

Modern Methods for Stimulating Creativity in Education

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Keywords: creativity, programmable logic controller, education

Received: July 24, 2006

Motivation and creativity are ones of the primary educational objectives, quite volatile by nature, difficult to understand and theorise. There are many studies treating creativity and motivation from different points of view and philosophical background. With respect to their interpretation of creativity, they could be classified into two major groups: considering creativity as a unique, sensitive phenomenon or as a quantitative entity of Education Theory respectively. The former approach is guiding the proposed study. This paper is based on the reports and research results of The Third International Workshop "Developing Creativity and Broad Mental Outlook in the Computer Age – CBMO-2006" in conjunction with the 10th Conference of International Society for the Study of European Ideas – ISSEI 2006, organized by the University of Malta, 24-29 July, 2006.

Povzetek: Opisane so metode za spodbujanje stimulacije pri učenju.

1 Introduction

The commonly accepted definition of creativity has three parts:

- Creativity is a complex process, subject to studies by Behavioral Psychology, Social Psychology, Psychometrics, Cognitive Science, Artificial Intelligence, Philosophy, Economics, Business and Management, etc.
- Creativity is an interpretation of past knowledge and experience in a new way
- Creativity contributes to the enrichment of the existing knowledge base

George Keller expressed this definition as "Creativity, it has been said, consists largely of re-arranging what we know in order to find out what we do not know" [1].

Some researchers of creativity consider the creative process as a five-step one: [2]

- Fact-finding
- Problem-finding
- Idea-finding
- Solution-finding
- Acceptance-finding.

Certain cognitive characteristics contribute to the one's creative behaviour [3]:

- Fluency
- Flexibility
- Visualisation
- Imagination
- Expressiveness
- Openness.

Such skills could be learned or they may be situational. Fluency is related to the number of meaningful responses to a challenge, while flexibility reflects the diversity of the responses provided. These features are involved in the psychometric study of creativity too [4].

In order to achieve the objectives related to creativity, education theorists are debating different pedagogical methods and alternatives to the officially favoured Learner – centredness. Some scholars explore new ways of approaching the problem introducing culturally oriented pedagogies:

"There can be no justification for a universal and homogenising pedagogy if indeed teaching and learning are contextual activities. A universalised pedagogy necessarily marginalizes pedagogies based on alternative epistemologies. For example, by treating learner-centred pedagogy as a one-size-fits-all approach to teaching and learning, pedagogies that are based on indigenous knowledge systems are marginalized" [5].

In addition to the above said, the list of all five steps of the creativity process requires certain access to information and communication facilities. Such prerequisites imply further marginalisation of some social layers, promote the development of the spirit of individualism, rationalism, laissez-faire economics, just to mention a few [6]. In the sense of this trend, some authors (Prof. Hiwaki, Prof. Tong) consider creativity as a distorted feature of the contemporary world and offer an alternative that plays the role of a "social immune system" and "social glue and lubricant" [7].

Prof. Hiwaki's philosophical treatment of the subject matter tries to link cultural values and creativity in order

