Applying Gagne's nine events of instruction in development of a serious game for training maintenance activity on power live-lines

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ABSTRACT

A prototype serious game is being developed using Unreal ® Engine 4 (UE4) within an R&D project proposed by an energy utility company. In this "point-and-click" serious game, the main goal is to perform the replacement of a damaged pedestal-type insulator in a power substation. As a conceptual basis, the theory of learning proposed by Robert Gagné was used. Gagne proposes a nine-step process that details each element required for an effective learning and provides educators with a checklist to use before and during the training activities. As each step is accomplished, learners are more engaged and retains more skills and information. Gagné´s model has been widely accepted as a means to better manage learning and training processes. This work describes an application of Gagné´s model to a serious game which aims at providing electricians with a more effective learning tool, focusing on knowledge, skills, attitudes and decision-making during a very risky activity.

Keywords: education, game design, serious games.

1   INTRODUCTION

Due to the difficulty that currently exists in the training of people with specific skills and abilities to perform critical activities in the electric sector, a research and development (R&D) project was created for a virtual environment for the training of substation technicians and power transmission lines. The goal of this R & D is to provide great benefits, both in terms of learning, as well as in terms of resource savings, time, risks, life danger, logistics, flexibility and availability.

 Within this larger project, the need arose to carry out a pre-assessment of the operators through a complementary method mainly regarding their decision making and learning in a specific activity, for which a point & click game is being developed. This game will simulate possible situations for the accomplishment of a standardized task: the replacement of pedestal isolator in a substation.

In order to accomplish this task and validate the results obtained, the concepts of learning and instructional design presented by Robert Gagné in his books were used: [1] Conditions of Learning, [2] Principles of Instructional Design, and [3] The Essentials of Learning for Instruction.

Gagne's theories presents the idea that different instruction events are required in order to obtain different learning results. Some events are applied directly to the student in order to constitute necessary learning conditions and specific operations. The theory of learning hierarchies define what intellectual skills are to be learned in a well-defined sequence of instructions.

2   SERIOUS GAMES

The problem of interaction and mediation between humans and computers depends on several topics, based in [5]: emotions, affective computing, cognitive ability, decision making, social perception and virtual interaction among others. It is understood that in the context of games that present a high level of computer mediated interaction should focus on man-man and human-computer interactions. The use of technology as a systematic complementary training mechanism promotes technological evolution through new methodologies, state of the art and new interaction models, being characterized in a context R&D. In this context, serious games are defined as games that convey a message rather than being merely an entertainment tool.

These games can try to raise awareness for a specific social cause, can be used in advertising and product placement, education, vocational training, being part of therapies and many other fields. This does not mean that entertainment and fun are not considered, as it may be part of the experience intended by the designer, this means that the message takes precedence over such matters. The term serious game is believed to have first appeared in [4]: "Games may be played seriously or casually. We are concerned with „Serious Games" in the sense that these games have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement. This does not mean that serious games are not, or should be not entertaining". In other words, serious games are games in which entertainment is not the main factor. It may implement some techniques to make the experience increasingly enjoyable or even fun, however that is not the real purpose of the system.

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3   THE CONDITIONS OF LEARNING

Robert Mills Gagné was a psychologist who focused his studies in the educational area. He has created a nine-event process that details each element and condition necessary for effective learning. These events have been widely used in training activities. This theory predicts the existence of several different types or levels of learning, which require different types of instruction. For Gagné, learning is a visible (internal) process of change in the individual's capacities and occurs mainly in the interaction of the subject with his/her environment (physical, social, psychological). If learning occurs, a persistent behavioral change is observed.

Gagné identifies five categories of learning: verbal information, intellectual skills, cognitive strategies, motor skills and attitudes. According to Gagne [1] different internal and external conditions are required for each type of learning. Within these categories are eight different types of learning (from the simplest to the most complex):

1. Signal learning - conditioned reflex with general, diffuse and emotional responses

2. Stimulus-reaction learning (SR) - motor learning, which is distinguished from the above mainly by the results - the reaction obtained to a stimulus (S) is reasonably precise, defined and muscular.

