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**SIGNIFICANCE OF THE CONCEPT OF QUALITY
OF EDUCATION FOR DIDACTICS OF MATHEMATICS
IN UNIVERSITIES IN POLAND**

Arkadiusz Maciuk

Abstract. In the last twenty years the number of students and universities in Poland has increased more than four times. This quantitative increase has meant for the didactics of mathematics the need to reduce the level of education. Currently, this upward trend is in reverse and the higher education sector, practically in all Europe, can expect reductions. The current efforts of policy makers and academic staff are focused on improving the quality of education in order – among other reasons – to stay competitive. Shifting focus from quantity and efficiency to quality of education can be an opportunity but also a threat. The problem is how to understand the quality of education and how it can be put into pedagogical practice. Maths education has its own specific conditions. Taking them into account may result not only in improving the quality of didactics of mathematics, but more widely – improving the quality of what is understood as the process of higher education. The article gives an overview of the changes taking place in the Polish higher education sector over the last two decades and of the various definitions of the quality of education. It also presents some conclusions on the relation between the interpretation of the quality of education and didactics of mathematics.

Keywords: didactics of mathematics, quality of education, higher education sector in Poland.

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1. Introduction

With the increase of competitiveness in virtually every type of market, the following natural process takes place. At the beginning, when demand exceeds supply, a lot of attention is paid to quantity – that is the development of “manufacturing ability”. When demand is fulfilled and competitive pressure can be increasingly felt, effectiveness becomes the guiding word, identified mainly with cost reduction. In contrast, when supply exceeds demand, quality becomes an increasingly important factor.

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From the perspective of recent years, one can see that an analogous process has taken place in the higher education sector in Poland. Since the change of political regime in the late eighties and nineties of the twentieth century Polish universities have continuously undergone many significant and often radical changes. These transformations, determined by political, economic transitions and demographic processes, have had at different times different goals and character. In the 1990s the overriding aim of the policy makers initiating these changes was the creation of such conditions at universities which would enable to maximize the number of students – in accordance with the principle that the more people have higher education, the more there are professionals and “enlightened” people so needed in the new economic realities.

2. The transformation of the higher education sector in Poland

Previously, universities admitted a predetermined number of students to the so-called full-time studies, financed by the resources allocated from the central budget, and to part-time studies (evening and extramural studies) for which a specified fee was collected from students. Initially, to increase the availability of studies, within their capacity, universities started to admit a larger number of students, especially for part-time studies. A new opportunity also appeared for the establishment of new universities operating on a commercial basis, obtaining funds directly from their students. As a result, during the period from 1990/91 to 2000/01, the number of universities and students studying in Poland increased more than fourfold (see Table 1).

This rapid increase in the number of students generated the need for universities to increase the effectiveness of education, searching for ways to reduce costs of the educational process. In practice, this meant an increase in the number of students in study groups and increasing the number of teaching hours for academic staff, along with a significant reduction in the number of classes for students. This trend was intensified in Poland by the adoption of the Bologna Declaration of 1999. One of the major assumptions of this declaration is that the student is indeed focused on studying creatively and effectively, which can be described by the principle of “one plus two”. For every hour of classes at university a student devotes two hours in order to prepare him/herself. There are books and other teaching materials widely available, students can contact the teachers, for example, during office hours, so the number of teaching hours per teacher can be significantly reduced.

Table 1. Selected parameters characterizing higher education in Poland in 1990-2013

	Academic year					
	1990 /91	1995 /96	2000 /01	2005 /06	2010 /11	2012 /13
Number of universities in Poland	112	150	310	445	460	453
including non-public schools			195	315	328	321
Number of students (in thousands)	404	927	1585	1954	1841	1677
including studying full-time study mode (in %)		77.2		48.6		57.9
Number of faculty full-time (in thousands)		70.7*	80.2	86.8	100.1	100.7
Number of doctoral students (in thousands)	2.7	10.5	25.6	32.7	37.5	42.3
Gross enrollment rate (in %)	12.9	22.3	40.7	48.9	53.8	51.8
Net enrollment rate (in %)	9.8	17.2	30.6	38	40.9	40.2
The share of public expenditure on higher education in relation to GDP (% of GDP)		0.6	0.7	1	0.7	0.7
The share of employees with higher education (as % of total employment)	12	11		21	28	

* data for the year 1994/95

Source: own study based on data from GUS – Central Statistical Office of Poland, Pomianek, Rozmus (2010) and Buchner-Jeziarska (2011) (two last rows).

