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EXTENSION OF THE CONCEPT OF MICRO-WORLD TOWARDS COOPERATIVE LEARNING THROUGH AN EXAMPLE

O. Gibaud[1], F. Tarpin-Bernard[2], P. Gaspard[3]

ABSTRACT

We had proposed an extension of the concept of micro-world using simulation and hypermedia techniques. In relation to Intelligent Computer Assisted Education, we had defined our concept as a new manner to consider learning and communication between participants (pupils, teachers, technical assistants, etc.) within an educational framework, with the aim of stimulating active learning within a systemic approach. In order to adapt this concept to cooperative learning, we present here a micro-world the pedagogic objective of which consists of the mastery of a driving situation demanding the respect of the Highway Code. For that we propose an integrated visual interface which associates the control of the driving system and the communication between the participants. The role of the pupil consists of handling a car in a collective context, supervised by an instructor. This work is supported by the realisation of a prototype under Windows.

Keywords: Micro-World, Cooperative Learning, Courseware, Simulation, Control of System, Vocal Communication, Highway Code, Role.

1. Département M.I.S. - Ecole Centrale de Lyon - B.P. 163, 69131 Ecully Cedex, FRANCE.
Tel. (33) 72 18 60 00, Fax. (33) 78 33 16 15, email: gibaud@cc.ec-lyon.fr

2. Id., email: tarpin@cc.ec-lyon.fr

3. Id., email: gaspard@cc.ec-lyon.fr

INTRODUCTION

Our research work is trying, on the one hand to extend the concept of micro-world, on the other hand to study and implement the mechanisms of cooperation within the framework of cooperative learning.

In particular, we have studied the possibility of cooperative learning centred on communication within the framework of the teaching of the Dynamic Data Exchange (DDE) protocol under Windows [1]. However, to define the limits of our approach we separated the systemic learning offered by a normal micro-world, from the communication proposed in priority by the DDE micro-world. We are attempting here to benefit from the two learning approaches.

Cooperative learning can a priori be either with a cooperative task (for instance in the framework of air control [2]) or with an individual activity. The first approach lends itself naturally to cooperative learning. But we are seeking here to bring to the fore the cooperation modes that can appear within the framework of an individual task.

For this we have chosen **Road Code learning** with a view to emphasising the cooperation aspect which can install itself between the driving instructor and his pupil and which can emerge from the communication between pupils in a same group. It is a question here of cooperative learning with emphasis on micro-world simulation.

THE EXTENDED MICRO-WORLD CONCEPT

A Micro-World is a learning system which allows a pupil (or a group of pupils as will be seen later) to control a simulated system interactively [3].

A Micro-World has at the same time a long term **pedagogic objective** which allows the Micro-World to play a role throughout a given learning period. A short term **game objective**, relative to a given working session, is associated with the pedagogic objective in order to motivate the pupil when he is using the Micro-World. It is understood that the game objective is there to contribute to the pedagogic objective.

A Micro-World is a learning system with a simulator (see for example [4]) which is inscribe within system with four component parts adapted to this kind of learning :

- the simulator model represents the **dynamic** aspect of the system and the simulator user interface allows for the activating and the evolution of the model. This represents the **multimedia** aspects of the system (visual, sound, text, etc.). The simulator user interface is organised around a key interactive image which induces the behaviour pattern of the pupil.
- a help module represents the system in its **cognitive** aspect (goals, behaviour patterns, etc.). This help comports exercises parallel to the simulation, Multiple Choice Questions and also the rules which can be applied to a simulated situation to propose solutions numbered and amply explained.
- the pupil sequence model interprets the relationship between the pupil and the simulator. This interpretation is based on observation of the behaviour of the pupil (the recording of his plan of action) and the synthesis of the results. The pupil sequence model represents the system in its **interactive** aspects (dynamic and cognitive interaction).
- the pedagogic control regulates rights of access to the simulated model and activation of its elements as well as the user interface, etc. It represents the system in its **pedagogic** aspect.

TOWARDS THE CONCEPT OF A COOPERATIVE MICRO-WORLD

In the framework of learning, two types of cooperation can be noted [5]:
- cooperation **between tutor and pupil**,
- cooperation **between pupils**.

