e. Synchronized Presentation through different visualizations

The tool (Figure 3) will allow the synchronous visualization and presentation of the available multimodal material: motion capture, video and audio (music and/or respiration).

Users will be able to view the motion capture files in the repository in different ways, including stick figure, anthropomorphic avatars, abstract visualizations, etc. This will allow them to focus on specific aspects and qualities of the movement, according to the learning scenario.
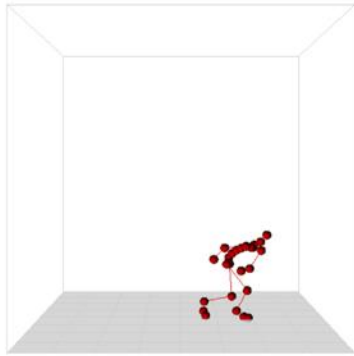
Figure 3. Synchronized view of stick-figure and video prototype

f. Content annotator

Appropriately authorized users will have the possibility to enrich the movement repository metadata through annotations. A set of annotation modalities are provided: categorical (tags) and graded (real value) metadata on the whole performance or graded (real value) time-dependent annotations.
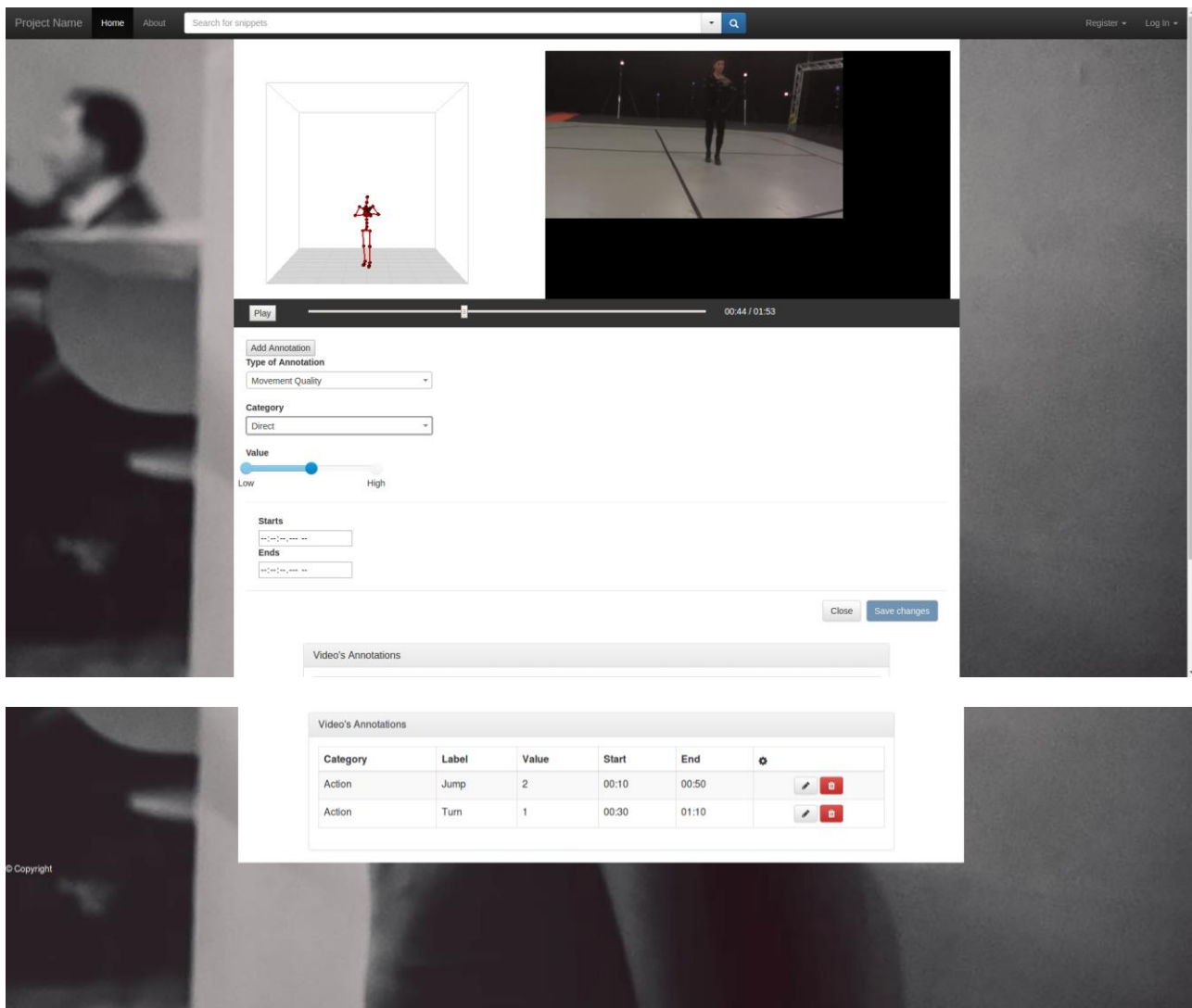
Figure 4 Annotation interface prototype