Such rapid growth in the number of students and the universities, due to the marketization process of studying, also raises some pathologies. Two categories of students were formed: those who got to study within the existing limits of daily studies conducted by public universities, and other students who had to bear the expenses associated with studying. For the latter category a very important factor when choosing a field of study was the size of the tuition fee. In response to that the vast majority of newly opened faculties are those which do not require additional funds, for example infrastructure, labs and expensive equipment; others include economics, admini-

stration, pedagogies and the humanities. After some time it turned out that a growing group of people who graduated from these types of faculties have had a lot of trouble finding a job because there are more of them than needed by the market, as opposed to graduates of technical or medical schools who are comparatively scarce. Educating the latter, however, requires significant investment and appropriate facilities, which effectively discourages potential investors from the education sector.

The large increase in the number of students in a relatively short period of time forces a decrease in the intensity of scientific work (Wilkin 2013). One cannot suddenly increase the number of faculties and the number of classrooms and teaching materials at universities, it will always take time. The rapid growth in the number of students, along with the small increase in academic staff, means that statistically there is less and less time and resources for the own research work of the employees. This effect is intensified by the newly established private universities, for which it was cheaper and more efficient to hire temporary contract lecturers from among public universities rather than having their own employees. Thus a significant part of academic staff works at several universities at the same time, dividing their time between all of them. This also means a decrease in the average level of education quality. When universities admit a relatively small group of students, the standards which a potential candidate must meet can be and are high. When the rule applies that the income of universities is closely related to the number of students admitted – virtually anyone willing to study is accepted, and the requirements for the candidates come down to having a secondary school baccalaureate ('matura') (Piotrowska-Marczak 2013). This results in a lower level of comprehension of lectures which forces university teachers to reduce the difficulty of exams, because otherwise the vast majority of students will not be able to pass them.

3. The issue of quality of education

In this situation, the term 'quality of education' appears frequently in the discussions on the functioning of the universities in Poland. One of the major purposes of this debate is to prevent and eliminate the above mentioned negative practices, as well as to increase the level of education.

For people teaching mathematics professionally, the definition of quality and thus of education quality is a subject which is to some extent troublesome. Firstly, the definition of quality is vague or ambiguous, which often makes discussion on this topic selective, or even nonessential. Secondly, the

quality of education is affected by so many different factors that the degree of the commitment of lecturers can have a relatively small impact on the overall quality of the education process. Nevertheless, the concept of quality in both the discussion on the educational process and the organization of teaching plays an increasingly important role.

Table 2. Summary of the advantages and disadvantages associated with the definition of quality classification by Reeves and Bednar

Type	Advantages	Disadvantages
Excellence	Ethical and marketing benefits, unambiguously recognized symbol of no-compromise high performance standards	Not highly useful in practice, difficult to measure, the attributes of excellence may change over time, need of finding customers willing to pay for excellence
Value	Concept of value uses various quality attributes, focuses on the efficiency of the organization, allows comparisons between objects and in time	Difficulty in assigning values to specific elements of the product, quality and value are not easily countable units
Compliance with the specification	Allows for precise measurement, leads to increased efficiency, essential for global strategy, should force analysis of customer needs, proper for institutional clients	Customers are not interested in internal specifications, not very useful for defining the quality of services, can limit the ability to adapt to other conditions, specifications may be worthless given the rapid changes in the market, oriented to within the organization
Meeting customer expectations	Assessment from the client's perspective, possible to use in any industry, reacts to market changes	The most complicated, difficult to measure, customers often do not know their expectations, biased customers' judgments may affect misleadingly the results, evaluation of short-and long period can vary, difficult to determine customer satisfaction

Source: Reeves, Bednar (1994).

