E-learning methods for teaching of movement

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Abstract The use of advanced e-learning methods for the teaching of movement (dance, different forms of sport or martial arts) has not been considered before in the e-learning literature. E-learning could have many applications in the teaching of movement as supplementary or reviewing material for a classroom course, or as material that is fitted to the individual student profile (student physical health and fitness, age, sex). In this respect, the instructional material for teaching of movement could be considerably different (for instance, teaching children would be very different from teaching adults). Finally, using advanced computer graphics and computer vision tools, it could be possible to introduced limited forms of feedback that evaluates the student's execution of movement.

Keywords e-learning, martial arts, dance, sport, computer vision

1 Introduction

Among many contemporary applications of e-learning technology, there are a few examples of the teaching of movement: dance, different forms of sport or martial arts. These applications [2, 3] usually focus on two aspects of teaching of movement: theoretical information about movement (for instance, teaching of traditions and behavior related to the dance styles or martial arts forms) and teaching of practical movement execution (for instance, steps and figures of a dance or positions and forms of a martial art). In the teaching of theoretical information about movement, simpler forms of e-learning (hypertext presentations) are usually used. In the teaching of movement execution, diagrams (figures), photographs and instructor films are usually used. To date, there has been no attempt to apply advanced e-learning methodology to the subject of teaching movement. Yet, we consider that in this area e-learning can be very useful.

Applications of e-learning for the teaching of movement would allow to create instructional materials that are more individualized and student-centered than traditional lessons. E-learning material for the teaching of movement can often be very useful for reviewing purposes. If a student wishes to exercise learned material at home between lessons with an instructor, e-learning can help him remember and exercise the movements learned during previous lessons. Also, e-learning material could include and use information that is not utilized during traditional lessons due to lack of time. Last but not least, e-learning material for the teaching of movement can be individually adapted to the needs of the student that depend on his physical fitness.

In order to use advanced e-learning methodology, it is necessary to fulfill the following conditions:

- Structure the information about the problem domain to improve information access and learning,
- Create and use a student model to improve student learning,
- Use pedagogical information in the design of course structure,
- Create feedback about the student's performance that allows a student to correct his mistakes.

In this article, we shall present the results of a case study that consisted of creating an e-learning course of the Chinese martial art wu-shu. The case study can be considered as an initial step in the development of e-learning methods for the teaching of movement. Our goal has been to identify the most difficult problems in this domain and present tentative solutions to some of these problems. The main reasons for the choice of wu-shu as a subject was the availability of an instructor, and the large complexity of the movement in wu-shu exercises. A cooperation has been started with the trainers of the Polish national sports team in this discipline. This cooperation consists of joint preparation of instruction material, training program, and the use of established e-learning methodology (for instance, interactive adaptation of the training material to the knowledge of the student).

2 A student model for teaching of movement

One of the most important drawbacks of traditional, class-room methods for the teaching of movement is that instructors rarely have the time to adapt their teaching to the physical fitness of individual students. This can make it difficult for some students to follow the rest of the group, or, in extreme cases, cause physical injury. On the other hand, e-learning material can easily be adapted to the individual profile of a student. In the case study, we have identified the following characteristics that can be used to form a student model for adaptation of the course:

1. physical health (the record of previous or current diseases) and fitness
2. student expertise and knowledge
3. physical dimensions (weight, size)
4. age
5. sex

Additionally, other factors that influence student learning (such as time of day, temperature, etc.) could be taken in to account in the student model.

In the case study, the course material has been adapted to student expertise and student health/fitness by suggesting additional exercises (such as such as stretching exercises or exercises that increase the strength of certain muscles) or different ways of performing the movement, depending on the characteristics of the student. The adaptation of the material should be consulted with specialist (physicians). In particular, certain students may be advised not to proceed with certain exercises or parts of the material that exceed their physical capabilities, in order to increase the safety of exercising.