3. Chain learning - - sequencing of two or more previously learned SR connections, provided there is contiguity between them

4. Verbal association - - learning verbal chains, can be considered a particular case of the previous one, to which special emphasis is given, given the importance of language in the human being; Each individual develops from his childhood his own codes.

5. Learning multiple discriminations - often identified with "colored" knowledge, consists in discriminating, from previously learned chains, elements with a set of common characteristics; The new chains seized may interfere with the previous ones, which is a possible explanation for forgetfulness.

6. Learning concepts - - correctly identifying an object or event that first appears as belonging to a class.

7. Learning principles - establishing a chain between two or more concepts, should not be confused with a simple verbal association.

8. Problem solving - requires internal conditions (thinking); Two or more previously acquired principles are combined in a way to produce a new capacity - problem solving strategy. If this represents a principle of higher order, we are in the realm of creativity.

3.1   Nine events of instruction

In addition, the theory outlines nine instructional events and corresponding cognitive processes, 'these events should satisfy or provide the necessary conditions for learning and serve as the basis for designing instruction and selecting appropriate media'. [2] (Gagne, Briggs & Wager, 1992).

The following we have the nine events of instruction and how they relate to the learning process, reproduced form [2].

1. **Gaining attention - Reception of patterns of neural impulses.**
2. **Informing learners of the objective - Activating process of executive control.**
3. **Stimulating recall of prior learning - Retrieval of prior learning to working memory.**
4. **Presenting the stimulus - Emphasizing features for selective perception.**
5. **Providing learning guidance - Semantic encoding; cues for retrieval.**
6. **Eliciting performance – Activating response organization.**
7. **Providing feedback - Establishing reinforcement.**
8. **Assessing performance - Activating retrieval; making reinforcement possible.**
9. **Enhancing retention and transfer – Providing cues and strategies for retrieval.**

4   APPLYING THEORY IN PRACTICE

In this topic we will cover the insertion of the steps and stages of the game with the nine events of Gagne's instruction. For the first learning event: Gaining attention (reception) an introductory stage was developed in which players will be inserted into a story with a short video showing where maintenance activity will take place and what happened to make the replacement of the isolator necessary.

For the second learning event: Informing Learners of the Objective (Expectancy) the goal of the mission to be fulfilled as a whole, as well as the secondary objectives of learning during the step-by-step, will appear on the player's screen. In this event is very important that the players understands why they're learning this new information, and what the risks are if they don't learn it, they'll be more motivated and more receptive to your training.

For the third learning event: Stimulating Recall of Prior Learning (Retrieval) players will have to apply their previous knowledge by performing a checklist of the equipment necessary to carry out the substation pedestal insulation replacement, with Safe Line Safety and Standardized. The equipment is presented in a virtual room in which the player chooses them beforehand, at the end of this step the player is informed if he has made the right choices or if he must retake this step so that he can proceed to the next phase.

For the fourth, fifth and sixth learning events: Presenting the Stimulus (Selective Perception); Providing Learning Guidance (Semantic Encoding) and Eliciting Performance (Responding): the players will have to effectively perform the activity by following a step-by-step that is displayed on the screen with each click with the mouse. In these phases it is guaranteed that the players demonstrate their knowledge about this activity. To be perfectly accomplished, it is necessary for the trainee to complete the stages and the thirty goals step-by-step as follows:

Stage 1 - Signaling and Isolation: Players should choose to signal and isolate the area using reflective tapes and cones.

Goal 1 – Pick the necessary tools and individual protection equipment (IPE)

Figure 1: Prototype of substation and inventory.
Source: OneReal Research Group.

