

Natural Seriousness in Learning

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ABSTRACT

This paper addresses student's seriousness in learning. It is investigated through an experiment with teams of students working on a design project. Students are provided with minimal instructions to design a mobile vehicle with Lego RoboLab. It is a powerful tool integrating technology managed through icon-based programming. Our study accounts for students' step-by-step work necessary to design such a vehicle. It reveals how important natural seriousness is in the process. Our point is that traditional educations have despised natural seriousness at the advantage of cognitive view of student's abilities. We see computer-supported learning as an occasion to correct an historical misconception regarding education. Our experiment shows how knowledge is an entirely pragmatic matter that includes, for example, scenic features of the classroom environment.

Keywords

Computer-Supported Learning, Instruction, Design, Scenic Features of Knowledge, Natural Seriousness.

INTRODUCTION

This paper describes a case of students' learning under natural condition of seriousness. This is done at university level thanks to a design project that consists to build a computerized mobile vehicle. This detailed description of the experiment shows how to avoid many pitfalls of a cognitive model of rule following. This is critical of the model of teaching as knowledge delivery. We call it 'experiment' because the teaching is dependent upon students' achievements that are unknown to tutors themselves. Students' work is done without a predefined set of procedures. It is a place where students have to design an object. The setting makes the best of student's emerging standard of adequacy of relevant knowledge for a given purpose, at a given time of the achievement of the project.

This project has already some historical background that is necessary to remind (Johansson and al. 1998:2). The experiment started through a project carried out in an upper secondary school of Wämöskolan in Karlskrona (Sweden). The aim of the project was to find out the possibilities and the reception of the use of computer Lego by the education system. The interest in this device is that it allows children to work with devices they are already familiar with and introduce them with some of the basic characteristic of computer programming. This programming has direct implication for the functioning of their Lego construction (like moving a lift up and down, rotating a helix, creating a grabbing mechanism, etc.).

In this paper, we are less interested in describing the notion of experiment than to unravel the tacit knowledge that informs this approach of teaching. The aim of unraveling the tacit knowledge of this 'experimental' way of teaching searches to bring to the surface of pedagogical consciousness (a) students' ability to work out technical requirements of object design and (b) students' natural seriousness. The point is to find tools to rethink teachers complains against the shallowness of student's involvement with materials. This paper provides some evidences of what this natural seriousness is about by considering the context of following rules in the design of a computerized mobile.

I – MINIMAL INSTRUCTIONS AND OVERVIEW OF THE ROBOLAB KIT

Our project has taken place at Blekinge Institute of Technology (Sweden) in 1998. We saw an opportunity to address some issue of higher education knowledge transfer thanks to this kit (Gregory Gargarian: 1996). The aim of this experiment was to learn by assembling a model. We wanted it to work with minimum specifications. We put some requirements on the University Intranet for students to look at. In fact, those instructions have been given *viva voce* to students in the room. This is how the minimal instructions look like:

Design anything that will be mobile in a non-specified environment. The first exercise you have to implement is to construct 'something' autonomous which works by itself, that is, the final task should be carried out without the help of human manual skills. The 'thing' should move from one site to the other (diagonally) and be able to avoid obstacle that could be seen or even unpredicted.

- Document the construction of the 'thing' and the execution of the task with the help of materials on site.
- Help support: Use what is required to succeed! Please do ask any materials that could be needed. (For example, paper, tape, etc.)
- Work in group of 2 or 3 persons
- Estimated time of the experiment: 2.5 to 3 hours.

Those minimum specifications provide for the meaning of 'experiment'. The goal to achieve is very clear. But little information is given about how to achieve it. This point is important. In a more traditional teaching environment, this approach will appear to be a serious problem. Here, the experiment counts already on the fact that information search and its relevance will be available to students on site. Teachers work explicitly with minimal instructions as a conscious choice. We do not work with a predetermined set of bullet points on a white board. It turns out that, the experimenters themselves had to change the formulation of their minimal requirements according to the situation they face with the student in the classroom. In our last formulation, done in the classroom, the minimal instructions consisted to (1) built a mobile which (2) could go from one point to another, (3) hits obstacle and (4) manages its way out.

