

Comments on the Reconceptualization of the Baccalaureate Degree in Mathematics

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Abstract

In October 2002, the Faculty of the Department of Mathematics and Computer Science of the University of Puerto Rico at Río Piedras approved a Proposal to “reconceptualize” its BS in Mathematics degree. We analyze this Proposal’s content and the processes that led to its approval. We conclude that the Proposal is gravely flawed as a curricular reform proposal, both because of the weakness of its content and the inadequacies of its approval process. If implemented, it will likely lead to a serious and unacceptable decline in the academic level of the baccalaureate degree in Mathematics at the Río Piedras Campus and worsen the already catastrophic situation surrounding Mathematics Education in Puerto Rico. We appeal to our colleagues of the Faculty of Natural Sciences and to the pertinent university authorities to withhold approval of this Proposal until corrective action is taken to ensure a degree which adequately prepares students either for further studies or to enter a range of mathematical professions. We also hope that this analysis serves as a case study to alert other university departments to the deficiencies of the Reconceptualization Project and the questionable ways in which the processes leading to its implementation are being conducted.

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1. Introduction

In 1995 the Academic Senate of the University of Puerto Rico, Río Piedras Campus, initiated a project to “reconceptualize” the baccalaureate degree. This initiative was identified for support by the ACE/Kellogg Project on Leadership and Institutional Transformation which is funded by the W.K. Kellogg Foundation. According to an American Council of Education (ACE) document [6]

*“Another key to the success (of the ACE project at the UPR) has been the careful **selection** of participants according to their capacity for teamwork. The one task force that has had the most difficulties in producing results is precisely the one in which **selection criteria** were not strictly followed.”* (Emphasis added).

Thus UPR “task forces” appear to have been *selected* using the rather narrow criterion of *capacity for teamwork*. How exactly was this capacity measured? Were any other criteria taken into account? Moreover, according to a letter (**Exhibit 1**) from Madeleine F. Green, Vice President of the American Council on Education to Dr. Pedro Sandín-Fremaint, dated May 20, 1999:

*“Although our role is not intended to be evaluative or directive, we could not resist offering a few suggestions about strategies for the future. We are concerned that the UPR is now at a pivotal moment. The process must proceed expeditiously; the time for extended deliberations is over. While the pace must be accelerated, **you cannot risk the important gains you have made to date through careful and inclusive discussion. You need to press hard towards closure and implementation...**”* (Emphasis added)

Unfortunately, this advice was followed. The document *Un Nuevo Bachillerato para el Recinto de Río Piedras de la Universidad de Puerto Rico* was approved by the Academic Senate on May 21, 2001. The final version differed substantially from that previously distributed. Despite this fact, departments and faculties were not provided with the opportunity to see or even comment on the final document before its approval. A letter to the then chancellor Dr. G. Hillyer requesting a faculty meeting prior to the Senate’s final vote was signed by more than 180 professors. This request was totally ignored.

The Senate document has serious flaws in its assumptions, its research methodology, and, therefore, its conclusions and recommendations. These have been well described elsewhere and the reader is referred to reference [1] for further details. As part of this “reconceptualization”, the Mathematics Department at Río Piedras approved a Proposal to reconceptualize its baccalaureate degree conforming to the parameters laid down for all baccalaureate degrees on Campus.

The corresponding document, **BS in Mathematics** dated September 18th, 2002 (**Exhibit 2**), henceforth referred to as the **Proposal**, was prepared by the Curriculum Committee of the Department of Mathematics and Computer Science. We assess both the **Proposal**’s content and the process that led to its approval.

2. Description of the New BS

The proposed baccalaureate has a core of 30 credits together with three options:

1. Pure Mathematics;
2. Computational Mathematics and Statistics, and
3. Discrete Mathematics.

The **Proposal** states that an option in Actuarial Mathematics will become available in the near future. The preliminary version of the Reconceptualized baccalaureate dated September 5th stated that an option in Mathematics Education may become available. The version of September 18th discussed herein is more ambiguous merely stating without explanation that

“the program is suitable for those planning a career in secondary education... The objective is to have a degree that leads to teacher certification.”

A list of courses is provided for each option. As well as completing the “core” of 30 credits, a student must choose four courses from one of the three options. The student must also take co-requisites consisting of one year of any natural science as well as either computability theory or algorithms, data structures and programming. All other courses are as specified in the Senate Scheme [5]. The total number of credits required of the student is 129.

