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Influencias de las relaciones hombre-máquina en el currículo matemático: mínimo enfoque de un gran problema

The influences of the new relations between humans and computers in the mathematical curriculum: a minimum focus of a great problem

Luis Rey Leo-Goliath
Eloy Guerrero-Seide
Mercedes Chavez-Jimenez
Facultad de Educación, Universidad de Guantánamo, Cuba
Correo electrónico(s):
luisrey@cug.co.cu
eloy@cug.co.cu
mchavej@infomed.sld.cu

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Resumen: Se presenta la necesidad de que en las universidades, la educación matemática, se realice con medios informáticos, superando concepciones para ilustrar, dominar acciones repetitivas o memorizar reglas formales de cálculo. Convendrían las que produzcan aprendizajes más cualitativos y desarrollen capacidades valorativas y creativas en el estudiante. El currículo crearía espacios, para evaluar el verdadero papel de esta ciencia para la solución de problemas concretos, utilizando medios de cómputo.

Palabras clave: Tecnología educativa; Matemática; Enseñanza de la Matemática; Sistema hombre-máquina

Abstract: The paper presents the necessity that the mathematical education faces at the universities, whether aided by information-technology means, surpassing conceptions to illustrate, dominating repetitive actions or memorizing formal rules of calculation. The ones that produce more qualitative learning and develop evaluative and creative capabilities in the student would be convenient. The curriculum would create spaces, in order to assess the real role of this science in the solution of concrete problems, utilizing computing means.

Keywords: Educational technology; Mathematics; Teaching Mathematics; Computer-person system

Introduction

The improvement of the pedagogical processes of mathematics education goes beyond a conception of "educational technology", which is only committed to the technification of didactic actions to produce the so-called optimal effects in education, but not an essential modification in the curriculum and the objectives of it. There are insufficient actions so that

the computing science and the application of informatic means become an indispensable part of the curricula.

At present, some pedagogical projects face the need to modify the literacy conception. Universal access to the ability to read and write is no longer the only essential determinants of the speed of social development. Universal access to computer methods and media in the teaching process is becoming a new problem that demands the attention of all those who are committed to the design, implementation and execution of educational policies.

Development

Implications of changes in the man-machine system

The creation of instruments and procedures to use them has characterized the cultural development of humanity. The imbrications of man in his surroundings testify to this fact. Results of man's interaction with nature have been: man's own evolution, the transformation of nature -not always in a positive sense and favorable to the sustainability of life - and a progressive identification of man with the environment. All of which is summarized in two aspects, the humanization of nature and the deepening of man's knowledge about the universe in which he lives.

Man and the instruments he has created, and his activity, make up a sui generis system, called the man-machine system.

In a philosophical perspective, such a relation classifies as a "dialectical relation". The work of man not only creates the instruments; it also modifies them. On the other hand, the activity of man with the instruments he creates, impact and accelerate his own development. The instruments modify man's habits, his abilities, his capacities and his value systems. They are becoming increasingly complex due to their own technological and scientific development; and at the same time, they become indispensable and irreplaceable for the life and activity of man. The creator of the instruments needs to adjust his own work activity.

In the paper "The role of work in the process of transformation of the monkey into man", and in relation to the work of man (which necessarily takes place with instruments) and the

influence of this activity on the transformation he experiences, Engels presents a set of ideas, among which are the ones analyzed below.

In first place, the author highlights what he considered the decisive step for the transformation of the monkey into man due to the anatomical and physiological changes of the hand, when the man managed to carve the first pebble in the form of a knife, meaning that the hand had been released, being able to acquire new skills.

The wise Russian psychologist Lev S. Vygotsky highlighted in his work the importance of activity mediated by instruments (tools and signs) for the development of man.

Undoubtedly the progressive transformation of the instruments modifies the man-machine relationship, as man himself undergoes transformations in his anatomophysiological structure and in his social projection, as consequences of the changes that man himself introduces into the instruments he constructs.

Other of the ideas that Engels presents in the aforementioned work is that the development of man, of his abilities, and consequently that of his instruments, is unstoppable and multidirectional. He expresses: "... it does not cease, much less, but continues, in different degrees and in different directions among the different peoples and at different times ... advancing as a whole in great strides" (Engels, 1981, p. 70).

