View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by Repositorio Institucional de la Universidad de Alicante

Available online at www.sciencedirect.com
ScienceDirect
ELSEVIER
Procedia - Social and Behavioral Sciences 93 (2013) 1663 – 1667
Procedia
Social and Behavioral Sciences

3rd World Conference on Learning, Teaching and Educational Leadership (WCLTA-2012)

The curricular value of mathematics in non-mathematics degree

Sastre-Vazquez,P. [a] *, D'Andrea R. [b], Villacampa, Y.* [c], Navarro-Gonzalez,F.J. [c]

[a] *Universidad Nacional del Centro de la Pcia de Buenos Aires,República de Italia 780, Azul 7300, Argentina*
[b] *Pontificia Universidad Católica Argentina. Campus Rosario,Pellegrini 3314, Rosario.2000, Argentina.*
[c] *Universidad de Alicante,Ctra.de San Vicente s/ns, San Vicente del Raspeig. Alicante.03690, Spain.*

Abstract

Higher education should provide the acquisition of skills and abilities that allow the student to play a full and active role in society. The educational experience should offer a series of conceptual, procedural and attitudinal contents that encourage "learning to know, learning to do, learning to be and learning to live together". It is important to consider the curricular value of mathematics in the education of university undergraduates who do not intend to study mathematics but for whom the discipline will serve as an instrumental. This work discusses factors that form part of the debate on the curricular value of mathematics in non-mathematics degrees.

© 2013 The Authors. Published by Elsevier Ltd.
Selection and peer review under responsibility of Prof. Dr. Ferhan Odabaşı

Keywords: Higher education; curricular value; mathematics curriculum.

1. Introduction

Higher education should prepare individuals to be competent professionals and/or researchers in a range of fields. The educational experience should offer a series of conceptual, procedural and attitudinal contents that encourage "learning to know, learning to do, learning to be and learning to live together". In addition, it should transmit the universal values of respect for others, life and liberty; values which themselves become part of the curricular content.

More specifically, it is important to consider the curricular value of Mathematics in the education and training of professionals who do not intend to study or teach Mathematics but for whom the discipline will be an instrumental or applied science. To a greater or lesser degree, Mathematics has become a constituent part of almost all the sciences. Scientific progress is impossible without the use of mathematical concepts to represent phenomena and investigate them in the different spheres of reality.

During their preparation for professional life, university graduates use many of the methods of classical

* Corresponding author name. Tel.: +54- 2281 43 32 92 (231); +34-965903691
E-mail address: pasava2001@yahoo.com.ar; villacampa@ua.es

1877-0428 © 2013 The Authors. Published by Elsevier Ltd.
Selection and peer review under responsibility of Prof. Dr. Ferhan Odabaşı
doi:10.1016/j.sbspro.2013.10.098

mathematics, and many mathematical concepts have become indispensable elements of our general culture. Even in everyday life, knowledge of the speed variation of a magnitude (derived) or the summary effect produced by a factor (integral) applicable to numerous situations, enhancing intellectual horizons.

2. Mathematics and the curriculum.

According to Kline (1968), mathematics is the simplest discipline created by humankind as it concentrates on very limited aspects of reality. The simplicity of its concepts almost guarantees that the facts established in relation to them are also elemental, but with a surprising effect on almost all aspects of life.

Nevertheless, the study of mathematics is conflictive and laborious at all levels of the education system, including at university level. The usual style of mathematical statements is influenced by the elaboration of the logical fundaments of this science which can occasionally hinder the student's understanding of extremely useful concepts and processes. In an attempt to provide a simple illustration of an important mathematical feature which is vital for its understanding, Kline (1886) said:

> Mathematics is, in itself, a skeleton. The flesh and blood of mathematics consists of what is done with it. In order to understand mathematics, it is necessary to know why a particular result is desired, what importance it has with regards to other results and what can be done with it.

Consequently, it is necessary to examine the elements that affect the design and development of mathematics courses and teaching process and that may have a positive impact on students' attitudes towards the discipline. This study must of course take into account the context of professional training in the 21st, although we mathematics teachers still very much belong to the previous millennium.

Which factors should be analyzed when dealing with the problem of teaching mathematics in universities? In the first place, the role of the teacher, as a mediator and a true master: there is a tendency to believe that the university student does not require thoughtful didacticism as this would be the type of support required for the immature intelligence of infancy. This is a mistaken belief. Everyone that begins the exploration of a discipline, even if they are specialists in other areas, need the intervention and guidance of someone with greater knowledge. There are few self-taught individuals that are able to reach a level where they can efficiently deal with the challenges posed by other fields of knowledge, because learning is the ability to attribute more and more complex meanings to achieve this we need sufficient, gradually delivered, information and the discipline and control of someone that 'knows more'.

