LEARNING TO COPE WITH STREET DANGERS: AN INTERACTIVE ENVIRONMENT FOR INTELLECTUALLY IMPAIRED.

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Abstract

Intellectual disabilities are one of the main causes due to which people can never reach a completely independent living. Among these, congenital disabilities that affect people from birth cause a deep limit, they have a lifelong impact and reduce their learning skills.

Down Syndrome is the world's most common chromosomal disorder and cause of intellectual disability. Cognitive development is usually delayed and learning difficulties persist throughout life.

Typically, individuals with Down Syndrome tend to learn more slowly, so learning requires a longer time. They also have difficulty in learning transfer (generalization), the ability to apply old knowledge or skills in a different situation or environment, they seem to forget learned skills from one day to the next, as previous learning is often not transferred to future experiences. This is a problem in every learning context, including mobility.

One way to support learning is to provide them a multisensory learning experience, using as many input channels as possible and involving repetition with expansion and reinforcement of previously learned skills. Furthermore, the approaches that are more concrete and similar to the real life world are often those that give better results.

As far as mobility issues are concerned, there is a problem related to the physical dangers that moving freely in the road implies. People with the Down Syndrome need a long training period that has necessarily to be carried out with the constant presence of an educator, usually starting from a simulated environment and moving into the real streets in a second moment. The simulated environment traditionally used guarantees safety but lacks in similarity to the real world.

The paper deals with the development of a system that tries to address this problem by providing a safe "real life" like environment in which the user can train to move safely in the road. This is reached through the immersion in a virtual environment through a multidisplay setup, a close reproduction of the street noises and a natural computer interaction based on gestures and body movements recognition.

Sight and hearing stimulations along with the free movements allow a total immersion of the end user, who is emotionally involved and therefore learns how to best react to frightening or emotionally stressing situations.

The foreseen advantages are that this innovative approach will reduce significantly the time needed to complete the "on the street" training and the risk of accidents. The system is still under development and will be tested on a significant sample of the target population.

Keywords: disability, cognitive impairments, Down Syndrome, mobility, serious games, simulated learning environment

1 INTRODUCTION

Down Syndrome (DS), also known as trisomy 21, is the most common genetic cause of intellectual disabilities. DS occurs in 9.0 to 11.8 per 10,000 live births [1], and is associated with impairments in language [2], cognition [3], learning and memory [4]. Furthermore, it appears not to change in time or geographical area, while it is closely related to the mother's age which is, in the western world, increasing. [5]

Even if in the last few decades, the percentage of babies born with the DS in Europe and USA has slightly dropped since more that 90% of pregnancies in which the DS has been diagnosed are terminated, the number of people affected by DS still is significant [6].

Their life expectancy has increased considerably in recent decades, from 25 in 1983 to 60 today and now that they are living longer, the needs of adults with DS are receiving greater attention.

With assistance from family and caretakers, a significant percentage of adult with DS show the capability to reach some level of autonomous living: have a job, do the shopping, help in house works, etc. Furthermore, they can have a satisfying social life and usually some activity to fill their free time. In order to reach these objectives, being able to move around town by themselves, in a safe and correct manner is fundamental.

Traditionally, the basic abilities for moving around town are reached after a long training under the guidance of educators. This training is “analogue” and gives the basic knowledge about dangers and the correct behaviours through films, images, drawings, verbal descriptions and indoor reconstructions of the road through toys, lines on the floor, etc.

A digital approach, which can better simulate the real roads and their dangers, will allow for a more effective and faster learning. At present, we have not found attempts in this direction described in the literature. This paper focuses on a digital serious game (“Friendly Road”) which meant to pursue the innovative digital approach.

Starting from the learning difficulties of individuals with DS, section 2 discusses the learning strategies adopted in the development of the game. In section 3, we discuss the traditional approach to the training for moving around town safely and, in section 4, we describe the game and its features. Section 5 concludes summing up our work and supposing further works.

2 LEARNING STRATEGIES ADOPTED IN GAME DEVELOPMENT

One of the main problems for intellectually disabled users is their weak capability of conceptualization and generalization [7]. It is therefore difficult for them to abstract a general concept from their experience and apply it to new situations.

According to Piaget's theory of cognitive development [8 and 9], the human intelligence goes through the following stages: sensorimotor, preoperational, concrete operations, formal operations. Keeping most of the learning on the sensorimotor stage, where the environment is experienced through sensory and motor experience allows cognitive disabled people to keep to the lowest level, the more accessible one and the one on which they have already based most of their basic knowledge of the world.

Working with a “hands on material” approach has shown good results in education strategies, as well as learning in real life situations, which do not require any abstraction processes. This is true also for mobility issues: any abstract learning as, for instance, reading maps, is not feasible [10]. The traditional approach is based on the real town environment where the impaired people are taken directly on the road by the educators to learn by doing.