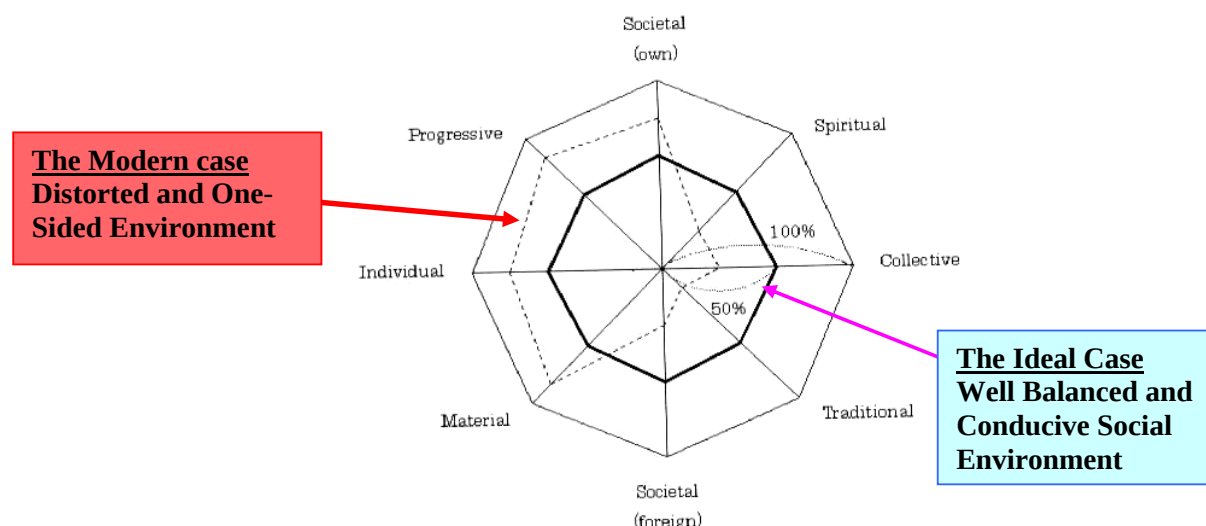


Figure 1

to create a well balanced and conducive environment for the society as a whole. His view could be illustrated with the diagram, Figure 1.

The distorted social and educational environment of today, all over the world, could be clearly seen from the following chart [8], Fig. 2:



Figure 2

Funds allocated to pre-primary, primary, lower secondary and senior secondary education are approximately one half of the money spent per student of tertiary education, despite their obvious importance, especially of primary education [9]. Some researchers are attempting various ways to fix such a discrepancy, mainly with the use of multimedia. In particular, the paper [10] describes AddizionarioPLUS (see Figure 3), an updated and extended version of Addizionario - a multimedia tool for improving the linguistic and cognitive development of primary school children. Addizionario was developed by the Institute for Computational Linguistics of the National Research Council (C.N.R.) in collaboration with the Department of Computer Sciences of the University of Turin in the late 1990's. This system has been successfully tested in several schools in Italy and abroad.



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Figure 3

The advantages of multimedia and simulation methods could be illustrated by the research of an Italian team [11], Fig. 4.

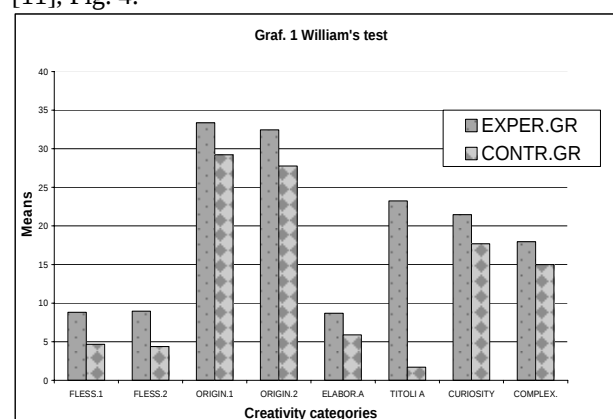


Figure 4

On the other hand, the sophistication of modern technology creates a divide between Production and Consumer with quite a negative impact on almost all ways of life, e.g. monopolization, technological dependency, corruption, etc.

2 A Computer Studies Course and Development of Creativity

Education is one of most affected areas of the modern society, especially in the developing world. The current situation favours a narrow and defocused mindset, mainly oriented to consumerism and “push-button” culture, shifting the main goal of creativity towards lower priority objectives. This tendency could result in activities with serious and dangerous social consequences. From a pedagogical point of view, more and more the Black Box approach is applied to the explanation of fundamental ideas of physics, biology, computing by teachers in secondary schools. Such a prevailing practice could be illustrated with the compilation of teaching materials for Computer Studies course offered by most of secondary schools and teacher’s colleges. Typical examples are the topics oriented to the general structure of computers and the central processing unit (CPU) and their class interpretation. The CPU is defined as the Heart of a computer system and is described with a few features in the spirit of the Black Box paradigm [12]. Such a simplification is justified to a certain extent only, because it could suppress the creativity and nurture a sense of technological dependability. The side effects of the simplification could be appeased if pupils are intellectually and emotionally challenged by the provision of new information concerning a certain topic in the form of virtual (e.g. multimedia) or physical demonstration.