This cooperation can be:
- either **external** to the Micro-World and elaborated with Micro-World remanent elements furnished by the pupil sequence model and usable for pedagogic control.
- either **internal** within the Micro-World (either in a real time session or not). In this case, the tutor-pupil cooperation gives real time access to the teacher in relation to pedagogic control. It gives the teacher the possibility of seeing what the pupil is doing (with the view of the pupil control post and the replaying of a recording of the sequence directed by the pupil sequence model. This also furnishes the student with the opportunity of demanding direct help from the tutor).

THE AUTOMOBILE MICRO-WORLD

The goal of the construction of the Micro-World consists of concentrating the effort of the pupil not on the driving itself (handling of the driving wheel, gear changing, pedal use, etc.) but on the **decisions** to take in a precise situation **in relation to the Road Code**. Thus, the pupil finds himself neither in a situation of a car-driving simulation, nor in the context of a questionnaire (Multiple Choice Questions) with slides of the driving school type. This intermediary level allows the pupil to participate in a dynamic situation centred on Code learning by direct adaptation.

The **pedagogic objective** of the Micro-World consists therefore for the pupil to be capable of respecting the code in any given driving situation.

With the aim of reaching and of testing this level of competence the pupil is presented with a **game objective** which consists of following a more or less detailed itinerary with for minimum details a departure point and an arrival point. For example: "You must go to Calais to Chancel & Co, 15, Resistant Street, buy some lace and then come back via Lille to pick up your grandfather, 5, Republique Street, and take him to your grandmother who lives at 45, General de Gaulle Avenue in Arras and who is waiting impatiently for you. In addition, in order to force the pupil to take decisions rapidly and to drive at a good speed, the entire mission is clocked and must be carried out in a minimum time, while obviously respecting the speed limits.

The simulator contains a network of **places**, (intersections, turnings, etc.) which is a virtual road network accessible to the pupil with the aid of a roadmap. Each place can give rise to a **driving situation**.

At a given moment the pupil situates himself either in one of these places (he is then at that moment in the process of confronting a situation), or he is in a **transition** between two places.

A place is a node of the network and, apart from the number of roads linked to it, it is characterised by its topography (the way in which it is joined to these roads) and by its simulated static elements such as houses, trees, etc.

A driving situation is characterised:
- on the one hand by **stationary elements** which give a concrete sense to the driving situation (road signs, road markings indicating the lane to follow, pedestrian crossings, etc.),
- on the other hand by **potentially dynamic elements** (other vehicles - cars, trucks, motor-bikes, etc. - pedestrians, traffic lights, traffic police, etc.). These elements react independently. Their reactions being either in conformity with the Road Code or define by a behaviour script linked to that of the pupil.
Thus, the acting of the dynamic elements are established in order to, for example, provoke a collision if the pupil does not respect the Code. In addition, if the pupil makes a mistake but succeeds in avoiding an accident, the simulator perceives this and, if necessary, gives him a ticket, for example.

We profit from the **transition** between places to handle the driver's mistakes by having a motor-bike policeman intervene and who deducts points from the pupil's licence. If the pupil does not make a mistake the transition time is used to provide him with driver information, direction signs, milestones, and luminous panels to give driving principles, the weather, the state of the traffic, etc. In both cases, the pupil can drive as far as the following place (which is usually the case and which is implied by the simulator) and either replay the preceding situation or turn back and confront a new situation in the same place.

The Key Interactive Image

Before turning on the ignition, the pupil sees the interior of his vehicle. He must think to attach his safety belt to adjust the driving mirror if necessary, and to release the handbrake. Once the ignition is on, he presses the "GO" button and find himself effectively in the road network.

Next, so as to be able to navigate in the network: the pupil is presented with a key interactive image (fig. 1). This always includes :
- a representation of the place situation confronting the pupil,
- a dashboard for vehicle control,
- a car telephone for communications with the exterior.

The **representation of the place-situation** corresponds to :
- either a view from above except for elements which cannot be identified or read, these being presented face up.
- or an image offered by a classical field of vision through a car windscreen.

In the present realisation of the simulator, the network only contains view from above for obvious questions concerning the possibility of animation. Later, the two views should be available to the pupil by simple switching over.

