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Is Math Adequately Taught for Tomorrow's Software Engineers?

Christian Mancas*

Department of Mathematics and Computer Sciences, Ovidius University, Constanta, Romania

Introduction

The 2012, July 28 New York Times, Sunday Review, The Opinion Pages editorial "Is Algebra Necessary?" [1] raised once more, not only in the U.S., legitimate questions on math teaching in high school and college. Published comments, both on the newspaper's Reader's Comments section, as well as elsewhere in the Internet (e.g. the LinkedIn ACM Group discussion on [1] are somewhat surprisingly assuming that [1] implies suppressing school algebra studies (although only its title might mislead–but titles are often used to better sell the paper–,as no such thing is stated in [1]), and are clearly divided into two categories: those that still fear math, and especially algebra (and would gladly applaud suppressing it immediately), and those that either love, like, or/and use it directly (and are outraged by such a possible suppression). Being involved for some 35 years both in the IT industry (mostly in Software Engineering) and in University Computer Science teaching, but also being a father (of both IT and non-IT graduates, as well as of very young pupils), I consider this topic a very important and challenging one, even when restricted to math teaching for tomorrow's IT and, especially, Software Engineers. [1] starts from U.S.-wide statistics showing that mainly algebra, but math in general too, is the main obstacle that blocks more than 40% of the students both in high school graduation and college enrollment. This is true also in other countries, including mine: let's call them for the rest of this paper the unfortunate ones. As, fortunately, there are also countries where this is not happening (e.g. Germany, Japan, Finland, South Korea, Canada, etc. let's call them here the fortunate ones), it is clear that there exist solutions for significantly improving at least the above percentage. This paper tries to summarize some basic facts and widespread relevant opinions in this area, and concludes with some suggestions aiming at better teaching math, both generally and, especially, for tomorrow's IT engineers, with emphasis on software ones.

Some Facts

Mathematics is the ultimate expression of human reasoning, foundation and language for all science. For example, you cannot solve probability problems without basic statistics; furthermore, you cannot solve statistics problems without understanding algebraic manipulation. Moreover, by using math we can communicate crystal-clearly, even when traditional language and cultural barriers are insurmountable. In particular, for example, every cell in any spreadsheet program (e.g. Excel, Lotus, etc.) or database (e.g. Access, Oracle, etc.), used in virtually every today's business, is an algebraic variable (having a name that is used in formulas and holding any number or text value). Obviously, there is no easy way out of it: 1+1 was, is, and will always be 2 and, just like Murphy put it, 2 is less than 3, 'even for the biggest possible values of 2'.

Math is a "science of patterns", not just a collection of techniques to manipulate numbers (i.e., arithmetic), shapes (i.e., geometry), and change (i.e., calculus). It is not about results, but about the process of getting them; it is not about proving or disproving, for example, equalities, but about understanding in what contexts those equalities hold, or hold not. Moreover, the ability to derive unknowns from knowns, to push boundaries, and the syllogistic logical mode usually begins with Algebra and Geometry. Especially modern math is even much more too: the study of mathematical structures and their methods.

Well taught math is a superb exercise for the mind, very much like classic music, poetry, and fine arts; dually, badly taught math becomes a morass of misery and, unlike music, poetry or fine arts, it is very hard to seek it out on your own for pleasure, even if algebraic equations may be thought of too as being analogous to sentences: numbers are nouns, functions are verbs, and solving for x is very much like finding the main idea of a story.

Certainly, algebra is not that easy; if it were, most probably the entertainment industry (or at least some software giants -Apple, Microsoft, Google, etc.) would have already gotten involved and some "Algebraic Entertainment" (in the line of CSI's ones for Anatomy, Toxicology, etc.) was improving graduation and enrollment statistics. Dually, there are, however, some marvelous books on math, and especially algebra (which can be enjoyed by almost everybody, including [1]'s author and all those that fear math, and are opening lot of minds and souls to this subject's beauty, e.g. [2], all references between [3-11], i.e. the math subset of the excellent Brockman Inc.'s Science Masters Series, etc.), some good school math text books (e.g. [12], [13], but also all those written and/or supervised by my superb and beloved math Professors Lucia Tene, during high school, Octavian Stanasila, Ion Sabac, Alexandru Dinca, etc., at the university, for which I'm not giving you complete references here only because they are in Romanian), as well as more modern similar approaches–from the captivating Norwegian Dragon Box [14],to the Prof. James Sellers' DVDs [15] (superbly teaching algebra for mastery, as it also anticipates points of student confusion), or Khan Academy's videos (explaining discrete mathematical concepts and operations) and Massive Open Online Courses (latter ones generally accessible, it is true, only starting with good colleges levels). It is surely worthwhile to advertise them always as vigorously as we can! And why not trying to make competition in intellectual pursuits as important as 'American/Romanian/etc. Idol'? Difficulties in math learning simply make it clear how important it is to teach these subjects, since an understanding of the ingredients of rigorous argument and an understanding of abstraction are and will ever remain crucial intellectual skills.