In one of the directions of the improvement of its instruments, man confers logical functions, an essential characteristic for automated processes, which expand the possibilities of freeing man from direct participation in productive processes.

The process of perfecting the "intelligent technique" is closely linked to the expansion and improvement of the capabilities of man. As a result of the improvement of the organization and operation of the man-machine system, on the one hand there is a simplification of the activity of man, while reducing the number and difficulties of the tasks he must perform, and on the other, new features are incorporated into this human activity, which becomes more complex and requires greater accuracy, all of which demands greater mental and psychological efforts of man.

In this analysis, it is interesting to note that the instruments that man creates for his work influence decisively in his progressive transformation, and that these transformations go beyond changes in habits, abilities and capacities, to impact and modify even his morphofunctional structures.

Computing techniques, educational technology and the objectives of teaching mathematics: its challenges

The theoretical-cognitive, practical-productive activities and the combination of these influence qualitatively one on the other; giving rise to the Technical Scientific Revolution (RCT) that affects not only the economic base; it also reaches the social superstructure.

Therefore, the levels achieved in science and technology constitute the center of new situations that impact, in one way or another, on the totality of the social life of humanity.

Today the creation, production of electronic and computer innovations, and the massive diffusion of them takes place at a rapid rhythm.

Not a few countries in Latin America and the world have implemented systems of actions embedded in teaching-learning strategies with the presence of equipment and technological resources. These strategies, in the field of Pedagogy, are collectively known as Educational Technology. The budget of such conceptions is that the equipment and technical resources make the work of teachers and students more effective.

The concept of Educational Technology has undergone changes over the years. In its origin the Educational Technology was identified with the use in lessons of instruments, machines, appliances and mechanical, electrical and electronic equipment, to facilitate the task of the teacher and improve the performance of the students. The Educational Technology referred to the use in the teaching-educational process, of modern technology products, as teaching resources, or as supports for various didactic functions. The technological basis of this concept is provided by a set of technologies developed progressively since the end of the First World War: audiovisual media such as cinema, still images, sound records, radio, computers, teaching machines, among others.

The primary concept of Educational Technology had its detractors in the very field of Western countries. It was accused of "dehumanizing" the teacher and the student; and at the same time, that it produced a robotization of instruction, inasmuch as the person, as such, became a receiving object, a product of manipulation by means of electronic or other technological devices.

The study of the effects of the indiscriminate and irrational use of these media showed the need to introduce modifications to the concept.

In a change of perspective, the concept of Educational Technology focused attention on the study of educational processes and systems, in order to optimize them. Its objective was committed to the technification of the didactic actions to produce the desired effects in the students: the achievement of the educational objectives foreseen

This conception advocates the rationalization of teaching, by the use of didactic materials and resources, conceived as a system, and on the basis of new models and learning techniques especially aimed at achieving the objectives proposed in the curricula and programs.

Educational Technology, as defined, continues to pay attention to technical materials, but also concerns the theoretical aspects of the teaching process, which does not exclude curricular design.

The Organization of Spanish speaking-American States (OEI in Spanish) has promoted a multinational educational technology project and has sponsored several international seminars on the subject in Latin America. It also promotes the so-called "transfer" of Educational Technology.

It is indisputable that the use of techniques can help to improve the teaching-learning process and contribute to raising its quality, but it should be borne in mind that the most important thing is not the means itself, but the content of teaching and learning, the way in which the process is directed to favor the development of a creative thought in the students.

The Technological paradigm has produced changes in the Mathematics Didactics. With the introduction of modern means of computation in the educational process of Mathematics,

the dialectic between the cause and the effect of the man-machine system charges different manifestations, due to the changes that occur in the curriculum.

Different international conferences and seminars have focused on the impact of the introduction of computer science and computing in the teaching-learning process of Mathematics at different levels of education. An example is the Third Seminar of Mathematical Methodologists of the Academies and Pedagogical Institutions of different countries, carried out in November 1985 in Dresden in the former GDR. In this event participated, in addition to the hosts, Bulgaria, Mongolia, Poland, the Czech and Slovak Republic, Hungary, the former USSR, Vietnam and Cuba.

The theme of this seminar was "The development of the culture of calculation in students under the conditions of the RCT". The very choice of the topic illustrates the importance that mathematics methodologists place on the international space on the contribution that the discipline must make to the understanding of the fundamental problems of computer science and the computation techniques for the processing of information and the taking of information related decisions.