5.2.2   Relevant learning scenarios

The repository exploration tools can be part of a variety of learning scenarios, which can start with the presentation of a "prototype" movement, i.e., an example of a proposed or "ideal" movement, or not. The interface invites the user to react in different ways depending on the context and the specific scenario. For example, one of the scenarios might begin by the WhoLoDancE Tutorial on a typical screen of a PC, laptop or a mobile application, or by browsing the library and seeing the stored movements from the library in 3D avatar or abstract visualization. Some scenarios might begin and end with the presentation of the motion-captured movement. This happens in the case in which the user just wants to see the captured material offline to study the material and reflect on it. The motion capture movement, according to the needs of each scenario might be visualized through a stick figure, an anthropomorphic avatar, a synchronized view showing both the movement stick-figure and a video of an avatar enhanced with visualization of motions, such as traces, arrows etc.

3. Whole-body interaction experience

WhoLoDancE considers a set of scenarios where the feedback to the dance learner while using the tools has two possible interaction scenarios:

- The dancer moves and the tool responds;
- The tool gives cues/prompts and the dancer follows those prompts.

To be able to capture and give the learner's movement as feedback of the learning experience, several approaches are being investigated, including inertial motion capture suits (Figure 5), MS Kinect (Figure 7), accelerometers, etc. These approaches will be evaluated as to their cost in comparison to the advantages they provide for different learning scenarios.
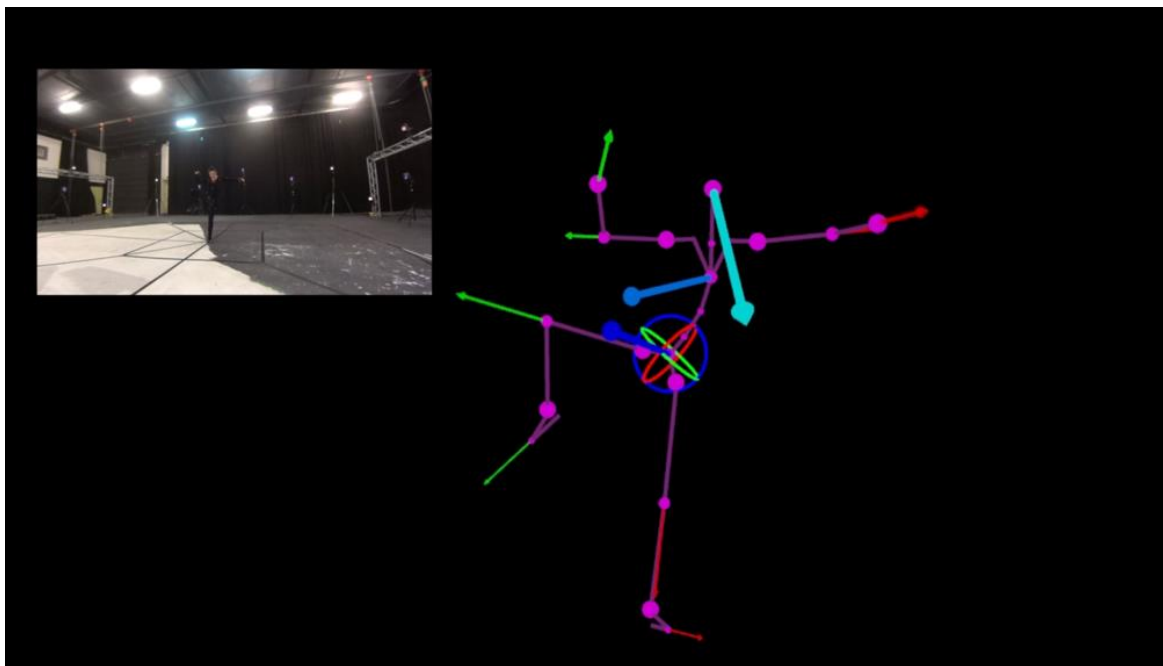

Figure 5. Arrows model showing the directions of the joints created by Motek during the MoCap sessions

5.2.3   Relevant Functionalities

Augmented Reality (AR) would be an effective tool for the presentation of either the virtual "teacher" or the learner avatar. There are several options being explored to deliver this experience, including:

- A simple desktop screen
- A projection screen
- A volumetric 3D display
- AR visualization devices

An example of an AR visualization device being tested for the use within the project is the MS Hololens (Figure 6), which creates a tether-less AR experience, enabling the dancer to move freely. However, it is estimated that several new devices will appear during 2017 and 2018 that may be proved to be useful for the project objectives.