Kebritchi et al. [11] identified five instructional strategies rooted in the concept of learning through realistic experiences with environment. The five instructional strategies include:

1. Learning by doing, where learning takes place in the context where it will be used, with a relevant goal, meaningful, and interesting to students.
2. Experiential learning, where the learner experiences are used to facilitate learning.
3. Guided experiential learning, which assumes that additional guidance should be provided to learners.
4. Case-method teaching, which provides trainees with opportunities to analyse rich and realistic stories that are relevant to their learning.
5. Experiential and inquiry-based learning, which focuses on hands-on actions and reflections as the two main components of the learning process.

Our approach is based on the first three strategies: it offers a learning by doing approach giving the player a virtual real-life like environment in which to act and uses his experience to facilitate further learning. Furthermore, an educator will supervise the game and will give further guidance whenever needed.

In literature, there are several other studies about learning taking place in a real life environment, based on concrete experiences.

According to Lave and Wenger [12], situated learning is learning that takes place in the same context in which it is applied. It is not simply the transmission of abstract and decontextualized knowledge from

one individual to another, but a social process whereby knowledge is co-constructed; such learning is situated in a specific context and embedded within a particular social and physical environment. Situated learning was first projected by Jean Lave and Etienne Wenger as a model of learning in a community of practice. This type of learning allows an individual (students/learner) to learn by socialization, visualization, and imitation.

This approach can be simply defined as using learner experiences to facilitate learning. During experiential learning, educators purposefully engage learners in direct real-life experience and direct their focus on learning reflection to increase their knowledge, skills, and values [13]. Experience occurs because of interaction between human beings and the environment in forms of thinking, seeing, feeling, handling, and doing. Experiential learning is also based on the observation that people learn best by doing. Although the experiential learning strategy can start with didactic (passive) forms of instruction, it soon progresses to experiential (active) forms of learning. An instructional strategy, posited by Kolb [14] embodies the principles of experiential learning; Fig. 1 shows the sequence of learning stages. The cycle starts from concrete experiences, which are the base for observations and reflections. These transform concrete experiences into abstract theories used to explain the previous observations, which stimulate new actions with the aim of testing them. The new actions form new concrete experiences, which give start to a new repetition of the learning cycle. The learning process is a continuous cycle of experiencing and exploring [15].

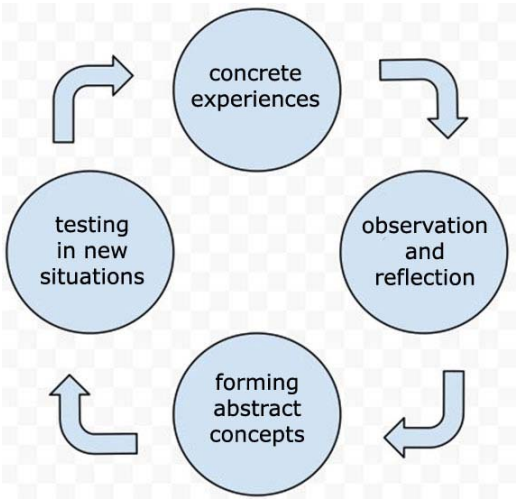

Fig.1 - David Kolb's Experiential Learning Model (ELM).

When dealing with people with DS, due to their limitations in abstraction and conceptualization, the same learning cycle is slightly different since abstract concepts will have to be replaced with the memorization process and the testing phase by repetition (see Fig. 2)

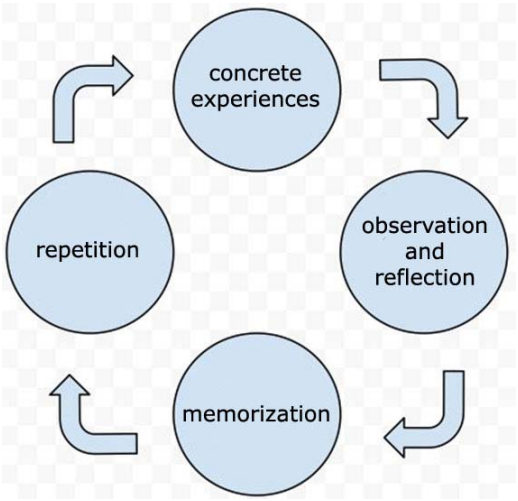

Fig. 2 - Adaptation of Kolb's RLM for people with cognitive impairments

The learning experience may take place equally in real or artificial environments. As Egenfeldt-Nielsen stated, “In today’s computer games you are part of a living, breathing, simulated universe with very concrete self-sustaining experiences–getting still closer to reality” (p. 125) [16]. Computer games, which may be designed to match the context of everyday life, can connect the players to real-life experience. Such concrete experience is the heart of the experiential learning approach in which knowledge is constructed, not transmitted, because of experiencing and interacting with the environment.

Our approach allows addressing these issues by offering a learning environment, which is as similar as possible to the real life experience, allowing a learning by doing experiential approach. At the same time, the virtual experience takes place in a safe place, where real dangers are kept away from the final user until the moment in which he shows that he is able to cope with them. Only at that moment will the user be allowed to exit in real streets and face its dangers.

Along with the previously stated limits in conceptualization, abstraction and learning transfer characteristic of people with DS, also memory management can have limitations.

If repetition is a central activity in any learning experience, it is even more so for people with DS since they tend to show weaknesses in remembering verbal inputs for a short time and selective deficits in memory retrieval [17]. It is widely suggested to teachers to rely more on repetition and positive feedbacks in order to allow the student to memorize and avoid losing interest [18].