Between the two views the only operation that is really modified is that of the functioning of the driving mirror. In the first case a glance in the mirror results in a picture change which allows the pupil to see what is behind him. In the second case, an image appears in the mirror which is calculated in function of the immediate driving situation.

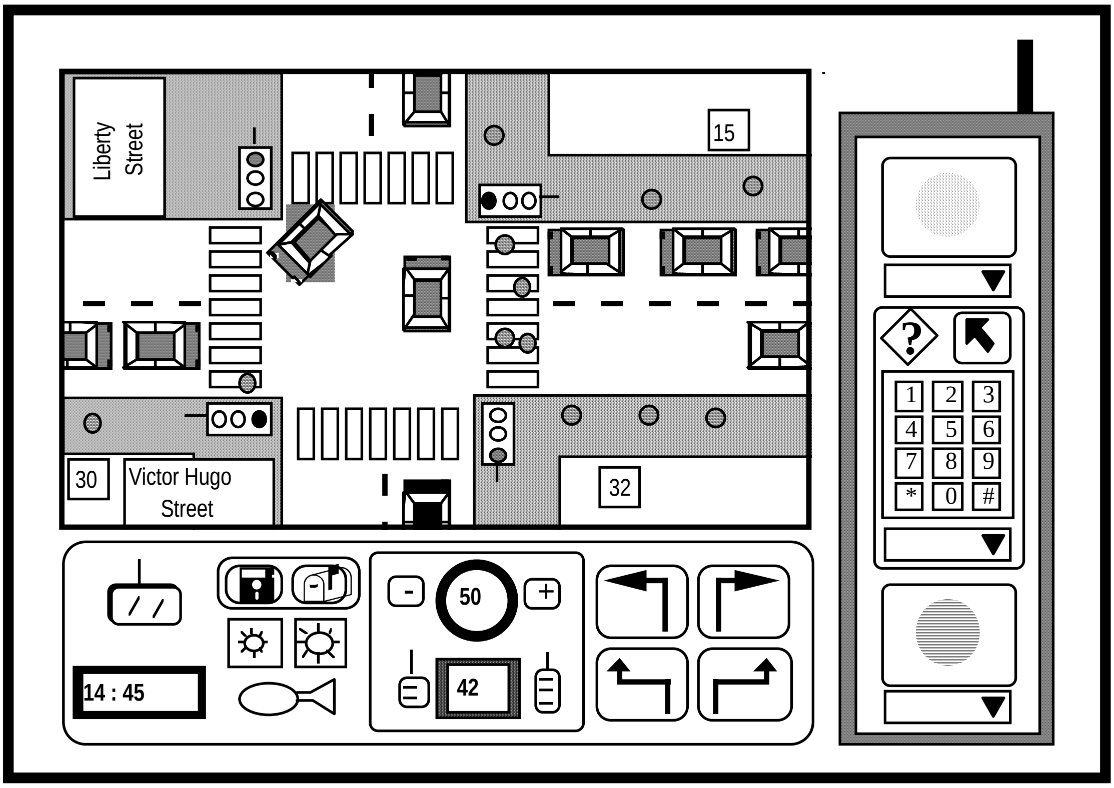

Fig 1 : Key Interactive Image of a Micro-World for a Pupil.

The actions controlled by the **dashboard** are situated, as previously mentioned, at the level of decision taking for the handling of the vehicle while respecting the Road Code. For this we have identified four types of action (from right to left in fig. 1) :
- direction control (turn left / turn right, lane changing to the left or to the right),
- speed control (to establish the speed limit, to brake / to accelerate),
- the control of hand levers (indicator to the left / to the right, headlight lowering or raising, motorhorn),
- control of the driving mirror and time reading.

The car telephone allows for vocal communication and is composed of three parts (from top to bottom in figure 1):
- the listening piece for taking a call (the name of the caller appears in the field),
- the digital keyboard gives the possibility of calling a correspondent by selecting one from a pop up list) and the activation of the "telepointer" or to ask for help.
- the microphone allows the pupil to interrupt a call (among the conversations taking place at a given time).