5.2.4   Relevant learning scenarios

In this set of scenarios the imagery and visualization examples are applied on the user's movement captured in real-time through appropriate motion capture equipments. E.g., the student will see on the screen the output devices of their own movement as an abstract "avatar" or augmented figure e.g., his silhouette with wings, in a cube, in a visible kinesphere, etc. In this case the visualization can be used to augment or alter the body image. For example, quality of the movement can affect the appearance/disappearance of the avatar or alter its visual aspects. The different visualizations can help to emphasize and clarify different aspects of the movement, through different visual metaphors, for example, visualizing gravity, and the quality of weight through a visual effect which is affected when the quality of movement changes.

Table 1 summarizes the envisioned tools that will be implemented as prototypes within the project to contribute towards an integrated personalized dance learning framework.

Figure 6 An example of using the Hololens during Motion Capture to visualize the volumetric space of the body (Kinesphere)

Figure 7- Display of a prototype using kinect

Table 1. WhoLoDancE tools and related objectives of the targeted User Groups

WhoLoDancE functionality set	Description and objectives per user group
2-a. Tutorial	To navigate and familiarize with WhoLoDancE tools and framework. (All) To experience a virtual dance class tour. (Dancer/Learner)
2-b Advanced search and browsing	To be inspired by different patterns within and across genres. (Dancer/Learner) To search specific examples in relation to verbal descriptions and understand different concepts. (Dancer/Learner) To see/learn specific examples of movements, actions, principles, actions or parts of the syllabi. (Dancer/Learner) To show specific examples to students, to understand the terminology. (Educator) To prepare a class by searching and focusing on specific examples of movements, actions, principles, qualities, etc. (Educator)
2-c Movement sketching to access the repository	Users will be able to perform a movement and/or dance sequence, record it through simple low-end motion capture devices and query the system to get similar movements in terms of movement and movement qualities. The users will be able: To search the repository of movements through a novel interface in a more direct and natural way (All)

2-d Blending machine	The Blending machine may, sequentially and/or in parallel, blend movement segments into longer or combined movement sequences:	
	To create innovative combinations to teach. (Educator)	
	To emphasize the composition and decomposition (analysis) of complex sequences. (Dancer/Learner, Choreographer)	
	To improvise, and experiment with new material drawn from different sequences within the same genre or from different dance genres. (Dancer/learner, Choreographer)	
	To experiment with new sequences and see them before the rehearsal, in different ways. (Choreographer)	
	To be inspired by seeing different combinations within and across dance genres, to bring something new, into his/her movement vocabulary. (Choreographer)	
2-e. Synchronized presentation through different visualizations	This tool is responsible for visualizing the MoCap files in the repository in various ways (e.g., stick-figure, 3D model, abstract visualization):	
	To focus on specific aspects of movement (e.g., the qualities by seeing the traces, the directions by seeing the cube) (ALL)	
2-f. Content annotator	Navigate through the Video annotator (view and add verbal descriptions on videos)	To show specific examples to dancers, and add verbal information. (Educator)
3- Whole-body interaction experience	The dancer in VR mode the user sees a third person (avatar) or him/herself as a 3D avatar in VR:	
	To focus on specific aspects of the movement e.g., Directionality, Rhythm. (Dancer/Learner)	
	To see in 3D space and real-size how a new composition of movements looks like. To improvise with the avatar. (Dancer/Learner)	
	To follow, imitate, or play and improvise with a real-size avatar. (Dancer/Learner)	

	To teach and monitor specific aspects of the movement e.g., Directionality, Rhythm (Educator) To enhance through reflection on specific aspects of the movement e.g., Directionality, Rhythm. (Choreographer)

6   Evaluation approach

Evaluation within WhoLoDancE will be realized in two phases: formative and summative.

Perhaps the best way to understand the difference between the two forms of evaluation is Stake's [S76] analogy: "When the cook tastes the soup, that's formative assessment; when the guests taste the soup, that's summative assessment". Nevertheless, in WhoLoDancE we will be conducting formative evaluation of the various systems and tools with end-users as well as with the project designers and developers.

Formative evaluation involves iterative testing of software components during the design stages to isolate problems and suggest changes that can be made to improve components as they are developed. No matter how well we imagine that an approach or a system will work, it takes exposure to real audience members to discover just what actually works, and for whom. With formative evaluation, concepts, approaches, tools, and systems can be improved before they are deployed and become too difficult or expensive to change.