3. Problems with the Proposed BS

3.1. Inadequate Justification

Three main reasons are given to justify the reconceptualized baccalaureate: to have a degree that also leads to teacher certification; to make the degree more “attractive” and thereby increase enrollment; and to have a degree with a similar structure and number of credits as that of certain universities in the United States.

3.1.1. Regarding Teacher Certification

The **Proposal** fails to explain exactly how the new BS in Mathematics is an improvement over the existing mechanisms for teacher certification. As explained in section 3.3, the level of the core of the BS has been reduced in the **Proposal** to about that of the existing BA in Secondary Education with specialization in Mathematics. Since Education is not a branch of Mathematics and possesses no theorems, it can be inferred that the electives for this option, if it is created, will be mainly courses in the field of Education. Thus the *mathematical* level of the proposed BS in Mathematics with either a specialization in Education or “leading to” certification in Education will be about the same as that of the existing BA in Education with specialization in Mathematics. This represents a serious lowering of the **mathematical** content of a **BS** degree in Mathematics.

While there is little academic benefit for this lowering of mathematical level, it is not hard to find pecuniary motivation. The federal government in particular has plentiful funding for baccalaureate degrees leading to teacher certification.²

3.1.2. The Fatal Attractiveness of the Reconceptualized BS

The reconceptualized baccalaureate assumes that having a “minimal” core and three options will be more “*attractive*” to the student than a strong core supplemented by electives. The so called “*flexibility*” offered by a small core and multiple options is in reality a trap. Firstly, students who have not first completed sufficient basic material may not have the necessary knowledge and mathematical maturity to decide which courses are most appropriate for their future careers. A course may sound very interesting to the student but not be truly relevant for their mathematical

²For example, in May 31, 2002, the NSF awarded \$5,000,000 to Puerto Rico in the form of NSF Award Abstract - #9753543 **Puerto Rico Collaborative for Excellence for Teacher Preparation (PR-CEPT)**. As part of this project academic administrators will develop Institutional Policies for Excellence in Science and Mathematics Teacher Preparation and a **degree in natural sciences** for elementary and intermediate teachers “will be pioneered”.

development. Presented with the babel of courses listed under the various options, the student could easily choose unwisely and so seriously limit or close off future career or study options. Moreover, the **Proposal** fails to clarify the issue of who will actually advise the students –and this is a crucial issue given the natural biases and preferences of the various faculty members.

True flexibility is provided by a core which is strong enough to provide students with sufficient basic mathematical knowledge and culture to lay a foundation for their future mathematical life, **no matter which area of mathematics or its applications they may follow**, thereby opening for them a wide variety of career opportunities and options for further study. Without such a core, graduates cannot be fully successful and competitive in their future mathematical careers.

Neither do the many courses mentioned in the reconceptualized degree add anything new to the BS. Many of these courses are currently offered as “Topics Courses”. These courses could easily be created as electives in the current degree. In reality, the way in which these courses have been assigned to each “specialization” in the new BS will actually reduce options. For example, the fact that, say, Graph Theory is listed in only the Discrete Mathematics option will make it practically impossible to offer this course. The total number of math majors is very small and if these students are then divided between three options, the number of students in a single option will not be large enough to keep courses open unless that course is common to more than one option. Moreover, in the case of Graph Theory, there is no mathematical reason for this restriction to the Discrete option. In many universities, Graph Theory is actually a pre-requisite for many of the courses listed in the proposed Computational Mathematics option (the internet is a graph) and is also widely taken by pure mathematicians. This overly conservative prescription of different courses for different options, without mathematical reason, is in fact rigidity masquerading as flexibility and serves only to further reduce students’ options.

Another rigid feature of the reconceptualized degree is the strange set of co-requisites. For example, **every** student must take a sequence of programming and computer science courses (e.g. programming I, data structures, analysis and design of algorithms) or (programming I and computability theory) which may have nothing to do with their area of study. This is a very rigid requirement given that these courses are inessential in most areas of pure mathematics and totally irrelevant for those students seeking teacher certification. The requirement that all mathematics students take algorithms or computability (together with the necessary prerequisites such as data structures) makes a mockery of the much vaunted flexibility of the new degree.