In the following part, we will present four pictures that will provide for:

- (1) an overview of the experiment.
- (2) a choice of sequence that overlooks the real time students' design achievement.



Figure 1:

This picture displays student's work environment on this Lego project. We see clearly the tools that students had to work with. They are: a conventional Lego Kit, a Lego computer (the brick in the first plan), an electric engine (close to the keyboard), a Lego booklet that provides some indication for construction, and an icon-based programmable application on the screen.

Figure 2:

Here is a view of the icon-based program. The window that contains a graphic represents a series of icons that are linked to each other and perform a kind of action. Each possible action is indicated by a series of icon available (on the right end of the screen). Each icon corresponds to a executable command. Those commands are sent via an infrared device to the Lego brick. Those commands are executed and stored in the brick itself that is part of the body of the vehicle.



Figure 3:

The group of three students (on the right side) are contemplating the result and functioning of their design. This is one of the final phases where some radical design decisions have been taken. We can notice that this 'light running vehicle' possesses two antennas on front. Those devices are a design solution that has been found after some testing of the sensor in the classroom environment.

Figure 4:

This last picture shows the same vehicle without its antennas after a choc with one student's foot during a test series. We see one of student running the mobile by activating the sensory mechanism with his finger at the front of the mobile. Even if design issues emerged at the final stage of the experiment, this team of students fulfilled successfully the requirements given by their tutors.



II – BUILDING A MOBILE: DISCOVERING TECHNICAL DESIGN

In this part, we describe the ‘experiment’ according to its step-by-step happening. The idea is to indicate how instructions fit pragmatically in the course of student’s action. In doing that, we remind that ethnographic observation of people action (Button, 2000) is an important tool of intellectual awareness useful to know what’s going on in educational practices. To highlight the well-grounded reason of our presentation of evidences, we will show how actions took place for the design of a mobile with RoboLab specifications in accordance to the instructions given by the tutors/experimenters.

The coherence of our approach is underlined by the display of a table where instructions will figure in the left column. In the right column, we will present the step-by-step description of students’ actions. This way of presenting our research results has the convenience to clarify in advance the philosophical confusion that could emerge when researchers thinks of ‘rule following’ in abstract, i.e. when they overlook the details of the sequences of actions by thinking in general about it.

<p>INSTRUCTION 1: Built a mobile</p>	<p>FINDING OUT THE RELEVANT KNOWLEDGE: THE DRIVING SPECIFICATIONS</p> <p>Students start to approach the components of the ‘Lego RoboLab’ kit. They take notice of the variety of pieces, their technical specificities, the infrared Lego-Computer, the Lego construction book as well as the first approach of the icon-based programming system installed in the computer dedicated to a team.</p>
<p>INSTRUCTION 2: Go from one point to another.</p>	<p>They learn to combine axis, cogwheels and an electric engine to create some kind of vehicle. Students agree to build a car. They put it into a test.</p> <p>The idea of the test comes out the need to verify how the electric engine propels the Lego platform. (its speed, if its move at all, i.e. the basic requirement of movements).</p> <p>The nature of this mobile propulsion is the kind of knowledge that student have to find out. The electric engine furnished in the Lego box is not necessarily design to mobile vehicle. It can be used to lift up parts or produce the rotating movement of a helix.</p>
<p>INSTRUCTION 3: When hit an obstacle, find its way out.</p>	<p>The test reveals a faulty design concerning the wheels. They were too big. The motor could not make them work. As a solution of the previous test, the group of students decided to make a lighter construction. They had in mind something like a dragster. This decision takes into account the former step. They also decided to have two engines propelling separately each wheel.</p>
<p>INSTRUCTION 4: Built it in 3 Hours Maximum.</p>	<p>Students also worked out the first programming requirement. The first icon-based schema stipulates (a) go forward, (b) when touch something, the vehicle go backward for one second.</p>
	<p>PROGRAMMING THE TURNING SPECIFICATIONS.</p> <p>Students find out that, in their case, it would be adequate to turn to programming. This is possible by instructing the icon-based program to make one engine turning in one direction for the left wheel, and in another direction for the right wheel. They put their decision into a test. They did so for the same reason than the first test, i.e. finding out the basic requirements. They had to build their own knowledge of its working. It appears that the mobile was turning on itself. They had enough knowledge concerning the design of turning specifications. In other words, they know how it works, now.</p>