Somewhat dually, at least in some countries (including mine), math (and not only) curriculum becomes denser and harder every 4-5 years. For example, when I learned geometry (some half a century ago), Ceva's and Menelaus' theorems were optional, i.e. useful only for those colleagues of mine who were participating at national math 'Olympic' contests; today, my daughter and all of her colleagues have to learn them too (and this is only one example out of many others, perhaps only the most striking of them all, as not only us, the parents,

***Corresponding author:** Christian Mancas, Associate Professor, Department of Mathematics and Computer Sciences, Ovidius University, Constanta, Romania, and Software Engineering Department, Asentinel Intl. srl, Bucharest, Romania, Tel: +40722357078; E-mail: christian.mancas@gmail.com

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but teachers and authorities neither can explain why should they be compulsory). As, moreover, it is compulsory too that even from elementary school all pupils must have at least 3 marks per semester for each subject, among too many other homework, teachers are requiring them to compile and present a paper at least for one of these 3 marks, which, even if generally done with the great help of the Internet and the parents, is still consuming a lot of pupils' (and parents') time with very little profit, if any, leaving even less time available to learn more and more non-essential, Ceva's and Menelaus' type of knowledge.

Unfortunately, as this pressure on pupils gets harder in every of the K-12 years, they not only tend to become more and more superficial, but, even worth, when they enroll to universities, more and more of them, every year, do not fully attend courses and labs (some are even attending only first ones, even if course attendance remained mandatory!), do not do their homework, and start learning and doing their projects only a few days before exams. It is increasingly worrying that in many of our classes a sizable minority of students is not even remotely diligent in their work: anyone of us, teachers as well as parents or executives, is aware that knowing how should failure to learn be addressed is an almost intractable issue immediately after students are 18. Part of the problem seems to be the rampant laziness among a growing part of world's youngsters, especially in the developed countries (and the new technologies services and products, from calculators to adult web sites, are surely at least encouraging it): they are always looking for an excuse to avoid doing almost anything that is the slightest bit challenging, even if we always recall to them, among others, that when President Kennedy mandated the U.S. to put first men on the Moon, it was definitely not because it was easy, but despite the fact that it was extremely hard (and also that mankind certainly would not have gotten there without math). Obviously, if you are not exposed to hard problems, you will never be prepared to solve such problems. Moreover, mankind will never measure cosmos distances by launching space crafts from any point in the Universe to any other one, but, as even Babylonians, Egyptians, etc. were doing it thousands of years ago, only by using math.

Again most unfortunately, let us recall too–from the other side of this "barricade"–that teachers (and, for example, in countries like mine, even university professors) salaries in unfortunate countries are from more than half a century so low that anyone with an aptitude for math will most likely go into much higher paying fields, rather than teach math in classroom. And not only there are too few financial resources in public education(e.g. pretending that one high school teacher can teach 100-150 students with any degree of success is at least ridiculous), but teachers (and, for example, in countries like mine, even university professors) are almost not at all respected or esteemed by authorities. On the contrary, in the fortunate countries teachers of all grades (math or not) are highly paid and respected.

Some Opinions

Obviously, math illiteracy is keeping lotteries and casinos not only alive, but more and more prosperous; somewhat dually, just as Orwell warned us, "ignorance is bliss" (and most welcomed by the political thought polices of all times and places). Moreover, I am surely not the only one to firmly believe the substantial lack of math-oriented life skills probably contributed to the subprime debacle that triggered the current world economic crises much more than usually thought of.