3.1.3. Appeal to (Educationally Failed) Authority

It is mentioned in the **Proposal** that in the US, *the concentration requirement is 39 credits*. It is concluded from this that the proposed number of credits (42) is adequate for Puerto Rico. This does not follow logically. The fact that students in the US take only 39 credits of mathematics does not imply that 39 credits is adequate in Puerto Rico. The educational background of the students in the US is not the same as in PR. In quite a few US universities, students have better mathematical backgrounds on entering the university than in Puerto Rico. In the US, pre-calculus is considered a remedial course for science majors. In Puerto Rico, it is still the basic entry course for such majors due to the poor high school preparation.

Even in the US, 39 credits may be insufficient. That this may be the case is suggested by the fact that the number of US students enrolled in Mathematics PH.D. programs has dropped by over 35% since 1977 and now less than half of all such PH.D.'s are awarded to US nationals. As a result, US universities are forced to rely heavily on immigration to fill university teaching posts in Mathematics. Because of the mediocre scientific and technical education students receive from high school to BS, the US is failing to produce mathematicians and scientists in sufficient numbers.

The actual situation in US universities is well described by Stewart S. Antman [2], a leading expert in differential equations and mathematical continuum mechanics and the 1999 winner of the Society of Industrial and Applied Mathematics' Theodore von Karman Prize. According to Antman:

*Our universities are turning out scientists whose knowledge goes scarcely further than the canned programs they learn to handle adeptly on their computers. In the United States, Great Britain, and elsewhere, engineers and physicists today (possibly with the exception of electrical engineers) scarcely have the mathematical knowledge presented to their forebears 50 years ago in books condescendingly directed to "physicists and engineers". They typically lack a legitimate course in linear algebra (to say nothing of a course in real variables), which form the entrée to a host of useful advanced courses in **differential equations and numerical analysis**. Most departments of mathematics impose on their students minimal course requirements in the hard sciences, for which now popular **courses in mathematical modelling make a grossly inadequate substitute**. The only way to develop a cadre of experts capable of doing fundamental work in the mathematical sciences is to produce a reservoir of scientists broadly and deeply educated in both science and mathematics (who, we may hope, are not cultural illiterates). [Emphasis added]*

By reducing the core of the baccalaureate, making optional important courses such as differential equations and algebra II, and by introducing in the applied math option ill defined courses such as "**mathematical modelling**", the UPR is heading in precisely the direction criticized by Antman.

3.2. Courses with Vacuous or No Descriptions

Many courses leading to certification in one or the other of the three options which are listed in the **Proposal** have no course number and no description such as MATH XXXX Biostatistics, Math XXXX Coding Theory, etc.

Other courses, such as Mathematical Modelling and Operations Research, have totally vacuous descriptions with no specific *mathematical* content. The characterization by Antman of Mathematical Modelling as a *grossly inadequate substitute* is completely born out by the UPR catalog description:

MATH 4090. Introduction to Mathematical Modelling. *Three credits. Three hours of lecture per week.*

Mathematical models, their utility and limitations. Abstraction, idealization and formulation of the model. Solution of the mathematical problem. Relevance of the solution to the original problem. The student will be required to complete a project involving the construction and analysis of a model.

The description of Operations Research, another elective in the computational mathematics option, is also completely vacuous:

MATH 4100. Operations Research. *Three credits. Three hours of lecture per week.*

Introduction to mathematical models and other techniques used in the identification and application of quantitative methods to optimization procedures.

The above descriptions provide no idea as to what should be covered. They lack any specificity. The UPR courses in mathematical modelling and operations research described here would not even prepare a student for the introductory course in operations research given in the undergraduate Operations Research program at Eötvös University:

Operational Research *(for third-year programmer students.) Goals: To exhibit the fundamental models of operational research and their computational methods. Prerequisites: linear algebra, basic topics of graph theory.*

Brief survey of applications. Optimizations models. Linear programming: Convex polyhedra. Linear programming problems. The simplex method and its variants. Efficiency considerations. Duality theorems of linear programming. Farkas theorem, Farkas lemma. Matrix games. Von Neumann's theorem. Sensitivity analysis. Parametric programming. Methods of multiobjective programming. Nonlinear

programming: Necessary and sufficient conditions for optimality. Kuhn-Tucker theorems. Problems with convex separable objective function. Convex quadratic programming. Discrete programming: Basic methods for discrete programming: cutting planes, branch and bound, dynamic programming. Knapsack problem. Assignment problem and its solution by the Hungarian method. Networks, maximal flow, minimal cost flow. The network simplex algorithm. Transportation problems. Cutting stock problems.