	<p>FINDING OUT HOW SENSORS WORK.</p> <p>The model was equipped with sensors. Those sensors have been put into test by making the vehicle runs straight. Students could see how those sensors react by touching an obstacle. It is a way to find out how sensory commands work. Students notice that the sensors worked manually by pressing on them. Pressing on the sensor was another test. It consisted to see how the command worked. This manual tests fulfilled student’s minimal requirements.</p>
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	<p>It appears very quickly that those manual requirements did not work the same way according to the scenic feature where the mobile evolutes. It turns out that the sensors work best against flat surfaces. The hitting of mobile device offers wide angle of impact. Students realize that the manual sensor test was a test that worked in idealized conditions. They decided to work out a system of antenna that could touch obstacle for far away and with flexibility that fix sensor cannot achieve. The sensors were related to some kind of antenna. By touching an obstacle, the sensors change the sense of the cogwheel that drives the wheels.</p>
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	<p>PROGRAMMING SENSOR SPECIFICATIONS.</p> <p>At this point, students introduced another programmable specification. It stipulates that the vehicle (a) runs backwards for one second, (b) then stops and (c) rotates for 2 seconds. This modification in the program design aims at placing the mobile in a different position after than before hitting the obstacle.</p>
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	<p>TESTING SENSORS DESIGN.</p> <p>But, in a second tests, the antenna broke down. The designers decided that it could be easily fixed later knowing how sensor could work without antenna.</p>
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	<p>KNOWING ENOUGH TO FIX A COHERENT PROGRAMMING.</p> <p>They had the information they needed to pass to another phase of the technological exploration and design. To summarize, the technical knowledge they have acquired at this point, the adequate of chassis had been found, the mobility of the model is secured, sensors have to be adapted. Preliminary knowledge of the programming has been acquired by considering (a) the turning capabilities of the double engines, (b) the backward abilities of the mobile and (c) the sensors activation.</p>
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	<p>The students have already worked out during the testing phases the minimum requirement of the programming on the icon-based system. They come back to it to fix the last requirements. It consists to assemble icon of action that fit with the information that have been collected from the driving tests. The knowledge accumulation and the tests have been all successful. The sequence of action in the icon-based program is successful according to the test done in the scenic environment of the room. This sequence of action is the result of successful engineering. It is seen so by the students themselves. They decided to take a further design decision. They add a loop on the program such that when the last procedure is completed, it repeated it from its first step. The mastery of all design phases has been complete.</p>
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Several remarks have to be made here. It appeared very clearly that the sequence of instructions provided by the teacher's minimal instruction have not been followed in sequence. It appears also that those instructions could not be followed as such. We want to indicate that no following them in sequence was not a problem at all. In other words, instructions, in this context, are not synonymous of 'following a convention of action'. On the contrary, the validity of the instruction emerged from student's correct use of them. This correct use depends of what is required by the student to know. The following part is dedicated to strip out some of the consequences and lessons taken from students' use of technical tools in real design environment. Some of this computer supported design project reveals some useful consideration to solve issue of learning that inhere the domain since Plato.