Math is essential for a career in all STEM branches, its truths transcend the "real" world, is as beautiful in its own way as music, fine arts, or poetry, may even be fun, and it's necessary if you hope someday to be able to help your own kids and grandkids with their school math homework; moreover, it mercilessly teaches logical thinking. In particular, algebra is a foundation stone for our ability to think critically, at least as are philosophy and logic. The critical skill learned in algebra understands what the whys and wherefores of a problem are and how to approach solutions to new types of problems. It teaches us how to make connections between disparate and different approaches, viewpoints, and perspectives, and to think inductively and deductively, critically, algorithmically (of which I would emphasize here exhaustiveness: you should always think of every possible case, for solving it adequately, as well as of every 'impossible' one, for rejecting it and providing the adequate corresponding 'error message'), analytically, and associatively, by factorizing (thus simplifying and optimizing…), aggregating, generalizing, particularizing, etc.

It has been shown that brain development is influenced by how the brain is used. New pathways are created, for example, by learning a second language early, by learning to read music and play an instrument. Certainly, learning algebra and geometry, working on difficult problems and learning to think abstractly when you are in your preteens and teens is good for brain development. Fuzzy minds demand rigor. Would somebody argue that people shouldn't jog or do pushups because it wastes their energy? Let us all, always, develop both the body and the brain (*menssana in corporesano*).

Dually, of course, this demand for everyone to be able to solve multivariable equation systems, do subtle geometric proofs, learning to master trigonometric (in) equations, do complex balancing of chemical ones, etc., is coming at the expense of people being unable to use the most basic of math skills in their everyday lives. Math is a tool and nothing more and it should be also taught so that it can be effectively used by anyone who needs it. After a certain point, except for mathematicians, it is nothing but a challenging intellectual exercise, with no more value than chess or bridge.

Obviously, poets do not need to be good at math(although, clearly, the math ignorant poet is as poorly educated as the poetry ignorant mathematician, computer scientist, engineer, etc., and perhaps teaching math better would give poets skills they might use to support themselves while practicing their calling), but philosophers sure do (as most of the greatest philosophers were also brilliant logicians); composers, painters, sculptors, novelists, etc. did always take great benefits from also mastering math basics (e.g. symmetry), which, of course, does not mean at all that, dually, for example, we would have wanted Bach, Mozart, Beethoven, Brahmsor Chopin wasting any second in trying to improve their math skills; apparently, MDs do not need math (at least above basic arithmetic), but need chemistry and biology, which are much better understood if you have solid knowledge, for example, of basic algebraic structures like groups; lawyers and investigation journalists should study and legislators(not only in my opinion) should even pass exams before each candidacy on first order logic (at least for avoiding incoherent sets of laws, newspaper articles, or TV interviews, and for not abandoning their critical thinking skills when faced with (mostly falsely perceived as) numerical expertise–which happens mainly because they lack the confidence to question the blur of statistical propaganda disseminated almost daily from various political sources, especially in unfortunate countries, but not only, and especially as, at least apparently, no one seems to have learned much from Mark Twain's assertion that "there are lies, damn lies, and then there are statistics").

Math skills preserve democracy: without them we risk a lot ending up with a society that cannot decipher data and is easily fooled by manipulated statistics. Since ancient Greece, democracy needs educated

citizens; today's knowledge society needs scientifically and technically educated ones (a must for being able to make informed decisions and take adequate measures). Generally, we do not consider since centuries literate adults as shamans with magical powers: nor should we consider numerate ones as wizards anymore. The ability to think logically and rigorously is most probably our most important both weapon in war (Hitler was defeated in great part because of the superb work of the Alan Turing led team of mathematicians) and guide in life. The ability to think critically is crucial even to decent survival (and I firmly believe that the author of [1] is completely wrong when he says that critical thinking doesn't lead to more credible political opinions or social analysis; and, by the way, is political science needed anymore, as almost everywhere in the world, but especially in unfortunate countries, people go in lesser and lesser numbers to vote?).

Education is the process of raising students as upper as possible above what they would otherwise be. Young ones should be able to make the transition from concrete to abstract reasoning, and arithmetic and geometry followed by algebra and logic, properly taught, is a beautiful and effective way for promoting this cognitive growth, especially as understanding algebraic manipulations is fundamental to deal with the barrage of numbers that we face in our daily lives (and as no calculator can substitute for understanding them!). Math is studied perhaps especially in order to develop and wire the brain's generalized capacity to understand that which is abstract, logical, and quantitative. What would we prefer: problem makers or problem solvers? Trivially, we should continue to adequately prepare engineers for solving problems and creating new services and products (not to mention gadgets, an industry with an amazing growth, even during crisis times). Moreover, as life is hard and you cannot be successful if you give up easy, math should always be used to teach students perseverance and rigor too (and even the fact that you neither can nor should always excel at everything). Perseverance to overcome complex, tedious and painful concepts and tasks is what most people derive from their math studies: only great musicians, actors, and sports performers may achieve it without math. Let us not forget that job performance is a function of perseverance too and that today's job market pays only those who demonstrate the capacity to overcome and command a bevy of technical and intellectual tasks.