In the field of mathematics it is particularly important that the definitions of the terms used are unambiguous, because the lack of precision and ambiguity may result in the defectiveness of mathematical concepts. They

may become incoherent, incomprehensible or even logically contradictory. The concept of quality is not easy to define. Similarly as in welfare, beauty, justice and health, it is a subjective term. Everyone intuitively knows what quality is, but in practice two different people may understand it in various ways. It is also a multifaceted concept that, depending on the context, can take on a different meanings. Quality can be identified, for example, with perfection, efficiency – defined as the quotient of the measure of all the utility and emotional values and costs of acquiring it - with compliance with the established norms or standards, with efforts to suit the needs of the client or an internal effort aimed at continuous improvement. Each of these aspects of perceiving quality has its advantages and disadvantages (see Table 2).

The same applies to the quality of education. In the literature the definition of this term is approached in many different ways, often contradictory to each other. For example it can be noted that defining the quality of education is very difficult, if not impossible, and it is left to the reader's intuition. Another way is to narrow the concept to a single point of view, taking into account a particular interest group. Comprehensive definitions trying to include many contexts of this term can be rarely found. This requires an indication of the stakeholders, that is the entities that have an influence or are affected by the quality of education. As there are numerous potential interest groups and meanings of this term, the definition of this type cannot be concise and precise.

One can, analogically to the divisions introduced in economics, distinguish three categories of stakeholders: policy makers, manufacturers and consumers. In the case of universities, the category of decision-makers can include central and local government authorities and the authorities of the university, a group of manufacturers – teaching and administrative staff, and consumer groups are students and employers. This division is not separable. For example, the university authorities comprises of teaching staff. It is therefore a group that can fall into two categories: decision-makers and manufacturers. Doctoral students frequently teach other students so they are both consumers and manufacturers. Employers hiring college graduates make use of their skills acquired during the studies – undoubtedly belonging to the category of consumers, but also for various types of business relations which have an impact on university life – are thus also a group of decision-makers.

Despite its imperfections, this division illustrates well an important issue. Each of these three groups of stakeholders have different interests and

different approaches to the issue of quality of education. For the higher education policy makers in Poland, improving the quality of education means improving the social perception of universities and the effectiveness of education. Their attention is focused on creating specific requirements and verifying whether universities meet them as well as on improving the university management model. The tools used to serve this purpose are: at central level – PKA (Polska Komisja Akredytacyjna) – the Polish Accreditation Committee, and at university level – WSZJK (Wewnętrzny System Zapewniania Jakości Kształcenia) – the Internal Education Quality Assurance System (Macukow 2011). University employees, through the quality of education, understand good organization of their work and its effectiveness, involving the right choice of curriculum content and the facilitation of their daily work with students. Students, by stating that a university offers high quality education, generally understand that their process of studying was an interesting and enjoyable life experience that resulted in acquiring the necessary skills and abilities to find an attractive job in the future. For a potential employer a good quality of education means that a graduate will be a valuable employee, i.e. on the one hand he/she will have the appropriate knowledge related to the profession, on the other hand will be independent, creative, resistant to stressful situations and will work well in a group.

As the conditions of the functioning of the universities in Poland are changing the discussion about the quality of education is evolving. More and more authors do not only look upon the matter in terms of compliance with the norms and standards, but begin to treat quality comprehensively – either in terms of meeting the expectations of “customers” of education or all the groups of stakeholders (Grudowski and Lewandowski 2012), or as a continuous improvement in relation to the previous state. This type of understanding of the quality of education does not yet have too much practical value in Poland. It is however mentioned more and more frequently and analogical to the processes taking place in the realities of the markets of North America and Western Europe (see Table 3), will be sooner or later implemented. To a large extent, this means that the needs of students and employers will count more and more. This trend will be strengthened by the demographic situation both in Poland and Central and Eastern Europe. Given the Polish demographic data, it can be easily estimated that in the 2020s there will be 30-40 percent less students than in the first decade of the twenty first century. This is particularly problematic as the needs of students are different and evolve over time. The first grade students frequently do not have a solid opinion, not only in terms of what the study requires, but also