Summative evaluation takes place after an application or system has been developed and installed. In the past, summative evaluation was the norm, and this often meant that evaluation findings produced at the end of a project which suggested changes to be made to an application, were often ignored because of budgetary and logistical constraints.

6.1   Evaluation objectives

Among the basic factors for any software to achieve its intended purpose, one is to make sure that the system is effective, both in terms of usability and user experience.

6.1.1   Usability

Usability evaluation means essentially to discover the appropriateness of the system for the purpose for which it was designed. Usability of any system is dependent upon an appreciation of who the intended users of the system are, the tasks those users will perform with it, and the characteristics of the physical, organizational and social environment in which it will be used. ISO 9241-11 [ISO98] defines usability as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use." Hence, the three measurable usability attributes are:

- Effectiveness: the ability of users to complete tasks using the system and the quality of the output of those tasks.

- Efficiency: the amount of effort expended in performing tasks.

- Satisfaction: users' subjective reactions to using the system.

Nielsen in [N94] defines usability in the context of overall system acceptability, adding more usability attributes. Combining with the above three ISO usability attributes, leads to the following six usability attributes:

- Effectiveness: completeness with which users achieve their goal.

- Learnability: ease of learning for novice users.

- Efficiency: steady-state performance of expert users.

- Memorability: ease of using the system intermittently for casual users.

- Errors: error rate for minor and/or catastrophic errors.

- Subjective Satisfaction: how pleasant the system is to use

6.1.2   User experience

User experience (UX) evaluation means investigating how a person feels about using a system (product, service, non-commercial item, or a combination of them). It is non-trivial to evaluate user experience and come up with solid results, since user experience is subjective, context-dependent and dynamic over time. Laboratory experiments may work well for studying a specific aspect of user experience, but holistic user experience is optimally studied over a longer period of time with real users in a natural environment [L11] [L09].

In the case of WhoLoDancE, studying user experience means to examine a plethora of parameters in addition to the user's profile, skills, equipment and tool used, etc. These parameters are high-level constructs of user experience that can be used as the basis for studying it and include:

- affective (motivational, emotional) response, and whether the user feels stimulated, engaged or fatigued and bored

- immersion (in the sense of suspending disbelief and supporting the feeling of presence in the experience),

- cognitive or conceptual change, or even pedagogical value, as a result of the user's creative encounter with the tool

- perception of value - whether the system is important to the users and what is its value for them

- inspiration - whether the system inspires the user, whether it delivers 'wow' experiences

6.1.3   Learning tools effectiveness

The WhoLoDancE tools and functionalities aim to support a variety of learning styles and approaches, beyond a specific technique or practice and traditional models such as the "demonstration-reproduction" model, but embracing self-reflection, conceptualization on movement and improving movement literacy, improving imagery ability and enhancing the ability to create new movements and generate new kinetic material. Since the target group of WhoLoDancE, addresses individuals which have some experience with dance, the focus of the learning experience and its impact extends beyond the reproduction of specific kinetic material.

WhoLoDancE addresses four different dance genres as use cases (ballet, contemporary, Greek folk and flamenco). Even if we focus on these four dance genres the diversity in both the kinetic

vocabularies and the teaching methodologies is still wide and one of the biggest challenges is to find learning objectives that are common across genres. Through focus group with the participation of dance teachers of all genres, as well as validation through questionnaires and interviews (D1.2 Interviews Report), WhoLoDancE targets the following *Learning Principles* and a summary of the different teaching styles applied in different practices are as follows:

- **Mimesis**: imitation/copying: the teacher is teaching the student a specific movement or sequence of movements and the student follows the movement. This is a case where the learning is largely based on observational abilities of the students as they are asked to see and do;
- **Generative**: the teacher gives the student an exercise/phrase/sequence as a starting point to achieve technical and creative goals. In this case the student is allowed to generate new kinetic material, or alter things as long as he or she is consistent with the technical or creative goals;
- **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, as in contrary to the mimetic approach the student has to remember the sequence, rather than see and do, and at the same time is allowed to alter or generate new material, as in the generative approach;
- **Traditional also known as "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.