The Role of the Tutor and Tutor-Pupil Cooperation

The tutor plays the role of a driving school instructor controlling several cars at the same time except that he does not intervene to avoid an accident. In fact, in the framework of a simulated environment an accident is an excellent factor of pedagogic reinforcment. On the other hand, he is always advised of an accident and intervenes to analyse the causes with the pupil. He can in that case "take over the wheel" and show the pupil what he should have done. In addition, if he judges the situation sufficiently pertinent the tutor can interrupt other pupils so that they can share in his explanations and establish a collective dialogue. The dialogue between the tutor and any one pupil at a time is performed vocally to authorise effective "multi-modal" communication which is better adapted to this type of situation.

From a preventive point of view, the tutor can reply to the pupil's questions and also check the pupil's knowledge with reference to the road signs and signals met during a precise situation. Thus a question is always posed in its precise context. On the technical side, it is the "telepointer" [6] which is used to authorise the following sort of "multi-modal" question: "What does *this* road sign mean ?" (*this* is the one designated by my "telepointeur").

The tutor has equally the role of adapting the difficulty of the drive to the capacities of the pupil. For this, on the one hand he chooses a drive in term of stages (long or short drives, in built up areas, on motorways or highways), and on the other hand he chooses the type of situation proposed to the pupil by the drive (intersections with traffic lights, intersections or crossroads with respect for priority, overtaking of a slow vehicle, etc.). The situations are constructed beforehand with the aid of an editor. Nevertheless, they are chosen by the simulator as the pupil's drive evolves in order to respect the proportion of different types of situation desired by the tutor. In particular, the positioning of stationary elements at intersections, and of course the mobile elements, change from one game session to another.

The choice of the foregoing factors intervenes at the level of pedagogic control. It can take place before the session but can equally be modified in function of the pupil's mistakes during the session.

In addition, the tutor can propose that the pupils, either navigate in an independent network where they cannot meet other pupils, or navigate in a common network. In the latter case meeting up is encouraged and pedagogic control of the types of situation encountered will no longer be effected during a particular drive but in the entire network. Here it is a question of establishing a collective situation.

The Role of the Pupil and Cooperation Between Pupils

The pupil play the role of a car driver but is exempted from reflex actions while driving.

Concerning cooperation among pupils we envisage two types of cooperation:
- participation in a collective game scenarios,
- driving with a driver and a co-driver.

In order to motivate pupils collectively with a common game objective, a pupil can see himself proposed with the following goal: "You have an appointment with Phillip at 2 p.m. in Lille at the service station in Jean-Jaures Street. He will give you a document then you must go to the station to meet your son who will arive on the train from Paris at 2.15 p.m. Finally you must go to Wilson Square where you have an appointment with the other pupils at 2.30 p.m." In this case the coordination of the actions has no other objective than to motivate the pupils.

Another possibility consists of proposing that the two pupils drive the same vehicle with two computers. One plays the role of a driver, the other of the co-driver. The second indicates to the first what he must do (in this case, only the co-driver knows the way and he must indicate the itinerary to the driver as he goes along). This type of cooperation improves the explanation of the decision making process. This possibility also allows the tutor to intervene directly in the conversation.

THE PRESENT WORK SITUATION AND FUTURE PROSPECTS

We are currently realising this prototype with the Toolbook and C++ langages under Windows by basing our work on the "Multi Facets Agents (AMF)" cooperative model which we have already elaborated [7]. Network communication respects the communication rules of N-DDE of windows.

From the point of view of the chosen example we have intentionally limited our analysis to the case of an essentially individual task (to drive a vehicle) in a collective environnment (supervised teaching and other network users). To analyse coordination of action learning within a group, it would be advisable to choose an example where the task to be accomplished is collective by nature. Nevertheless, this first analysis has turned out in this particular framework to be one of the most useful because it has already established the evidence of many interesting situations of cooperation.

In addition, it seems to us indispensable to test and to evaluate our product in an operationnal situation in order to study the way a group will make use of it. It is in this sense that it seems to us that our approach which consists of concentrating on the problem of cooperative learning with concrete examples on basing our work on a concept and an architecture which has already proved itself is the most fruitful. In fact, in the matter of cooperation, if the technical aspects are indispensable and must continue to be elaborated, it is the establishment of new uses that is still bitterly lacking.

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