Programmable Microcontrollers could be very useful when software and firmware are explained to students. They are very cheap and easy to attach to commercially available computers through a parallel, USB or serial ports [13]. Most commonly, Programmable Microcontrollers (PLCs), and PLCs could be considered as the only real “Plug and Play” devices, because installation software and hardware requirements are not necessary. Arguably, PLCs are the most popular microelectronic components today. Their invention in 1968 marked a milestone in the development of theoretical and practical

computing – the structural decentralization of hardware and software products. Today it is unthinkable any process control application to be organized without PLCs. PLCs are everywhere – from household appliances, to endless industrial and entertainment facilities, to deep space explorations. In education PLCs could be used instead of the traditional paper media and could be re-cycled many times passing them on from student to student, from class to class. The teaching technology is relatively simple – every student, doing a course related to PLCs or complemented by PLCs, is provided with a microchip, Flash/EEPROM type. There are cheaper types, but they either require more time to be erased (Ultra Violet light erasable, UV type), if necessary, or are not suitable (One-Time-Programmable PLCs) for training purposes [14].

Programmers for the available PLCs are connected to a few computers in a student lab, reflecting the curriculum requirements and the assessment practice of a school or tertiary institution, Fig. 5.

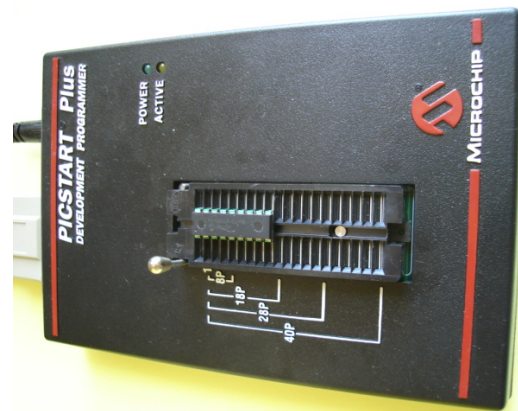


Figure 5

A simple computer - a tester for student’s work – is provided as well, Fig. 6.

The System Time is emulated by a Light Emitting Diode (LED) blinking every second. The Display Unit (DU) is another LED that is controlled by a student’s program. Students are given tasks with different numeric values, e.g. the design of a time interval of XX microseconds. The marking procedure is a mixture of an

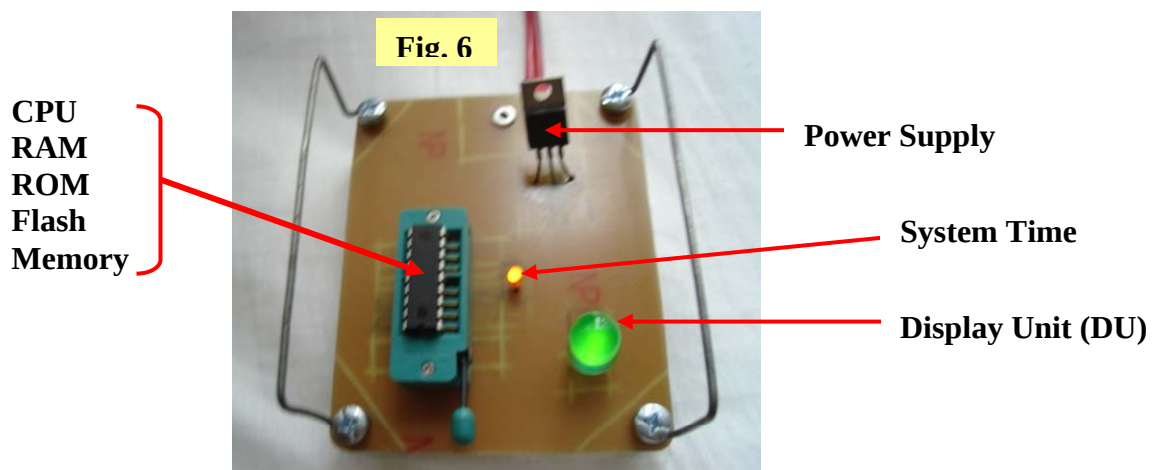


Figure 6

oral examination/presentation and demonstration of a working PLC as per the task given. The revival of a traditional pedagogical method (oral examination) allows students to share ideas and teachers to find better ways to organise the course.