It was found that there is clarity regarding the importance of the introduction of technical computing resources in education. The following were considered as criteria that justify this action:

- it is an important component for the preparation of school children for life,

- the calculators increase the speed of the "calculations", which influences the mathematical formation of the students, the development of their intellectual activity and their independence,

- offers greater possibilities to initiate the development of the algorithmic culture in the students from an early stage and to lay the foundations to use the techniques of information processing,

- decisively influences the displacement of the center of gravity of the teaching of Mathematics at school: it requires changes in its contents and objectives and encourages the development of new methods of work. (Campistrous, 1986, pp. 35-36).

Methodologists coincided in the same way that "written calculations ... extensive, are ... unnecessary in daily practice ..." (Campistrous, 1986, p.36).

However, there was no consensus on some aspects such as: the degree of maturity with which these skills should be developed without the use of auxiliary means of calculation, the internal structure of mathematical content in the school, the time that should be dedicated to the teaching of numerical systems and their objectives.

In the Mathematics courses taught in the different levels of education in our country, certain slowness can be observed in terms of the conditioning of its content to the modern technological paradigm.

All cases have advanced in the accuracy of the "new skills" and the new objectives of the work with the technical means of computation are not an essential part of the mathematical curriculum. Nor is the teaching of Mathematics, conditioned to the procedures and methods of normal science in this technological paradigm.

In higher education, "old" criteria still apply in relation to the selection of teaching content: the student must know all possible mathematics. In this conception the student must be able to use the formal tools of Mathematics that are taught. The objectives of the teaching of Mathematics are therefore restricted to the application of theorems, concepts and procedures. Professionalization is understood as the analysis of examples of the specialty and the solution of teaching exercises linked to the specialty, and that can be solved using the concepts and mathematical techniques that have been studied.

Consequently, there are no experiences in which variants are used, for which the student has computers and software, which eliminates the need to teach many techniques and "traditional" skills. In these variants, new needs are met in correspondence with the scientific-technological reality of our times. The student should know where to go to help them, what they can "ask" to the computer, and how to guide and control the machine, developing the knowledge and skills related to it. The role played by Mathematics in this context is as a way of thinking, a "mental exercise" and training in rigor.

The challenge to the teaching of Mathematics. Necessity of a change in the objectives for teaching Mathematics

Mathematical content has always been considered part of the curriculum at all levels of education, because of the important role that mathematics has played in the development of science and technology.

At the same time, the teaching of Mathematics offers multiple possibilities for the education of logical thinking schemes and important features of the personality, such as perseverance, organization, and many others. All this constitutes another reason to place the mathematical activity in a prominent place of the pedagogical process.

There is, however, a tendency to believe that spontaneously, without attending to teaching methods, to a suitable selection of content and to the organization and structure of it, the expected objectives of mathematics education can be achieved.

Several studies on learning agree in the statement that in general students perform very poorly when it comes to understanding processes or apply mathematical knowledge to the solution of specific problems. Performance improves when it comes to applying simple rules that can be memorized.

The cause of this fact is linked, fundamentally, with the traditional procedures used in the teaching of Mathematics, which promote an "understanding" of such content by the student from an essentially procedural and symbolic point of view. In the models that are generally applied, the mathematical knowledge of the student, means knowing a sufficient number of algorithmic procedures, that allow him to transform a symbolic expression into a succession of other transformations, so that the last of the expressions, in the list, have the form that he recognizes as valid, and propose the answer.

In fact, the student must be able to identify among the "learned" algorithms, the one that corresponds to a situation that arises. They must not only identify the algorithm, they must also know a valid form of it and the procedures to apply them to the specific situation.

Limiting mathematical knowledge to work with mathematical objects, from a symbolic and procedural point of view, reduces the possibilities for the student to learn to use this knowledge in the solution of concrete problems of practice.

The changes that occur today in the world, include work activity. While some disappear or diminish their exercise, others arise with new characteristics and demands. Some socio-economic studies reveal a downward trend in the number of people employed in industry, agriculture or construction, while there is a tendency to increase the number of those employed in jobs related to environmental preservation, telecommunications, health, education (Escobedo, 1995, p.12).