Moreover, another thing that algebra and higher math teach is modeling, i.e. establishing adequate relationships between the real world and science. One of the excuses given for the current financial crisis is that the models failed, although, in fact, the mathematicians who built those models knew exactly what they were doing and the problem is actually that most of the decision makers who made investments based on these models did not understand them fully and/or correctly. It should be trivial that algebra and higher math are absolutely necessarily for anyone working in finance. On the other hand, it is also true that there are only some parts of currently taught math that are critical (even former math teachers and tutors admit that, for example, it's about 40% of algebra and 80% of geometry from the high school curriculum). It is true too that curriculums would greatly benefit from discussing more applications and fun facts (e.g. 1+3, 1+3+5, 1+3+5+7 etc. is always a square), history or modern problems (such as the 4-color theorem, or the fact that every integer can be written as the sum of four squares, but not three), ultra-fast convergent series for Pi and its application in finding related magic numbers and cryptography, or creation of good random generators (and discuss why Excel is bad at that).

Looking now at the "dark side of the moon" too, obviously, one of the reasons students drop out is that we, their parents have not enough control over their where abouts, that there is no significant societal consequence to their dropping out, and that their value system places cherishes little of the non-twitter/facebook/chat/etc. fundamentals. Almost surely, at least for some students, the problem isn't math, but merely motivation. The success always lies with the student and the teacher and the parents and the regulating authorities. If, automatically, when a subject is "too difficult and has no use", it should not be required, then, trivially, reading and writing ought to be the first to question, as way too many pupils and even students still fail basic read/write skill tests. Moreover, in a world of audio and video, why waste the time with it? (And I confess that I was tempted at the beginning to give this paper the far more inciting title "Is Reading and Writing Necessary"?). Is the assumption that 'everyone is equal', not just 'under the law', but also in talent and ability (some, 'just needing additional coaching and attention') actually true? In particular, is everyone 'equally capable' and 'equally in need' of more demanding math and science (but not only) courses?

Finally, as long as we will continue to keep thinking that teaching school in K-12 (and even in universities, like it is still the case in some countries, including mine) should be a low-paid, low status job, we are going to continue to see these unwanted results. Is paying huge bonuses to bankers, for example, actually helping societies? Wouldn't rather paying hefty bonuses, however, to good math teachers be?

How About Software Engineering Math?

Obviously, in order to well prepare software engineers you first need good quality K-12 and college math both curriculum and teaching, so most of the above opinions are applicable in this particular case too. In my opinion, differences should start only for universities. As good teaching is well understood (and, generally, even in countries like mine, is the best one overall –as usual, with the exceptions that should always be and generally are corrected–, even there where salaries and social status are not at all to be envied), I am only referring in what follows mainly to curriculums.

I'm striving since two decades to teach to my university students a completely algorithmic approach to business analysis, conceptual data modeling, database design, implementation, and their instances update and querying, based mainly on the (semi-naive) algebra of sets, relations, and functions and on the first order logic with equality (see, for example, all references between [16-24]). At least the best of them (but not only) discover only then why they had to learn, for example, (minimally) one-to-oneness, commutative function diagrams, minimal and coherent sets of logic formulas, etc. Not rarely, some of them that previously feared math (and especially algebra and logic) are not only overcoming this fear with this occasion, but even start to fall in love with, at least, sets algebra and logic. Please also note that since 35 years I was also working in parallel as a computer science engineer (which always provided me with lot of extremely helpful and beautiful examples in this field and, dually, benefitted of my solid math background and also love for math).

Just like for any other specialization, software engineering requires more of some math subjects, less of others, and none of the rest. First of all, when considering exceptions, it is clear that there should be some optional advanced math: for example, those that want to specialize in computer graphics should also learn more geometry (e.g. fractals), those that want to work from the beginning for scientific applications (e.g. for nuclear plants) should also learn corresponding advanced sciences concepts (e.g. nuclear physics), those that prefer financial software should also learn more from statistics and corresponding math modeling, etc.