The different perspective that each dance genre brings as a use case, as well as the diversity which is brought through the different learning approaches, raises the challenging question "What do we measure in order to evaluate the effectiveness of a dance learning experience?". Answering this question is much more rich and complex than a single-dimensional perspective of "doing the correct move". In addition, parameters such as satisfaction, motivation, engagement, perceived results by the students themselves are aspects which are worth testing in cases of low performance, repeated errors, inability to progress, increased drop-offs, low self-esteem and disappointment. Having this in mind, WhoLoDancE aims at evaluating the learning effectiveness of the different tools and functionalities through defining some of the parameters which eventually take place in a "good dance learning experience". WhoLoDancE tools are aiming to innovate the teaching of dance, by providing tools for self-reflection, and generative perspective which allows space for creativity and cross-fertilization of the learning practices coming from different dance practices and genres. Enhancing the ability to conceptualize a movement and reflect on its own or other dancers' movement is an important part of dance learning. This ability to analyse and observe and deconstruct the aspects of movement makes a dancer able to recognise the details and enhance a technique or style, learn specific patterns with precision, and/or generate personal new kinetic material.

This observation is related to the following Movement Principles and Movement Qualities as have been described in relevant deliverables. The more the different parameters of movement makes sense for the dancer the easier it becomes to memorize new structures, patterns and create new movement.

WhoLoDancE provides a variety of tools and functionalities that aim to enhance the understanding of such principles and qualities, varying from learning by example, to understanding the connections between the different aspects of movements through the content, to enhance the imagination and imagery ability of students, and allow them to challenge themselves in increasing new skills through the different visualizations and kinaesthetic whole-body interaction experiences.

The parameters we want to evaluate for these tools in a learning experience, in general, are the following:

- Perception of learner: the student estimates his progress based on her/his perception. "I learned some new steps by using the tool", "I have improved my technique on steps which require balance"
- Motivation: the student provides feedback on the extent to which she/he feels motivated to take part in the learning experience and how the tool works
- Satisfaction: although satisfaction is a parameter which is connected with the usability and user experience as a whole, the satisfaction from the learning experience deals with the satisfaction of the student from the content, the way the paradigms are presented as well as how the feedback is provided by the system. Is the content satisfying as a learning experience? Are the content and the tasks aligned with her/his level, background and expectation? Does the learning experience provide something new in terms of presentation and knowledge?
- Engagement: this aspect, as well as Motivation and Satisfaction, are related to the usability and user experience as a whole, but at this point we are evaluating the Engagement of the user as a learner. Does she/he feel related to the examples and tasks provided? Do the tools facilitate a learning experience which takes into account the variety of learning needs and learning styles?

In fact, the WhoLoDancE tools aim at facilitating a learning experience which does not substitute the actual, physical experience but provides tools which can add something in comparison to a traditional session or class in the studio. An additional parameter to consider is that the tool aims at the following goals:

- Enhances learning and the user's experience of exploring creative movement and different dance styles/genres.
- Encourages autonomy through the various learning environments/scenarios offered through the tool.
- Support "hybrid"/embodied methodology

- Enables the students/practitioners to self-reflect on their own movement without the stress of being constantly watched and judged by others
- Improve self-confidence/ body image working with the tools vs. working with the mirror
- Realize imagery examples through the visualizations
- Create a feeling of immersion
- Enable creativity and imagination

As an evaluation process, we plan to define 5-10 users which can use the tools for a short term period e.g. 3 months, and repeat interviews during intervals of time e.g.: What skills have you improved? What is the knowledge you have acquired?

We are expecting answers such as: "The tool helped me enhance my balance" "The tool helped me understand the structure of Greek dances", "The tool helped me improve directionality and use of space".

In what follows we present an example questionnaire which can be used as a basis for an interview with the users of the tools during the evaluation.

Questions ask when the users see the movement presented in different ways.

1. Did the specific presentation of the movement help you understand more clearly?

    1.1 the form and structure of the movement? e.g.,

    - Directions and use of space
    - Rhythm and phrasing of movement
    - Weight bearing and supports
    - Big movements as well as fine (small, isolated movements)
    1.2 Movement qualities

2. Did the presentation (e.g., the specific avatar) convey a specific expressive quality, mood, or emotion? If yes, how would you describe it?

Questions to be asked when the user sees particular dance forms and structures from the repository

3. Do you recognize this movement?
4. How familiar/expert would you describe yourself in doing this movement?
5. Did the presentation add something new to it? If yes, what?
6. Did the presentation of the movement change your understanding of this movement? If yes, how?
7. Did the presentation of the movement change the way you perform the movement? If yes, how?
8. Did the tags and verbal descriptions help you ?

9. Did verbal descriptions and the relevant content help you to understand the movement through a new perspective? Please elaborate

The questionnaire above will be customized accordingly depending on the specific evaluation of each tool/functionality, and will create the basis for face-to-face interviews, as they are most appropriate to get qualitative extended feedback.

7   Methods and instruments

WhoLoDancE will approach the evaluation of its tools with a combination of methods. A primary distinction in evaluation studies is between quantitative and qualitative methods [D99].