The minimal software and knowledge requirements should reflect the following points:

- Hexadecimal and Octal systems of Calculation.
- Data types
- Elementary Programming Skills
- Operation Codes (OPCODEs) of the PLC provided
- Software of the PLC Programmer available, Simulator software inclusive
- General structure of computers – Classic and Harvard configurations
- The operating system installed on the computer connected to the Programmer.

The OPCODEs of PLCs vary from manufacturer to manufacturer, but in general their number is quite limited. For example, 16F84A processor used in this presentation has 35 OPCODEs only with quite suggestive abbreviations [15]. The following codes illustrate the simplicity of programming PLCs:

- INCF means INCrement memory File register
- INCFSZ means INCrement memory File register and Skip if the new value is Zero
- A program segment that generates 500 microsecond time delay/interval (4 MHz processor, OPCODEs have 1 microsecond performance time, if not branching, otherwise 2 microseconds) has five (5) program lines only [16]:

```

.....
MOV LW    D'165'
MOV WF    counter
DEC FSZ    counter, f
GOTO      $-1
NOP
.....

```

Such a simple program is quite suitable for technical college or undergraduate students. For secondary school pupils a ready made program could be given and they should play around with the output signals of the PLC changing its functionality only, applying basic skills, e.g. Copy-Paste technique:

```

.....
L1:
BSF      Output      ; DU turned/set ON
CALL     Delay1s      ;One second ON
CALL     Delay1s      ;One second ON
BCF      Output      ; DU turned/cleared OFF
CALL     Delay1s      ;One second OFF
GOTO     L1
.....

```

In the above program segments the output is ON for two seconds and after that OFF for one second, repeating the sequence continuously. Pupils could just increase/decrease the preset timing by inserting/deleting CALL statements and program the processor on their own.

The performance of Operating Systems (OS) as the Computer Resource Managers could be discussed and

simulated processing Flash Memory storage and Internal Time interrupts. The necessary firmware is more complicated, but still within students learning capability. Here, the basic assumption is that OS is managing two processes: the System Time and Flash Memory access respectively. To introduce the topic, a new variable is necessary - readyYn is the outcome of the interrupt processing routine. Bit Zero (0) of this variable is reserved for the control of the computer Secondary Storage (Flash Memory in our case) and bit One (1) is for the System Time. The interrupt processing routine sets up the corresponding bits when the respective process needs attention (it is ready for a new operation).

The following program segment shows the initialization of OS:

```

.....
org      0x10
start
MOV LW   D'242'    ; to get 400 microsec
                      ; time interval
MOV WF   TMR0      ; the Internal Time
                      ; Register is initialised.
.....

```

Students should calculate the initial value of TMR0 register (242 in our case) bearing in mind the frequency of the internal R-C time pulses wiring. Another short segment illustrates that when the System Interrupts are involved in the management of the configuration resources, OS counts the number of time interrupts to produce the System Time:

```

.....
MOV LW   D'10'      ; the internal R-C
                      ; frequency is 33.3KHz
MOV WF   counter
BTFSS    readyYn, 1 ; O.S. is continuously
                      ; checking through
GOTO     $-1         ; readyYn if a time
                      ; interrupt has occurred
BCF      readyYn, 1
DEC FSZ   counter
GOTO     $-4
.....

```

The above segment generates 4 msec time interval.

The interrupt exercise could be generalized and organized in another way, but it requires more time than a single class session.

The essence of such a practice is to decompose the training process into smaller steps that could suit psychologically and mentally all students. For example, the majority could express curiosity only, a smaller group could be motivated to go further, but the necessary effort and knowledge will stop them at that point. A very few could manage to meet the intellectual and technical requirements of the whole process to design processors and control computerised equipment, in general. Therefore, challenging students allow teachers to gradually move from mere curiosity to more sophisticated learning stepping stones related to motivation, to the final stage of the process – Creativity, a process based on the natural facilities of students and their cultural background.

3 Conclusion

Creativity, as a teaching objective and a very sensitive and fragile phenomenon, should not be forcefully imposed upon teachers and students applying one pedagogical method or another. The teaching process should be flexible, allowing quick changes depending on the progress of students. In such a way the independent thinking and creativity of students could be stimulated in any teaching environment. In the case of computer related courses such objectives could be achieved relatively easy with the help of PLCs, without the need of big investment [17], just curriculum updates.

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