Secondly, we need to consider the question of the curriculum. Every course and every curricular activity form part of a whole: the education and training package that the university institution has to offer. Every course makes its particular contribution to the package. Teaching of mathematics in a sociology degree is not the same as in an agricultural engineering degree. In each case, the student uses mathematics for specific purposes. The teacher must be aware of their position as part of a team that makes a multi-disciplined contribution to a field of knowledge and competences.

The process of organizing the mathematics curriculum can be described according to the different theoretical frames of reference. So for example, the German tradition refers to 'Elementarization' as the active transformation of mathematical content to more elemental forms with a dual meaning: being fundamental and accessible to the students that study it (Biehler et al., 1994); the French tradition describes this process with the theory of 'Didactic Transposition', identifying the variables that take part in the transition of scientific mathematical knowledge to the mathematical knowledge that is desired and able to be taught in an educational stage. Hence the importance of contemplating the professional profile that is required and the skills that the student is expected to acquire, thereby identifying the contribution of our discipline.

3. Mathematics: Teaching and learning

Currently, one of the factors that deserves greater attention is the work of first-year students who have to confront the problems associated with the transition from secondary to higher education. This transition has an even greater impact on the teaching of mathematics which requires a clear understanding of pre-university knowledge and skills in order to successfully deal with the new content that will be introduced. But these difficulties are not limited to first-year university students; numerous studies on the assimilation of knowledge and skills in a range of courses have found the basic educational levels, especially of first-year students, to be insufficient.

The most common deficits are: Understanding of basic concepts and their formal accumulation; Skills for the analysis and solution of problems; attention and application deficit; and insufficient development of creative skills and abilities. First-year students also have problems related with time management and self-study.

It has been demonstrated that management and organization are among the factors that affect the results of teaching processes on basic courses (González et al., 1990). Rather than the simple accumulation of knowledge, courses should be designed so that they guarantee certain ways of thinking and the independent acquisition of knowledge, based on the essential elements that can be related to previously acquired knowledge and the application of generalized methodologies. A transformational shift in traditional teaching is required. Higher education must install a capacity 'to learn', that is to say, the role of the university does not only consist in imparting large quantities of knowledge but in teaching the student to think and act independently. And this implies organizing an educational system that encourages the development of the before mentioned capacity to learn: the student as a passive subject becomes the centre point of the educational process, so the teacher must systematically seek professional self-improvement, not only to keep abreast of new professional techniques but to ensure that the students do not only acquire new knowledge, they also 'learn how to learn'.

Classroom work should be undertaken to ensure that mathematics achieves the objectives set out in the degree courses, and can be summarized as (Carlos, 2000): Mathematics as a calculation tool, as a tool for the modeling and solution of engineering problems, mathematics as a universal language capable of contributing to the knowledge and development of other disciplines relevant to other professional profiles and mathematics as a tool for developing logical thought, reasoning and dealing with new situations.

The continuous development and training of the mathematics teacher should, therefore focus on the discipline of mathematics itself, the knowledge of student profile, didactics of mathematics and new information and communication technologies.

Clearly, self-improvement in mathematics must be systematic, even more so if the development of new theories, such as fuzzy logic and fractals, are taken into account. Awareness of the student profile is of great use to the teacher when giving examples, motivating the students, demonstrating the role that mathematics plays in the degree and the logical link between mathematics and other academic disciplines. The teacher must be aware of other disciplines that use mathematics as well as the tools, notations and methodologies that will help stimulate student interest in mathematics and the degree course that is being followed.

Nevertheless, it should not be forgotten that mathematics, in addition to provide techniques that allow the quantification of variables, also studies the structures of objects and their relationships. This helps to clarify concepts from different disciplines and with different applications, thus creating a unified frame of reference and logic. Obviously, the need to consider modern, quantitative analytical methods must not be purely teleological, in the sense of an immediate practical application, as its pedagogic value is of the utmost importance in our search for a deeper and efficient education of the student.

The educational system must confront the dilemma of defining its quality, taking into consideration the continuous evolution of teaching models that may be of a more practical or theoretical orientation. It is clear that the curriculum must simultaneously involve the two inseparable educational perspectives: basic (organization, intellect, conceptual analysis, theoretical criteria) and applied (organization for action, technical comprehension and instrumental function).

The mental processes that supply the content for mathematical objects are complex. For the successful completion of this task, there must be:

a) Complete abstract understanding of the mathematical methodology to be applied.

b) Knowledge of the problem to be solved: the identification of the intervening variables and their interrelationships, and the establishment of the initial hypotheses in accordance with the nature of the problem/s.

c) The transformation of applied concepts to provide content for the mathematical objects, taking into account the initial hypothesis

d) The application of the methodologies indicated in point a) and results.

e) The applied interpretation of the results obtained, taking into account the characteristics and peculiarities of the phenomenon that we are attempting to describe/structure and/or quantify.