Quantitative methods attempt to classify diverse opinions or behaviours into established categories. Quantitative studies are designed to look for numerical patterns in data, summarizing the reactions of many people to a limited set of variables. They often make comparisons between categories of data by using statistical tests to establish the nature of relationships among variables. They may include experiments, tests, observations, surveys or other means of comparing the responses or behaviour of different groups. A primary advantage of quantitative methods is that they provide findings that can be generalized to larger populations.

Qualitative methods, on the other hand, emphasize depth of understanding over the generalizability of the data. Qualitative methods allow the evaluator to examine individual cases or events in depth and detail. These methods may emphasize overall trends, but they may also seek out exceptions, particularly how special cases differ from the mainstream. Qualitative methods utilize direct quotations, open-ended narrative, detailed reporting of events and behavioural observation. Qualitative studies can be especially helpful when starting to examine a problem, and also whenever the important issues are not yet clear. They are also very effective as a way of understanding complex phenomena that cannot be easily summarized into discrete categories.

Quantitative and qualitative methods are best used in tandem, so that the strengths of each approach can be put to advantage. A single evaluation study may use qualitative methods to generate ideas, categories, questions, while at the same time it uses qualitative methods to verify those results for a larger population and when particular and valid quantitative measures exist.

The WhoLoDancE evaluation approach will utilize a mixture of the two categories of methods, qualitative and quantitative (known as a Mixed Methods approach), according to the evaluation needs of each phase. Formative evaluation will be based on more qualitative approaches that may offer valuable insight for re-design while summative evaluation will use both approaches. The methods for evaluation employed may include:

- Heuristic evaluation with design experts
- User observation during the use of the tools, in laboratory settings or at the user's environment

- Questionnaires provided to the users directly after the evaluation, designed to provide quantitative feedback

- Qualitative semi-structured interviews after the evaluation, asking participants to describe the service in their own words, followed by a semantic analysis to get at how they have understood the service

7.1 Heuristic evaluation

Heuristic evaluation involves having a small set of expert evaluators examine the interface and judge its compliance with recognized usability principles (Nielsen, 1995). The goal of this evaluation is to assess the coverage of each release's functionality against its respective specifications.

The simplicity of heuristic evaluation is beneficial at the early stages of design. This usability inspection method does not require user testing but only one expert, reducing the complexity and expended time for evaluation. Using heuristic evaluation prior to user testing will reduce the number and severity of design errors discovered by users.

7.2 Questionnaires

Questionnaires are a useful research method to collect users' opinions and to quantify the subjective impression of the tool directly after its use; their use, in conjunction with structured or semi-structured (reflective practice) interviews, can turn them into a powerful evaluation tool. In the context of WhoLoDancE, we combine existing standard questionnaires for measuring usability and user experience with the questionnaire developed within WhoLoDancE to record the learning effectiveness of the tools.

7.2.1 User experience questionnaire

The User Experience Questionnaire[1] (UEQ – see Appendix) allows a quick assessment of the user experience of interactive products. The format of the questionnaire supports users to immediately express feelings, impressions, and attitudes that arise when they use a product.

The scales of the questionnaire cover a comprehensive impression of user experience, i.e. measure both classical usability aspects (efficiency, perspicuity, dependability) and user experience aspects (originality, stimulation).

The UEQ contains 6 scales which are measured through a Likert-scale questionnaire of 26 questions:

- Attractiveness: overall impression of the product. Do users like or dislike the product?

- Perspicuity: is it easy to get familiar with the product? Is it easy to learn how to use the product?

- Efficiency: can users solve their tasks without unnecessary effort?

- Dependability: does the user feel in control of the interaction?

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[1] www.ueq-online.org/

- Stimulation: is it exciting and motivating to use the product?

- Novelty: is the product innovative and creative? Does the product catch the interest of users?

Attractiveness is a pure valence dimension. Perspicuity, Efficiency and Dependability are pragmatic quality aspects (goal-directed), while Stimulation and Novelty are hedonic quality aspects (not goal-directed).

7.2.2 System Usability Scale

The System Usability Scale questionnaire (SUS)[2] is a standard Likert-scale questionnaire that consists of 10 questions, used directly after the responder has had a chance to use the evaluated tool. [B96]

7.2.3 User testing

User testing takes place in a controlled setting where the users are asked to perform specific tasks and their performance and reactions are recorded. This process is to be differentiated from the system performance measuring and evaluation procedures. For WhoLoDancE we will combine this approach with the Think Aloud Protocol method, during which authors are asked to verbalize their thoughts, comments, emotions while using the system. The process is observed and recorded by one or more evaluators.