III – SUSTAINING SERIOUSNESS: KNOWLEDGE SENSITIVE TO SCENIC FEATURES

What this study has achieved is the demonstration of the nature of natural seriousness in student's handling of their team project. This natural seriousness is the fruit of student's correct use of tutors' instructions. A point should be done about the correct understanding of instruction as 'indication to be used at the relevant point of design' rather than 'a set of action guided by a predefined convention'. It must be clear that the choice between the two interpretations of instruction has never been an issue in the first place. This has been the case, not because tutors embraced a set of ideological reasons to choose one understanding over the other but because the design of a mobile vehicle was thought to be the occasion of freethinking given the tools at disposal. In other words, the nature of the design exercise did not fit, in the first instance, with an understanding of instruction as a set of predefined conventional actions. The choice to design a vehicle with computerized capacities had a serious implication for the educational approach of both the understanding of knowledge as well as student's sustained seriousness. It is our case, in this paper, that observed and reported facts sustains those conditions of seriousness. It has to do with the relevant knowledge needed to bring to project to a successful end. By underlying some of the relevant feature of knowledge involved in the design of such vehicle, we will specify in which conditions knowledge is context dependent. And, in return, part of the knowledge necessary to make a successful design project has to be found in context throughout students' continuous attention to details. To appreciate student's seriousness, we have to see the role played by relevant context of action. It demands, from us, to understand the uniqueness of internal logic of the experiment.

- The necessary knowledge is formed, partly, by some tacit knowledge in computer science programming and Lego building. Nevertheless, most of the actual design concerns are answered by an active search of knowledge relevant to scenic requirements (Sharrock & Anderson, 1994).
- The main knowledge delivered through scenic requirements is designed to work out basics requirement of the vehicle. Those basics requirement of design are all obtained by testing. Students, in this group, have tested all basics requirements such as (a) the driving abilities of the vehicle (big wheels and heavy body design as been abandoned at the start of the process in favor of a light version with double engine), (b) the sensor working (though manual manipulation), (c) the programming command (turning, stopping, running backwards) at each stage of the verification of proper functioning in the real environment of the classroom.
- Design errors are not punitive. Errors in design are a step toward correction or alternative ideas. The error is not related to a predetermined standard that sanctioned the faulty step. The faulty step is a genuine effect of ignorance that has to be worked out. Students don't know the working of each pieces of the Lego RoboLab unless tried in the classroom. One again, the genuine technical (what requirement is necessary) and scenic (in which condition it works) ignorance is a natural step toward the approach of relevant knowledge. In other words, the full consciousness that we don't know provide not only the will to know but also the indication of what has to be looked for.
- The working in-group allows a division of labor, exchange of information between peers. Those features are nothing to do with the transcendental value of 'community work'. Here, what is at stake, is the fact that some students takeover some task that nobody else bother to dispute. This way to proceed is a tacit distribution of competence. This can be fairly easily accepted as a normal mode of functioning if all students have a recognize domain of competence. The division of labor is well understood not only as the actual reflection of people's own technical value but also as a device of efficiency in regard of time constraints provided for the project completion. Seriousness is maintained until the project is completed.

- Design project unveils clearly the nature of knowledge. Knowledge has nothing to do with cognitive aspects of thought. Knowledge is what permits relevant action to take place. It does not support any metaphysical inclination of pure forms isolated from their world concreteness. Knowledge is what allows things to work correctly.

We have seen how the step-by-step working of the design project has protected the students to think of design requirements as an inflexible predetermined set of action to follow. Tutors as well as students have used the pre-definition of instruction as a topic to work out in practice. The pre-definition of instructions do not belong to the tutors. The point is that this allocation of specific knowledge to a professional body isn't a requirement at all. The mobile vehicle design solution provides for the emerging knowledge requirement that suits at each stage students' questioning and worrying. In this environment, success is a practical result of the implementation. It is the result that is here for all to see. Judgment of the validity of learning is revealed through the completion of the object that makes tutors' instructions a working reality thanks to good technical choice and design. The fact that student task would have not been successfully completed does not bring the issue of failure as a decisional and judgmental issue. Whatever the issue and failure will pop up, the intractability of the issue will always remain to be investigated, to be examined. The description of our computer supported experimental teaching has exemplified the idea of education in the terms of a rewarding teaching and in site building knowledge. This approach shows how practical condition of learning cannot be separated so easily from its content.