The minimum to be expected of the proposers of the reconceptualized degree is that they provide course descriptions which are detailed enough to permit sensible discussion, such as that provided above.

A student in the computational mathematics option who completes his/her requirement by taking such courses as mathematical modelling, operations research, as described in the UPR catalog, and supplemented by courses such as Biostatistics XXXX, with no specified descriptions, will have an incoherent preparation and a very poor basis for professional work in applications or for further study.

3.3. The Core Is Not a Core; the Options Are Not Options

The new BS has the curious property that two students can graduate in distinctly named options while taking identical sets of courses. One will receive the title of specialist in Pure Mathematics and the other specialist in Computational Mathematics and Statistics or perhaps Discrete Mathematics. That this bizarre situation can arise is a result of the failure to recognize that there is a large amount of basic and essential material which must be known by all mathematics students. It supports our contention that the proposed core is too small. A single strong core supplemented by electives would be a more rational and simple structure. The proposed division of the degree into three degree options is artificial, providing a royal road to the baccalaureate but not to geometry. The result will be to bring the baccalaureate degree in Mathematics into disrepute and make it less attractive to good students who seek a degree of distinction.

The core is not a core, neither in terms of the number of credits nor in terms of its composition. Although Mathematics is a veritable ocean which has developed over many centuries and in spite of the fact that it is humanly impossible to study every area, mathematics students should have some exposure to certain main branches and methods. Fortunately, there are certain fundamental notions such as function, derivative, measure, integral, binary relation, equivalence relation, order, etc., that are common to almost all branches of mathematics and which it is essential that every student should know well. Similarly, certain areas of mathematics such as differential equations, ring theory, combinatorics and complex analysis are fundamental. The field of differential equations forms an essential part of the “scientific

cannon". Important physical axioms such as the laws of electromagnetism, mechanics, and quantum mechanics as well as equations such as the wave equation, the heat equation, the Navier Stokes equation, and many other important equations in the physical sciences are differential equations. The importance of ring theory derives from the fact that some of the most important structures used in Mathematics and its applications (e.g. the integers, the real numbers, the complex numbers, etc.), are rings under the usual arithmetic operations. Combinatorics too has become a huge area of mathematics with many important branches. Part (but far from all) of the reason for the importance of combinatorics resides in the ubiquity of various types of incidence structures such as lattices, graphs (the internet is a graph) and finite geometries. The area of enumerative combinatorics has multiple applications in pure and applied mathematics and is essential for an understanding of probability theory. Complex analysis is a very rich area with innumerable applications in both pure and applied mathematics. The complex logarithm lies behind the famous Mercator projection used by navigators in the last century. More recently, one of the central theorems of complex analysis, namely the Riemann mapping theorem, was used in conjunction with tomography to produce the first detailed map of a human brain. For these reasons, it is highly advisable that **every** student of mathematics, no matter what his or her specialization, should have at least one course in each of differential equations, ring theory, complex analysis, and in some branch of combinatorics such as graph theory. Yet incredibly, none of these four areas are compulsory in the reconceptualized BS. In fact, Differential Equations and Algebra II (where ring theory has been traditionally covered) which **were** compulsory for math majors will now be made optional. Since Physics has also been made optional, a student will be able to obtain the diploma of Bachelor of Science and never see, for example, Newton's Second Law. This is an academic crime.

True flexibility is measured not by the number of options in the degree but by the options a student has upon graduation. Only a solid mathematical foundation can provide the flexibility necessary to choose appropriately between multiple career or further study paths in mathematics and the mathematical professions. The "core" of the proposed BS is so small that it severely limits students' options and in effect reduces flexibility.

Just as the options are not options, neither is the core a core. By definition core courses are compulsory. However, a bizarre feature of the reconceptualized BS is that two of the "core" courses, namely Differential Equations and Statistics, are actually optional; so, by definition, they are not core courses. This pays lip service to the fact that differential equations are of fundamental scientific importance while at the same time providing the student with the opportunity to avoid them.