What impact does the teaching of Mathematics have on this? In order to respond to these needs, the objectives of teaching Mathematics cannot focus on the mastery of repetitive and memorial actions; rather, they must move towards a more qualitative learning in which the valuation and creative capacities of man are enhanced.

The teaching of Mathematics should place greater emphasis on the use of technical means of computation, to free the subject from learning, from the obligation to memorize formal rules of calculation and "remarkable" values. This would allow an evaluation in the curriculum itself, of the true role of science in the solution of concrete problems, and enhance skills in the use of computer media.

These changes in the conception of the teaching of mathematics are an imperative of the new organic and functional relationships of the man-machine system, which imposes the RCT. Failure to meet these demands means disregarding the ethical problem committed to the duty of preparing men to achieve the development their time demands. Our national hero, the apostle José Martí, wrote about it:

> It is criminal the divorce between the education that is received in a time, and that time. To educate is to deposit in each man all the human work that has preceded him: it is to make each man a summary of the living world, until the day he lives: it is to put it at the level of his time, to float on it, and not leave it under of his time, with which he will not be able to leave afloat; it is preparing man for life (Martí, 1975, p.281).

Today there are a significant number of systems and application programs, developed by large companies and consortiums producing software such as Microsoft, Apple; and others, by small companies, or by small groups of researchers. Although many of these computer products have not been developed specifically for teaching purposes, they make possible, when used, a more qualitative approach to the teaching of mathematics (in the aforementioned sense).

Examples are: a whole set of programs that contain statistical packages such as the SPSS (Statistical Package for the Social Sciences) and the Microstat; the programs Excel, Access, Word, etc., designed in a Windows environment, that make it possible to create and manipulate tables, graphs and databases, or for the design of texts and other applications.

In particular, there are systems for analysis and calculations of Higher Mathematics, which allow work with functions, matrixes, vectors, etc.

In all cases, the introduction of these programs in the curriculum may have a simple character of illustration, or on the contrary, meet the needs of performing routine, formal and repetitive work.

Formative experiments have been carried out in which the second of the two intentions mentioned above has predominated. However, in our opinion, global work is needed in this direction, imminently necessary, under the conditions imposed by the scientific and technological development.

In the balance between the principles of "centralization" and "decentralization" of the direction of the process of training of professionals, which takes place in Cuba, it corresponds to the state and its institutions, to regulate the objectives and essential contents of the study plans and programs of the teaching disciplines. Consequently, in the solution of the problematic that this research work addresses, not only the teachers have implication, but also the majors´ national commissions.

Changes of conceptions are required. The current independent researchs cannot be developed, without the computer and computing means. Increasingly, microcomputers

become essential resources for quantitative analysis in scientific research and therefore in the process of "mathematization" of science.

So, to maintain in the objectives and contents of the plans and teaching programs of Mathematics in the training of professionals, a conception of work with computer media as an illustration does not respond to this problem.

For professionals who graduate from higher education institutions to be "at the level of their time", actions such as:

- the redefinition of the objectives and contents in the Mathematics programs, adapting them to the qualities that the RCT demands of the professionals,

- the immediate improvement of all the professors who teach these contents,

- a change in the mentality of all participants in the direction of the process.

As it is evident, the process of "mathematization" of science today has a close link with the "computerization" of knowledge, and the teaching of Mathematics cannot ignore this reality.

The fears manifested by those who oppose these ideas are understandable; for some questions like the following have a meaning: are all the implications of the "computerization" of teaching beneficial? What transformations will these new man-machine relations produce in man and what will be the consequences at the level of society?

All these questions deserve to be analyzed in later studies, so that their effects are mitigated, but the need to modify the curricula is imminent.

Conclusions

As a generality, the use of new computing and informatics resources is inserted into the mathematical curriculum, as a simple demonstration of the potential of these techniques. In this way, the skills, habits and abilities that students develop in working with these media, parallel the abilities and capacities for work without them; the problem of the implementation of methodological procedures to systematize both forms of execution of the abilities and capacities for working with such objects remains latent and without an

immediate solution. Consequently, the teaching of Mathematics shows some delay in the use of the potential of its content to disseminate the current results of ICT.

Clearly, the objectives of teaching Mathematics can; and in fact they must, assume the adaptation of man, as learning, to the work with the computer technical means, to solve the problems presented. In addition, objectives are needed to free the learner from repetitive and mechanical actions that demand an abusive use of memory.

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