The development of the above steps not only requires mathematical knowledge but also specific knowledge on its application. It requires a special ability to identify the multiplicity of variables found in the initial hypotheses that are assigned. Using trial and error, these hypotheses can be discarded and reconstructed as often as necessary, taking into account that the outcome of points d) and e).

The previous paragraph expresses the basic difficulties involved in learning and applying mathematics in general and in the discipline in particular. The operations indicated in c) require the prior fulfillment of a) and b). The first demands theoretical knowledge of the mathematical methodology to be applied. b) demands specialist professional knowledge of the problem to be solved. Undertaking the transformation indicated in c) requires the simultaneous use of the knowledge required by a) and b).

4. Mathematicsand assesment.

Assessment can be conceptualized as a dynamic, systematic and continuous process, focused on changes of conduct and performance, through which it is possible to verify achievements made in relation to the objectives that have been set. Assessment becomes more meaningful when it also tests the efficacy of the teaching activities and enables their continual improvement. A key element in the contemporary conception of assessment is that it should not be for its own sake, it should be aimed at improving programs, organizing tasks and shifting towards a more efficient selection methodology.

When we assess a student, we are assessing ourselves as teachers. We are analyzing which strategies need modifying to help students 'compensate' for the knowledge they should have acquired during a previous stage as well as the shortcomings that limit student interest in learning. If these obstacles occur in previous educational levels, institutional decisions will 'compensate' for these shortcomings, not rejecting the student but providing them with opportunities to compensate for them.

In a more technical sense, assessment can be defined as:

.the stage of the educational process that has, as its aim, the determination, in a systematic manner, of the extent to which the previously set objectives have been achieved. Education being understood as a systematic process destined to achieve long-lasting and positive changes in the conduct of the subjects integrated in that process, based on objectives that have been defined in a specific, precise, social and individually acceptable manner.(Laforucade)

Assessment is an act that consists in emitting a judgment of value, based on information on the evolution and results of the student, with the aim of taking a decision. (Maccario)

Assessment is a systematic operation, integrated in the educational activity with the objective of achieving continuous improvement, through the most exact knowledge possible of a student in all aspects of their personality, contributing information on the process itself and on all the personal and environmental factors that may intercede. It identifies the extent to which the educational process has achieved its fundamental aims and compares the fixed objectives with those that have been genuinely achieved. (Pila Teleña).

The majority of authors (Tyler, Bloom, de Landsheere, Maccario) group the objectives and functions of assessment into three broad categories:

1) Predictive or Initial Assessment (Diagnostic): Determining the student's aptitude prior to the educational program to placing it at the correct level, categorizing them and tailoring the starting point of the educational process on an individual basis.

2) Formative Assessment: at the end of every learning task, to provide information on progress and learning difficulties, allowing the teacher to seek more successful educational strategies, and providing continuous feedback on the development of the educational system.

3) Summative Assessment: completed after a learning period or the end of a program or course, its objectives are to provide a qualification of performance, be the basis for an award of certification and to offer information regarding the level reached to all interested parties (students, parents, the institution, teachers etc.).

These three assessment categories should be applied during the teaching process. They must be a medium that not only determines if the objectives have, or have not, been reached, but it should also incentive learning by assuring the students that their efforts are valued, this encourages responsible and efficient work, set knowledge goals and organise the principal ideas through synthesis and analysis, facilitate the process of self-assessment so that the students can recognise the progress that they make and identify, for diagnostic ends, the causes and the nature of learning difficulties.

5. Conclusions.

There should never be, for any type of education, a division between the theoretical and the practical. What can be varied is the emphasis placed on the two areas of knowledge in terms of the order and development of the curriculum and this must be regulated by the types of skills and competences required of the students.

The teaching process should bring theory to the classroom in such a manner that historical antinomies between intellectual knowledge and operational skills are cancelled out; both should be united in a convergence aimed at integral human development, as in human resources training.

References

Biehler, R. (1994). *Didactics of mathematics as a Scientific Discipline*. Dordrecht: Kluwer Academic Publishers.

Bloom, B. (1975). *Evaluación del aprendizaje*. Buenos Aires: Troquel.

Carlos Rodríguez, E. (2000). La superación del profesor de matemática en la Universidad de hoy. Una experiencia cubana. *Acta Latinoamericana de Matemática Educativa*, *8*.

González, O. (1990). *Perfeccionamiento de la enseñanza de las disciplinas y la formación de habilidades y capacidades específicas*. Informe Final, La Habana.

Lafourcade, P. D. (1973). *Evaluación de los aprendizajes*. Buenos Aires: Kapelusz, S.A.

Landsheere, G. (1985). *Diccionario de la evaluación y de la investigación educativa*. Barcelona: Oikos-Tau.R.

Maccario, B. (1989). *Teoría y práctica de la evaluación de las actividades físicas y deportivas*. Buenos Aires: Lidium.

Tyler, R. (1949). *Principios básicos del currículo*. Buenos Aires: Troquel.