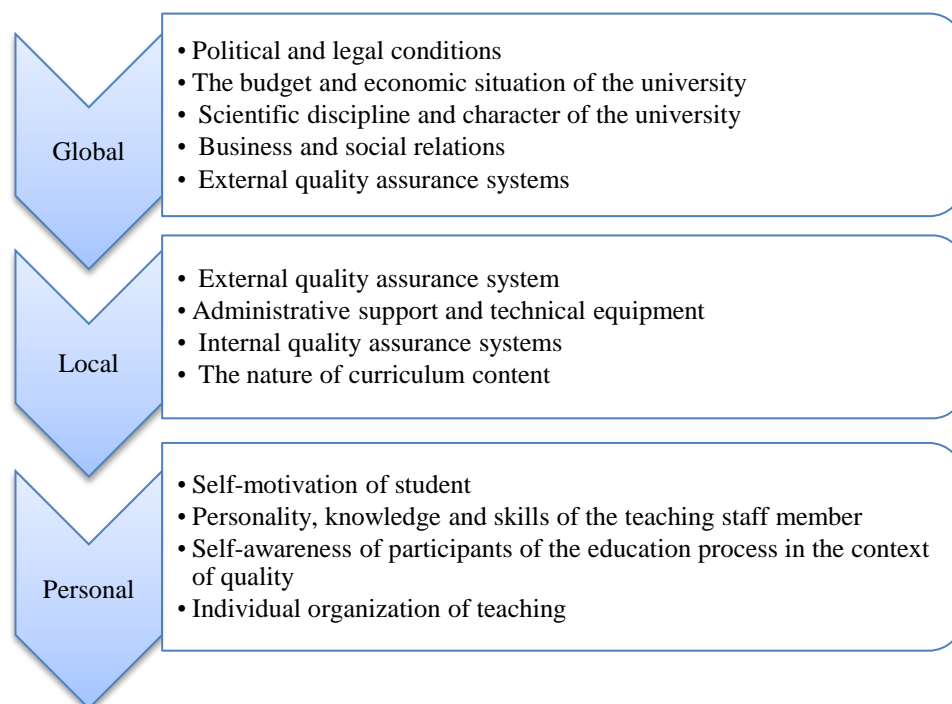
about the motives of their choices. This is analogous to the needs of employers. The process of studies takes time. If one chooses a field of studies based on the current situation in the market, one must take into account the fact that after graduation the situation may look very different.

Table 3. Characteristics of quality definition categories according to Löffler

Quality definition by category	Conformance to technical norms and standards		Utility and effectiveness	Conformance to customer requirements	
	I	II		I	II
Quality management system	Quality inspection	Statistical quality control	System-oriented quality assurance	Company-wide quality control	Total quality control
Time period	1945-49	1949-51	1951-late 60s	Late 1960s-80s	1980s-present
Superior quality parameters	Quality of final product		Production process optimization	Customer needs	Customer expectations
Management instruments	Standardization	Statistical methods	Root cause analysis	Quality function deployment	Continuous improvement
Management instruments	Mass production		Short product life-cycles	production + service economy	
Quality assessment	Third-party assessment			Self-assessment	
Aim of the assessment	Objective parameters			Composition to latter state	
Time dimension	Static		Dynamic		

Source: own compilation based on Löffler (2002).

Table 4. Determinants of education quality in universities.



Source: own compilation based on Grudowski and Lewandowski (2012).

The matter is also complicated by the fact that the quality of education depends not only on one factor, but on several factors of a different nature (see Table 4). Considering only one or a few is not sufficient to improve quality, one also needs to take into account their relations and interactions. The quality of education is also not an average, therefore disregarding even one of them may distort the potential improvement efforts.