For the rest, the above math subjects are of no relevance, so they should not be compulsory. Obviously, there are other math subjects too that should not be compulsory for preparing any software engineer (e.g. number theory, operations research). Moreover, some other math subjects that are needed by the majority, but not all software engineers (e.g. advanced graph theory) should also be optional. Finally, in my opinion, first order logic, sets, relations, and functions algebra, and complexity should be compulsory for all.

Unfortunately, there are countries (including mine) where obsolete nineteenth century "common trunk" policies are still enforced, which severely affects math curriculum too (but not only: for example, in the Bucharest Polytechnic, the best in my country, computer science students still have to study technical drawing too and, what it is much worse, are not drawing graphs, or trees, or E-R or UML diagrams, but taps, just like 175 years ago!). In Polytechnics, for example, advanced differential equations are compulsory in every department, while in Math and Computer Science faculties of all other universities statistics are compulsory too. Dually, for example, complexity theory is not taught by the polytechnics math departments, so that computer sciences ones have to offer it too. For short, there are still unneeded math (but not only!) subjects and topics, while some needed ones are missing.

Moreover, inter-disciplinary connections and real world examples are still too rare. For example, my students (from both above university types) learn only from my database classes that *Capital* is a one-to-one mapping from *Cities* to *Countries* or, even worth, that neither one-to-oneness, nor the minimal one are not absolute properties, but heavily context depending ones (e.g. international telephonic prefix is one-to-one in the E.U., but not worldwide, intra-countries state/land/department/regional/etc. ones are one-to-one only within countries, etc.), and that it is part of their professional duties to always correctly analyze any such context for any such function (be it a single or a product one).Same goes too for the fact that transitive closure, computed with least fix points, is the best way to find out all of his/her ancestors/descendants, the total number of files, folders, and needed disk space for copying/moving data stored electronically, etc.

Conclusion

Mathematics, both pure and applied, is one of the most important keys to our world's future success as a global knowledge society. Especially for software engineers and non-software IT ones (but also for many others, like aerospace, applied chemistry, biotechnical systems engineers), even some truly advanced math subjects are mandatory. Even everybody else need daily some basic math, at least for a minimal understanding of household finance, public statistics, etc., and even of personal car driving responsibilities. Consequently, math has to be studied by all, even in most of the vocational tracks. Discarding math or even dropping needed basic or advanced math subjects and topics would be an enormous error, depriving the young ones of fundamental chances to be successful later, not only professionally, but also as "modern" human beings. Obviously, adequately tailored math (but not only) curriculum should be designed for all groups of people, teaching tracks, and study levels. Currently, there is improvement room in this area even in the most fortunate countries, not to speak of the unfortunate ones. All of the non-essential subjects and topics (and, at least in my country, there are a lot) should be immediately dropped from all math (but not only) curricula, at all levels (from elementary school and up to math M.Sc. programs). What is worth, establishing and modifying math curriculum is almost everywhere now still largely dominated by mathematicians, which, not only in my opinion, is not the best possible solution: even starting with the second half of elementary school, best computer scientists, polytechnic engineers, biologists, sociologists, linguists, doctors, lawyers, etc. should represent at least half of the deciders in this matter (dually, of course, mathematicians should always be involved too in establishing the rest of the world curricula: there would most probably be less incoherent, better structured, clearer, and simpler school and university textbooks, with much more inter-connections with both math and other disciplines). We should intelligently re-group people by tomorrow's career types (and up to the mid-sixties, there were three such groups, still existing, but ignored today in most of the unfortunate countries: trades or labor, business or service, and college/university) and custom-tailor (not only) math curriculum for them (as most of the fortunate countries always continued to do).

If you expect less you will get less: our goal should not be to make the math curriculum dumber so that more students can graduate, but a dual one, of adequately tailoring it (and also national tests and exams levels!) by need types and teaching math better, with much more today's interesting examples (and not only text and simple graphical ones, but with more and more visual, animated images ones), concentrating much more on algebraic and logic reasoning and much less on the mechanics of algebraic and logic manipulation. Certainly, we should teach youngsters too, as examples, elementary, every-day skills not only like understanding that the Consumer Product Index is an weighted average, but also like banking and balancing a checkbook, the relationship between Discount and Markup, how to compute, for example, a $\$x$ annuity @ y% for z years, how to budget (e.g. when acquiring the newest iPad/Phone), the cost of owning a car you are about to borrow, how the toll of the loans for college students are impacting their monthly income, or that credit card solicitations offering "zero percent interest", but with a 5% "balance transfer fee", are costing the about same as a regular credit card with a 13% APR, etc. Math teachers should give at least three real life examples for any concept they teach (e.g. starting from the fact that, for example, lot of math -and especially algebra and logic- was, is, and will always be needed for their beloved Google, Facebook, YouTube, etc. engines, movie and music players, notebooks, pads, smart phones, etc., that even a lot more is crucial for space crafts, airplanes, trains, cars, ships, but also for health, trade, finance, etc., etc., etc.). For short, let's always teach interestingly and intelligently all needed basic and only useful advanced math (but not only math!).