This computer-supported learning practice has achieved pedagogical aims where traditional teaching fails to deliver. It would be simplistic to reduce traditional teaching to a vast area of misunderstanding on pedagogy. We do not have the naivety to believe that 'finding out design solutions' can just be applied in the large spectrum of taught topics. For example, this experiment has no application when it comes to teach the social philosophy of classical thinkers of the XVIII and XIXth centuries. We are the last ones to despise the invaluable teaching of school of thought. We do it ourselves. By traditional teaching, in this context, we mean that students are thought essentially as receptors of content. Essentially, teachers produce an evaluation of student's abilities throughout a vast area of cognitive presuppositions. This is a common philosophical mistake among teachers as well as pupils' parents who are prone to claim their children abilities. The restrictive traditional model of teaching we refer, here, assumes that knowledge works according to the provision and the good reception of a set of information. Failures are rarely thought as emanating from the source. Too often, it is thought as a matter of bad reception. If failures are assumed to be students' ones, then the problem of reception is addressed in terms of student's problem. The concentration of the issue on the dimension of the student's personality brings pedagogues to concentrate the issue around student's subjectivity, behavior, personality and cognition. In our experiment, student's understanding could not be checked out by a test. The result is the result of the practical solution their find out when they encounter some problems.

This paper has shift the emphasis of teaching from cognition to seriousness. We have brought some evidences indicating that it is possible to provide an environment where teachers are experimenters themselves. They do not know necessarily much than their students (Garfinkel, 1990). But, this has never been an issue, neither in their own eyes nor in students' ones. By bring a contrast between computer-supported learning vis-à-vis traditional standard of education, we wanted to make available the contrast between a cognitive model of students functioning and a pragmatic one. And nothing is more pragmatic in educational matter, as well as other fields of competence, than a problem-solving attitude.

CONCLUSION: ON PROBLEM SOLVING ATTITUDE

This Lego RoboLab experiment has brought the fore a classical lesson of pedagogy. It shows how students' working out of their own ability can be an efficient learning tool when they know clearly what is expected of him/her. This is where the good use of instruction reveals its importance. Also, it is an effective tool for teacher to offer a more socially balanced education. The problem-solving attitude takes into account student's tacit knowledge relevant to the issue at hand. This is often overlooked in a more traditional teaching situation. Teacher's evaluation in this context created by the supported computer learning environment do not count *essentially* on student's writings skills, more or less imaginative stock of knowledge, etc. In most educational settings, no problems have to be solved. Here, the adequacy of students' results is the visible working of the mobile itself. Methodologically speaking,, the problem solving attitude is crucial in the sense that it takes full accounts of the natural ordering of sequence of action (what comes first as what has to be known first) as well as hierarchy of phases (where instructions fits according to the

scenic knowledge of mobile design). In other words, the problem-solving attitude is a pragmatic attitude *par excellence*. As such it cannot afford to economize real time, step-by-step ordering and building of knowledge. On the contrary, it provides evidences for its working on the basis of a sequential anatomy of the problem-solution relationship. (Button & Sharrock, 2000: 47 & 65).

The problem-solving attitude is explicitly rendered sensitive in the computer-supported design of mobile vehicle as a natural way to deal with emerging issues. The issue has not been that student could not cope with the natural emergence of problem. On the contrary, all problems has been solved. Our use of the Lego RoboLab supported learning recognizes students' common-sense knowledge as perfectly-in-order-resources. Those resources are not used to solve the intellectual issue that experimenter would have predetermined and imposed upon them. Those resources of common sense understanding and logic-in-use are fully recognized as an unavoidable know-how that has to be used to solve the practical task that is: to built a mobile with technical requirement both physical and software. In consequence the evaluation of student's success does not entirely belong to what the experimenter think is the good solution. This experiment avoids the classical teaching issue of teacher's omni-potent judgment based on standards of evaluation that overlooks the kind of skills developed throughout the exercise. In the worst case, the good organizational reasons for teachers to formulate bad students' evaluation place them in a position of judge of students' achievement rather than pedagogues. The computer supported learning design practice allows some necessary flexibility in the approach of relevant knowledge in education. Not all students' groups had the same kind of knowledge, or manage the same amount of information. But the development in time, as well as the opportunity to acquire the relevant circumstanced knowledge is left to student's capacity to solve his own issues. This is what sustained the seriousness over the all project.

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