3 Structuring the information about movement using anatomical knowledge

The information about movement could be structured using an interactive, 3D anatomical model of the human body. This model would include information about the human skeleton, tendons, joints and muscles, together with the appropriate medical terminology. Note that this model is a form of system knowledge that is used to structure the knowledge in the problem domain – that is, knowledge about the execution of movement. An instructor could use the model to indicate the muscles and tendons that should be working or should be relaxed during the execution of certain exercises. This information could be later used by the student to evaluate and improve his performance.

Another application of the proposed body model is the searching for information about related exercises, or the impact of exercises on the human body. The student could select certain body parts, and the system would suggest a sequence of exercises for that body part; the exercises could be adapted to the physical health and fitness of a student.

4 Creating feedback in the e-learning of movement

From a methodological point of view, the use of photographs or films for the teaching of movement execution has a limited value. In a direct contact with the instructor, the student is able to copy the instructor's movement and compare his movement to the movement of the instructor. The study is simplified also because the student can observe the instructor from an arbitrary direction. Using a computer that displays an instructor film, the student can have difficulty to copy the instructor's movements, since the instructor is visible on a monitor and the student has no possibility of directly comparing his movement to the movement of the instructor. A film can also be insufficient if the student requires to observe the movement from a different direction than the direction of the camera.

To increase the efficiency of methods for computer-aided teaching of movement execution, it is possible to use an additional camera that films the student during movement execution. Such a film, or pictures of the student in certain positions, can be used (under certain conditions) to analyze the movement of the student and compare it to the movement of the instructor. (Note that a much better analysis could be carried out if the student would have access to a motion tracking system. However, since these systems are very expensive and require special equipment, we assumed in the case study that the student would have access to at most two digital cameras or WebCams.)

One of the methods of such an analysis would be overlaying the film of the student and the film of the instructor. This would enable the student to compare his movement to the movement of the instructor. In order to overlay the films, it becomes necessary to synchronize the movement of the student and of the instructor. This can be achieved by the previous exercise of movement speed and by synchronizing the student's movement using sound signals (a voice that describes the stages of movement of the instructor). Additionally, the two films should be made on a similar space.

Another method of analyzing the movement of a student relies on the extraction of information about the movement from films or photographs. In the case study, we have used two pictures of a student standing in selected wu-shu positions. The information about the position of bending points in the body of the student and the instructor could be extracted by using markers worn by the student, or by asking the student to mark certain points on a picture (this approach has been chosen in the case study). This information would make it possible to use expert rules that have been prepared by the instructor, to correct the body position of the student. The mechanism used in the case study can be decomposed into the following stages:

1. Prepare two pictures of the student standing in a selected position from an identical distance and different angles
2. Ask student to mark certain body points on the pictures
3. Fit a 3D skeletal model of the human body to the location of the points
4. Use expert rules prepared by the instructor to evaluate the students' position, and suggest improvements

The fit described in point 3 could be carried out using techniques of stereovision. In the case study, we have used the Maya program to manually fit the skeletal model to the pictures.

To prepare the rules that evaluate student positions, the sequence of evaluating a position can be carried out using films or photographs of the instructor. The instructor could prepare material about correct and incorrect execution of the movement. These materials can be used to prepare an initial set of rules that would be later evaluated by the instructor. Note that the rules should not produce binary evaluations, but rather an evaluation on a certain scale, as well as suggesting a way to improve the position or movement.

5 Conclusion

In this article, we have presented the results of a case study in the creation of an e-learning course for the teaching of movement. We have proposed a student model that allows course adaptation, discussed ways of structuring information about movement, and described methods of introducing limited feedback about movement execution. Among the most difficult problems is the introduction feedback about the execution of movement. In the case study, we have proposed methods for creating feedback about static positions. However, this is clearly insufficient for even the subject of the case study (wu-shu). For instance, the speed of movement execution is a significant factor of correctness. The extension of feedback towards the entire movement requires further research. Among other problems is the development and use of expert rules to evaluate and correct movement execution. The other mechanisms proposed in this article (use of 3D anatomic models for the structuring of information about movement, and course adaptation using medical information) will be among directions of future work.

The created training materials will be tested by volunteer students and evaluated by instructors. Another aim of the research project is the study of methods for preparing instructional materials for e-learning of movement.

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