4. The practice of teaching mathematics

The last decade of the twentieth century and the first decade of the twenty-first century is a period in higher education in Poland in which the level of teaching mathematics clearly decreased. The main reason for this is the “popularity” of studies which are not elite anymore and – in consequence – an increase in the number of students in the groups together with a vast reduction of the number of hours for the implementation of the material in mathematics. As noted earlier, if students represent a relatively small

group of people selected because of their intellectual qualities and the ability to acquire knowledge, they will meet the high requirements. If virtually everyone is accepted, the average intellectual level of the candidates will vastly decrease, resulting in the fact that also at the later stages of university education teachers' demands will need to be reduced. Similar conditions also apply to other classes, however for mathematical education such reductions are more severe than in the vast majority of other subjects. Comprehensive skills regarding mathematics vary for individuals. There are students who can handle many issues themselves providing that they know what range of material to learn and what teaching materials they could use. However, for the vast majority of students, mastering new material in mathematics requires a lot of their individual effort as well as tutoring. For these people the possibilities of additional contact with the teacher are essential. The lack of knowledge of some important concepts (and mathematics practically consists in such concepts) can block further education in this field. A proper diagnosis regarding what material should be corrected and what should be done to overcome this blockade requires contacting a person who knows the issues well and has pedagogical practice. Equally important are proper ways of acquiring knowledge. Mathematics requires above all analytical thinking and the ability to draw conclusions, a good memory or even calculating skills are less important. Meanwhile, a large proportion of students is trying to replace analytical thinking with memorizing. This is largely the fault of the earlier stages of their education, which requires memory skills in mastering the material, and the ability of analytical reasoning is not sufficiently trained or even neglected.

An equally important problem is the reduction of the number of teaching hours combined with the decreasing level of mathematical knowledge acquired by students in the earlier stages of education. For example, in the 1990s in the faculty of economy, depending on the specialization, there were 90-120 hours of classes for linear algebra and calculus. In the first decade of the twenty-first century, this amount was reduced to 30-60 hours. Facing these problems – in connection with the aspects mentioned above – lecturers were forced to change the way of teaching. In practice, this comes down to reducing or totally neglecting the issues requiring carrying out proofs and solving abstract exercises, while focusing mainly on studying the specific formulas and algorithms necessary to master other subjects such as statistics, logistics and econometrics. This trend was intensified by further reductions in the mathematics curriculum in secondary schools. Virtually all the aspects of calculus are based on the concept of function and derivative.

Meanwhile, as of 2006, secondary school graduates do not know what a derivative of the function is. They know what a function is, but usually are not able to determine for example whether there is an inverse one (Maciuk 2011). That makes it even harder to teach such students within very limited teaching hours available.

5. Conclusion

In such circumstances it is highly important to understand what quality of education really is and what can be done to improve it. Both the quality of education treated in terms of a specific subject, and in the wider sense as the quality of the whole process of education at universities. For didactics of mathematics, accepting an interpretation of this concept as compliance with the specification given by decision-makers representing the central government will be negative, because in practice that will mean strengthening existing standards. Identifying the quality of education as meeting the requirements of customers of the education process has in recent years gained popularity. In particular, much attention is paid to whether university programs fit the requirements of the market. It is not only about supplying the missing professionals but also about supporting the future graduates and helping them develop the skills and qualities such as self-reliance, common-sense, the ability to assess situations and draw the correct conclusions, analytical thinking skills, risk assessment, responsibility, team work and so on.

Learning mathematics is not a “panacea for all diseases”. However it is difficult to find better ways of learning logical thinking or drawing conclusions than the analysis of mathematical theorems and their proofs. Viewing a math lecture as teaching formulas which are meant to be memorized is a misunderstanding. To prevent such tendencies, it is necessary to increase the number of teaching hours of mathematics so that it is possible to introduce elements of logic and selected proofs. When such a solution is not possible within the current amount of teaching hours, some of them should be devoted to presenting selected purely abstract mathematical constructions, such as: the function, the inverse function, the derivative as a function measuring changes in a function or the derivative as a linear function, and so on.

Last but not least – it is fundamental to keep in mind the issues that for some may seem obvious and are associated with involvement in what we do in all fields, including education. That involvement is synonymous with respect for the people with whom and for whom you work. For them, it may often be the primary determinant of the quality of education.

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