Stage 2 - Start the required activity
Goal 1 - 1 - Install the saddle and collar in the base column on side 1 (right);
Goal 2 - Attach the claw rod to the collar and saddle the side 1 (right);
Goal 3 - Attach the top of the claw rod on side 1 (right) on the driver;
Goal 4 - Install the saddle and collar in the base column on side 2 (left);
Goal 5 - Fix the inverted claw rod on the collar and saddle on side 2 (left);
Goal 6 - Fasten the reel with the synthetic fiber rope to the end of the stick;
Goal 7 - Rotate cage in order to raise the rod with the reel and rope at the tip;
Goal 8 - Install and hang the top of the insulator with a universal stick using a universal stick;
Goal 9 - Connect the string in the spool;
Goal 10 - Use a universal rod with the ratchet wrench to loosen the screws above the connector;
Goal 11 - Remove the top of the connector with a universal stick with a spine at the end;
Goal 12 - Suspend the cable through the gripper rod on side 1 (right);
Goal 13 - Tying the rope attached to the spool;
Goal 14 - Remove the screws from the bottom of the insulator with the ratchet wrench;
Goal 15 - Passing rope on the base of the insulator to assist in the descent;
Goal 16 - Pull rope to lift the insulator (remove from place);
Goal 17 - Completely remove the insulation from the floor;

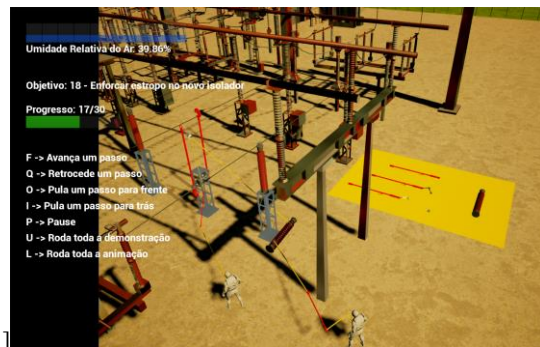

Figure 2 – Demonstration of goal 17 accomplished.
Source: OneReal Research Group.

Goal 18 - Hang strap on new insulation;

Goal 19 - Suspend new insulator;
Goal 20 - Attach guide wire to the base of the new insulator;
Goal 21 - Lift new insulator to the correct position with the aid of the guide rope;
Goal 22 - Screw the insulator base into the column using the ratchet wrench;
Goal 23 - Release the claw rod collar from side 1 (right) to lower the lead wire to the insulator connector;
Goal 24 - Close the connector screws using the universal rod with the ratchet;
Goal 25 - Disconnect the claw rod from the driver;
Goal 26 - Remove the claw rod from side 1 (right);
Goal 27 - Remove cell and paste claw from side 1 (right);
Goal 28 - Removing straps from the insulator;

Figure 3: Demonstration of goal 28 accomplished.
Source: OneReal Research Group.

Goal 29 - Remove cell and paste claw from side 1 (right);
Goal 30 - Collect equipment.
Stage 3 - Activity Conclusion

For the seventh and eighth learning events: Providing Feedback (Reinforcement) and Assessing Performance (Retrieval) after the players demonstrate their knowledge in the previous steps it is necessary to provide feedback and reinforce the flaws. Feedbacks should always indicate errors so players can improve their performances.

For the Ninth learning event: Enhancing Retention and Transfer (Generalization) players must replay the game and demonstrate full knowledge of the stages and should complete the activity without major difficulties. Repeated practice is the best way to ensure people get information and use it effectively.

5 CONCLUSION

Gagne's Nine Events of Learning provide a useful approach to gaming training for risky activities. When using the nine instructional events there are guarantees that the trainees understand and maintain the knowledge completely. A different instruction is always required for different learning results. The Gagne's learning events act in the players of ways to provide all necessary learning conditions in a serious game.

The prototype presented here sought to present this learning theories applied to education with the objective of future testing and certifying operators as to their knowledge of tasks, skills, attitudes and decision making during a risk activity in a work environment. We must remember that this short paper describes only the beginning of the development of the prototype game, thus still having many development stages to be fulfilled.

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