7.2.4 Goal-free evaluation

Software evaluation has traditionally meant measuring goal attainment, based on a carefully pre-specified set of measurable goals [P87]. In contrast to this common approach to evaluation, Scriven [S72] has proposed the idea of "goal-free evaluation". Goal-free evaluation means gathering data directly on software effects and effectiveness without being constrained by a narrow focus on stated goals. This type of evaluation lends itself particularly to qualitative methods because it relies heavily on description and direct experience with the software. Moreover it requires the evaluator to suspend judgment about what the software is trying to do and to focus instead on finding out what it is that actually happens in the program and as a result of the program. The evaluator thus can be open to additional data and insights that may possibly emerge from the use during the evaluation. This approach is expected to be particularly fruitful in the context of this project, as the high novelty of the tools developed for a dance education context means that possibly new, creative paradigms of use will emerge through the familiarization of the practitioners with the tools.

7.2.5 Semi-structured interviews

Semi-structured interviews are a flexible method for finding out from participants the issues which are of relevance for them including the ones that the interviewers may not have foreseen at all. These types of interviews are based on a questionnaire which is not presented to the interviewee but rather used by the interviewer as a guide to structure the conversation. However, questions are

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[2] https://www.usability.gov/how-to-and-tools/methods/system-usability-scale.html

not determined completely in advance and the interviewer needs to be responsive to the interviewee. The style of interview is conversational and allows for probing of specific topics of interest.

7.2.6 Focus Groups

Focus groups are essentially an established method for gathering multiple participant opinion on a problem or product under development. The participants tend to be selected to cover a typical or focussed range of the target user group. Focus group discussion is primarily managed by a facilitator who will allow the discussions to be either very focussed or more open depending on the individual context and characteristics of the desired outcome.

8 Evaluation activities

This section summarizes the formative and summative evaluation activities for the project.

8.1 Formative evaluation

Formative evaluation is crucial in the context of an innovative approach to dance learning where there are very limited existing relevant tools, very few of them validated with practitioners. Formative evaluation within WhoLoDancE will involve dance experts and practitioners from within and outside the project consortium in evaluating all proposed solutions, from the conceptual framework to the learning scenarios, tools design and implementation.

The main methodologies to be applied in the different stages of design and development will include questionnaires, focus group discussions, usability and UX evaluation in controlled settings and interviews.

8.2 Conceptual framework

The formative evaluation of the conceptual framework has started early in the project: in the series of events and Workshops where internal dance partners and external invited dance experts and practitioners worked in groups to brainstorm together on the WhoLoDancE conceptual framework.

The framework is continuously being updated and evaluated both with internal and external experts through on-line questionnaires, workshops, interviews.

8.3 Viewing and enriching content

The formative evaluation of the content annotator and viewer functionalities will take place in two stages, firstly through paper prototypes presented to UX and dance experts and then through the evaluation of the software prototype as it is being developed.

Phase 1. Paper prototypes

The paper prototypes will be evaluated both by UX and design experts and dance experts

Design expert evaluation – Heuristic evaluation

3-5 design experts will be recruited to perform usability evaluation on the prototypes, based on a heuristics evaluation approach.

Dance expert evaluation

The paper prototypes will be evaluated by dance practitioners and experts in terms not only of usability and UX, but also of their offered functionality. The users will be prompted to reflect and discuss on the offered functionality and whether it is interesting and sufficient.

The aim will be to involve in this process at least 2 dance experts per genre.

Phase 2. First version of the software prototype

The software prototype will be evaluated by dance practitioners and experts in terms of usability and UX. A laboratory setting user testing method will be used where the users will be guided by the evaluators to perform a series of pre-defined tasks, including search, browsing and annotation of content.

The aim of this evaluation activity will be to involve in this process at least 5-10 dance experts per genre from the different user personas relevant to this tool.

8.4 Whole-body Interaction Experience

The whole body interaction experience developed in the context of the project will be evaluated early on through software prototypes.

The software prototype will be evaluated by dance practitioners in terms of usability and UX, as well as its suitability for specific learning objectives. A laboratory setting user testing method will be used where the users will be guided by the evaluators to use the offered toolset, either going through specific movement sequences instructed by the evaluators or given a more general task objective or simply aim for free improvisation.

The aim of this evaluation activity will be to involve in this process at least 5-10 dance experts per genre from the different user personas relevant to this tool.

8.5 Summative evaluation

For the summative evaluation of the WhoLoDancE software similar methodologies as in the formative evaluation will be applied. However, the focus will shift on evaluation in more realistic settings and ideally for a more prolonged period of time.

For long term use a structured "diary" could be used, a form where the user could provide feedback after each use of the tool.

The aim of this evaluation activity will be to involve in this process at least 15-20 dance experts representing all user groups.