3.4. Paucity of Credits

Although the Senate Scheme permits more than 135 credits if so justified, mathematics professors were informed by the Curriculum Committee that credits in excess of 135 credits are intended only for professional schools for purposes of accreditation. In reality the Senate Scheme nowhere mentions “professional schools”. Even if it did, the idea of aiming at the **minimum** number of credits is like a student aiming to pass a course with a grade of D. Hardly a recipe for quality. As discussed in the previous section, a quality mathematics degree needs a relatively large core which includes areas such as combinatorics and discrete mathematics, differential equations, and ring theory.

3.5. Problems with the Co-requisites

By definition, a co-requisite is essential to the degree. The co-requisites listed in the reconceptualized degree are:

1. CCOM 3033 (Programming),
2. CCOM 5050 (Theory of Algorithms),
3. Two courses in any of the remaining departments of Natural Sciences.

Moreover, in order to take CCOM 5050, the student must first pass the prerequisite CCOM 3034 (Data Structures). For the majority of mathematicians, both “pure” and “applied”, these courses are not essential. Moreover, since the algorithms and data structure courses taught in the Río Piedras Campus currently place more emphasis on engineering aspects such as the programming and implementation of algorithms, usually in the current most fashionable programming language, rather than on the science of *computation* which is a mathematical discipline, these courses are about as useful to most mathematicians as are laboratories in which students are required to cut out paper flowers (not unheard of in the UPR). On the other hand, the natural science requirement is too vague to be described as “essential”. If any of the sciences could be considered essential for a mathematician, it would probably be Physics for the simple reason that many areas of Mathematics arose out of the study of Physics and, in turn, Physics is the source of much mathematical intuition and terminology. Definitely, a well designed course in Physics would be of far more fundamental importance to the mathematician than a course in the engineering discipline of programming or the implementation of data structures in a soon to be obsolete language.

3.6. The Elimination of Trigonometry and Analytic Geometry

It is very disturbing that all departments of the Faculty of Natural Sciences plan to eliminate the five hour course M3018, Trigonometry and Analytic Geometry (and the equivalent sequence M3023-M3024) from their reconceptualized degrees.

In a report of the office of the Dean of Academic Affairs, entitled *Informe al Senado Académico: Consejo de Implantación del Nuevo Bachillerato- Parte II* of January 31, 2003, it is stated:

“El Comité (Timón) a nivel de Facultad (de Ciencias Naturales) recomendará: ... eliminar el curso de pre-cálculo como un requisito, de modo que el estudiante que aspira a tomar un bachillerato en ciencias, tiene que haber aprobado este curso en escuela superior. En el verano se llevó a cabo un experimento para ofrecer el curso de pre-cálculo a los estudiantes aceptados en la Facultad, previo a comenzar sus estudios universitarios.

In light of this recommendation, all departments of the Faculty of Natural Sciences (including Mathematics!) plan to eliminate the Pre-calculus course MATH 3018, Trigonometry and Analytic Geometry (and its two semester equivalent Pre-calculus MATH 3023–MATH 3024), from their “reconceptualized” degrees. The elimination of these courses is predicated upon the assumption that students interested in the Natural Sciences will have the opportunity to study this material in the high school. Indeed, in well organized high school systems, the material in these courses is typically covered between the tenth and twelfth grades and this should certainly be a goal of the Puerto Rico Department of Education. However, the current situation, as witnessed by deteriorating College Board scores and by the Natural Sciences entrance exam, indicates that most students receive very poor to almost negligible mathematical training, especially in the public schools. Basic and important mathematical topics are not covered, either because they are not in the curriculum (see [4]) or because no teacher with the necessary expertise is available. For these reasons the pre-calculus course is critical for a large majority of those students who wish to study science. If these pre-calculus courses are not required for the degree, students will either be forced to pay for them or use valuable elective credits which would otherwise enable them to take more important courses in their majors. More worryingly, many will cut corners and simply not take them, and thus many of our students will be hampered in their progress by very serious gaps in their basic mathematics.