We all, regulating authorities, parents, teachers/professors, should also strongly encourage students' self-discipline and perseverance. Somewhat dually, school (and especially math, but not only!) should never overwhelm the young ones with too much home work (like it happens still at least in some countries): in average, 2-3 well-chosen exercises per topic should be enough; daily requiring dozens of them is another main root of "math is hard, boring, etc.". We should solve the teaching problem by providing all the rewards necessary to attract qualified people for math instruction. We all, and especially those in unfortunate countries, will always need to adequately fund the present in order to prepare for the future.

In my opinion, math (but not only) is not adequately taught, at least in the unfortunate countries, either generally or for well preparing tomorrow's software engineers. Obviously, for addressing all of these conclusion issues, a huge jointly effort is needed from students, but especially from parents, teachers/professors, and, above all, regulating authorities, starting with republic presidents, PMs, education ministers, national and local legislators, and down to university departments heads and school masters. Will we all be ready to make this effort in the foreseeable future?

References

1. Hacker A (2012) Is Algebra Necessary? The New York Times, Sunday Review, The Opinion Pages.
2. Enzensberger HM (1997) The Number Devil: A Mathematical Adventure.
3. Stewart I (1995) Nature's Numbers: The Unreal Reality of Mathematical Imagination. Harper Collins Canada/Basic Books Division, Canada
4. Rees M (1999) Just Six Numbers. The Deep Forces that Shape the Universe.
5. Livio M (2002) The Golden Ratio: The Story of PHI, the World's Most Astonishing Number. Broadway Books.
6. Seife C (2000) Zero: The Biography of a Dangerous Idea. Souvenir Press Ltd .
7. Barrow JD (2005) The Infinite Book: A Short Guide to the Boundless, Timeless and Endless. Jonathan Cape ltd.
8. Pickover CA (2006) The Mobius Strip, Dr. August Möbius's Marvelous Band in Mathematics, Games, Literature, Art, Technology, and Cosmology. Basic Books.
9. Livio M (2005) The Equation that Couldn't Be Resolved: How Mathematical Genius Discovered the Language of Symmetry. Simon & Schuster Inc.
10. Devlin K (2008) The Unfinished Game: Pascal, Fermat, and the Seventeenth-Century Letter that Made the World Modern. Basic Books.
11. Singh S (1997) Fermat's Last Theorem.
12. Bourbaki N (1943-1971) Elements of Mathematics: Algebra I, Addison-Wesley.
13. Larson N, Hake S, Wrigley P, Wang F (2012) The Saxon Math Homeschool, Houghton Mifflin Harcourt.
14. We want to know (2012) The Dragon Box Revolutionary Game.
15. Seller JA (2011) Algebra I and II, and Mastering the Fundamental of Mathematics, The Great Courses.
16. Mancas C, Mancas S (2005) MatBase Entity-Relationship Diagrams Subsystem Meta-Catalog Conceptual Design.
17. Mancas C, Dragomir S (2004) *MatBase*Datalog subsystem meta-catalog conceptual design.
18. Mancas C, Dragomir S, Crasovschi L (2003) On Modeling First Order Predicate Calculus using the Elementary Mathematical Data Model in MatBase DBMS.
19. Mancas C, Dragomir S (2003) On the Equivalence between Entity-Relationship and Functional Data Modeling.
20. Mancas C, Dragomir S (2003) An Optimal Algorithm for Structural Keys Design.
21. Mancas C, Crasovschi L (2002) An Optimal Algorithm for Computer-Aided Design of Key Type Constraints.
22. Mancas C (2002) On Knowledge Representation Using an Elementary Mathematical Data Model.
23. Mancas C (2002) On Modeling the Relational Domain-Key Normal Form Using an Elementary Mathematical Data Model.
24. Mancas C (2002) On Modeling Closed Entity-Relationship Diagrams in an Elementary Mathematical Data Model. ADBIS 165-174.