Table 2 Planned evaluation activities

Tools/interfaces	Month	Evaluation Method	Formative/Summative	Participants	Internal/ external participants
Conceptual Framework (Movement and Learning Principles)	March 2016 (M3)	Questionnaires	Formative	8	internal
Conceptual Framework (Movement and Learning Principles)	June 2016 (M6)	Interviews	Formative	19	external dance experts
Conceptual Framework (Movement and Learning Principles)	June 2016 (M6)	Questionnaires	Formative	48	external dance experts
Conceptual Framework (Movement and Learning Principles)	October 2016 (M10)	Online Survey	Formative	70	external dance experts
Conceptual Framework (Movement and Learning Principles)	July 2016 (M7)	Focus Groups	Formative	31	Internal & external external dance experts
Conceptual Framework (Movement and Learning Principles)	September 2016 (M9)	Focus Groups	Formative	35	external dance experts
Conceptual Framework (Semantic Representation Models)	March 2017 (M15)	interviews	Formative	6	internal dance experts
Conceptual Framework (Semantic Representation Models)	May 2017 (M17)	Focus Group /Interviews	Formative	10-15	external dance experts
Blending Machine	March 2017 (M15)	Focus Group /Interviews	Formative	5	internal dance experts

Content Viewer and Annotator	February 2017 (M14)	Paper prototype	Formative	-	2 external design experts + internal dance experts
Content Viewer and Annotator	May 2017 (M15)	first version of the working prototype	Formative	8	internal dance experts
Content Viewer and Annotator - Synchronized presentation of different visualizations	May 2017 (M17)	User testing	Formative	10-15	external dance experts
Whole body interaction	May - July 2017 (M7)	User testing, Interviews, Focus Group	Formative	10-15	internal & external dance experts
Whole body interaction	September - October 2017 (M21-M22)	User testing, Interviews, Focus Group	Formative	10-15	internal & external dance experts
Integrated personalized Learning Experience	January 2018 (M25)	User testing, Interviews, Focus Group	Formative	10-15	
Integrated Personalized Learning Experience	September - October 2018 (M33)	User testing, Interviews, Focus Group	Summative	15-20	

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10 Appendix

UEQ Questionnaire

10.1 UEQ -Questionnaire

Please make your evaluation now.

For the assessment of the product, please fill out the following questionnaire. The questionnaire consists of pairs of contrasting attributes that may apply to the product. The circles between the attributes represent gradations between the opposites. You can express your agreement with the attributes by ticking the circle that most closely reflects your impression.

Example:

attractive	○ ⊗ ○ ○ ○ ○ ○	unattractive

This response would mean that you rate the application as more attractive than unattractive.

Please decide spontaneously. Don't think too long about your decision to make sure that you convey your original impression.

Sometimes you may not be completely sure about your agreement with a particular attribute or you may find that the attribute does not apply completely to the particular product. Nevertheless, please tick a circle in every line.

It is your personal opinion that counts. Please remember: there is no wrong or right answer!

Please assess the product now by ticking one circle per line.

	1	2	3	4	5	6	7		
annoying	O	O	O	O	O	O	O	enjoyable	1
not understandable	O	O	O	O	O	O	O	understandable	2
creative	O	O	O	O	O	O	O	dull	3
easy to learn	O	O	O	O	O	O	O	difficult to learn	4
valuable	O	O	O	O	O	O	O	inferior	5
boring	O	O	O	O	O	O	O	exciting	6
not interesting	O	O	O	O	O	O	O	interesting	7
unpredictable	O	O	O	O	O	O	O	predictable	8
fast	O	O	O	O	O	O	O	slow	9
inventive	O	O	O	O	O	O	O	conventional	10
obstructive	O	O	O	O	O	O	O	supportive	11
good	O	O	O	O	O	O	O	bad	12
complicated	O	O	O	O	O	O	O	easy	13
unlikable	O	O	O	O	O	O	O	pleasing	14
usual	O	O	O	O	O	O	O	leading edge	15
unpleasant	O	O	O	O	O	O	O	pleasant	16
secure	O	O	O	O	O	O	O	not secure	17
motivating	O	O	O	O	O	O	O	demotivating	18
meets expectations	O	O	O	O	O	O	O	does not meet expectations	19
inefficient	O	O	O	O	O	O	O	efficient	20
clear	O	O	O	O	O	O	O	confusing	21
impractical	O	O	O	O	O	O	O	practical	22
organized	O	O	O	O	O	O	O	cluttered	23
attractive	O	O	O	O	O	O	O	unattractive	24
friendly	O	O	O	O	O	O	O	unfriendly	25
conservative	O	O	O	O	O	O	O	innovative	26