The serious game approach has the advantage to motivate the player by giving both goals to be reached and positive feedbacks, keeping therefore his interest high and facilitating the acquisition and memorization of the newly learned concepts. The game approach not only allows as many repetitions as necessary, but it also pushes them by asking the user to face the same situation several times in different layouts and environments. The basic concept is reviewed over and over while it is presented in most of its possible layouts.

3 TRADITIONAL APPROACH TO THE ACQUISITION OF MOBILITY ABILITIES

Most people with DS have or can develop the basic abilities to allow them to move around town on their own. Traditionally this objective is reached after a long training that is performed by educators specialized in the specific characteristics of the target population. During this training, particular attention is given to street dangers.

One of the typical effects of the DS is that reaction times get longer while fine motor control is compromised. This means that DS pedestrians have to be even more careful and know exactly how to behave to avoid dangerous situations in the road.

Furthermore, stress and frights may induce the wrong kind of behaviour. For example, when an ambulance goes by with the sirens on, the pedestrian may be alarmed by the loud noise and may step into the road as a way to get away from it. This could be a very dangerous situation. Therefore being able to manage his own emotions is one of the basic capabilities that are needed to move safely. People with DS often have also slight hearing impairments, which may cause them to react even more to sudden noises since they may be not so easily recognized.

Usually, the target population undergoes a first “theoretical” training level, in which they are given the basic knowledge about dangers and the correct behaviours. This may happen through films, images, drawings as well as verbal descriptions. At the end of this first level, the users are usually taken to a virtual reconstruction of a road in which they have to go through a pre-defined path in the safe and correct manner. It usually is an indoor reconstruction using toys, lines on the floor, etc.

This approach has the advantage that it puts the user in front of a safe reconstruction of the street situations, but there are several limits. The virtual environment is obviously not a real road; it does not have the same kind of stimuli (e.g. no wind, no street noises, no other people, etc.), therefore some level of conceptualization and generalization are needed in order to be able to apply the learned behaviours to the real life situation.

Fig. 3 - A traditional training session on mobility
(http://www.comune.venezia.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/62909)

After the user has demonstrated that he can correctly behave, he is taken out into the real life roads accompanied by the educator to face the real situations. When the educator feels that the user is ready, he will let him move around "alone", but still silently controlling him in order to be able to intervene if needed. At the very end, the user will actually be free to move autonomously.

Another drawback of the traditional approach is that while the user is learning in the street environment, not all potentially dangerous situations may naturally occur. While it is possible that the user actually learns how to walk correctly on the pavement, cross on zebra crossing, look at traffic lights, it may be the case that that user has never tried other specific situations. For example, he has never been on a narrow pavement while an ambulance is going by, or waiting at the red lights while other people are crossing.

The use of our game will certainly not replace the described procedure as a whole, but it will free some educator time giving the user the possibility to practise by himself and shortening the real world phase (the user will have learned more that he could learn with the traditional methods and therefore will be more ready for the road). The game will also offer the user the possibility to experience most of the potentially dangerous situations.

4 THE "FRIENDLY ROAD"

The "Friendly Road" is a serious game, specifically designed for intellectually impaired people, based on a virtual, visually immersive environment enriched with a close reproduction of street noises and events in which the user can interact with the computer through free natural gestures.

5 CONCLUSIONS AND FURTHER WORKS

At the present time, there is a significant percentage of the world population that is affected by some kind of intellectual disability and has, therefore, some level of learning difficulty. In particular, we focused on people with DS.

In order to reach a basic level of independent and satisfactory living, one of the main issues is autonomous mobility. Most DS people have or can learn the main abilities to be able to face the road and its dangers by themselves. This is traditionally reached after a rather long "analogical" training.

In this paper, we describe an innovative "digital" approach that starts from the specific limits and difficulties that characterize these types of disabilities and takes into account some of the most important learning theories to design and develop an immersive serious game: the "Friendly Road".

It is expected that the use of the "Friendly Road" will impact on the training phase that young adults undergo to gain the needed abilities to move around town by themselves. The game will be used with the help of an educator in charge of guiding the end user towards his independence. The educator will still have a very important role that cannot be replaced by any automatic evaluation, as well as being

physically present if needed until the trainee will have demonstrated a full and complete understanding of the street dangers.

Nevertheless, the “Friendly Road” will give the opportunity to practice more and alone, to keep the user motivation high [25] and give him the challenge to reach pre-defined goals. This will facilitate the educator’s role by helping the player in creating a good and solid basic knowledge on which it will be much easier to build the other mobility skills.

In future, the same game, based on such an intuitive and simple approach, could be useful also for other target populations such as, for example, young children. Mobility can be an issue that impacts also on education, therefore links with projects aimed at maximizing inclusive education [26] are planned.

Adaptation to other countries is also foreseen. The localization to different cultures will be taken into account during the development of the game so that it will be minimized. The road environment and the street signs will have to be changed to those belonging to the new target country, but most of the planned situations are culture independent and can therefore be re-used.

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