In connection with the plan to eliminate pre-calculus from the baccalaureate, the report mentioned above refers to the “experiment” carried out in the Summer of 2002, in which new students were invited to take MATH 3018 (Trigonometry and Analytic Geometry) as an “immersion” course, prior to entering the University. The course which is normally about 72 hours long, was given in just three weeks and two

days (17 contact days excluding exams) at a rate of five hours lecture and 3 hours tutorial per day for five days a week! This is a grave pedagogical error. Normal common sense dictates that it is impossible to properly absorb complex material such as mathematics at such a gruelling pace. In some days the course covered as many as 6 sections of the text! This so called “immersion” course was in reality death by drowning. It was apparent to the teaching assistants involved that many of the students could not possibly absorb the material and at least one assistant actually resigned on ethical grounds, thereby forfeiting his salary. The fact that everything was not working as it should was evidenced by the fact that towards the end of the course (i.e. after about two weeks!) most students were given the option of changing from MATH 3018 to MATH 3023 which normally covers **half the material** at about **half the velocity** and the course was begun over again! By this time, most students were probably so confused that it is doubtful that they could have fully recovered from the academic mauling they must have received, and for which dubious privilege they were charged \$180 by the Division of Continuing Education. An unknown number of students actually ended up taking the remedial course MATH 3001. Despite protests by various faculty members, the Dean of Natural Sciences, Dr. Brad Weiner, has publicly labelled this pernicious “experiment” “promising” and announced its continuation this year. It has even been trumpeted as a success by some of the professors involved and this “success” used by the Curriculum Committee of the Natural Sciences Faculty in support of their plan to eliminate MATH 3018 from the baccalaureate. In reality, this experiment had no control group, no (blind) independent graders, no literature reviews concerning similar “immersion” courses and, as far as we know, no follow up studies. The results are also skewed by the fact that a small number of “special” sections were reserved for students with very high college board scores who, of course, did well since they had seen much of the material before. Even more disturbing is the fact that although the course was given as a pass/fail course and grades were allocated by professors on the basis of this premise, a statistical analysis of this experiment was carried out on the basis of **letter grades!** Incredibly, the course MATH 3023 which was not even officially announced by the Division of Continuing Education but created half way through the “immersion experiment” to save the official course Math 3018 from total disaster is mentioned as a success in these statistics! In reality all the students in MATH 3023 failed the course MATH 3018 for which they were officially registered. Thus there is little scientific evidence to justify proclaiming this course a success. In medicine, it would be inadmissible to allow experiments on patients without review by an ethics committee. Yet there was no prior discussion of this project at any general meeting of the Mathematics Department.

Actually, the pedigree of this course is not entirely clear. The Alliance for the Advancement of Teaching ran an activity during the Summer of 2002 entitled:

“Scaling Up: Applying Pilot Project Improvements in Quantitative Skills and Precal-

culus Instruction to Incoming First Year Students at the UPR Río Piedras Campus".

If this was one and the same experiment as the "immersion" course, as seems to be the case, then this raises very serious questions: Which pilot project is being scaled up? When was this pilot project conducted? How does it differ from the regular pre-calculus? Was it an immersion program based on a course of duration 17 days? What are the so called Pilot Project Improvements? What is meant by the term "Quantitative Skills"? Have members of the Mathematics Department been consulted about all this? Is Federal funding involved? If Federal funding has been received, have statistics based upon the unofficial and meaningless **letter grades** described above been submitted to the granting agency? Was the disastrous midstream change of course number mentioned in the final report?, etc.

Coincidentally, an attempt is now being made to change the grading system for summer courses from pass/fail to letter grades. On Wednesday March 26, 2003, professors of the Mathematics Department received from the chairman Dr. L. R. Pericchi a request entitled

Consulta a la facultad del Departamento de Matemáticas

asking them to return by Thursday, March 27, 2003 their "vote" on a proposal to give "letter", rather than "pass/fail", grades to incoming freshman students who take introductory courses in the Department prior to entering the UPR. The one-page survey stated that this matter would be raised in a Meeting of the Faculty of Natural Sciences. The courses referred to are MATH 3001, MATH 3018, MATH 3023, MATH 3024, MATH 3105, and MATH 3151.

This raises a number of important issues. Firstly, a poll of professors is a very strange mechanism to decide important academic matters. A poll is a totally inadequate substitute for free and open discussion based upon the presentation of evidence and solid arguments. Secondly, the proposal under discussion is predicated upon the assumption that pass/fail grades fail to "motivate" the student, but no evidence for this is presented. Of the above courses, only MATH 3001 and MATH 3018 have been regularly offered in the Summer as pass/fail courses, so clearly little or no evidence exists concerning student opinion for the other courses mentioned above. Furthermore, since many students receive quite low grades in MATH 3001 and MATH 3018, it is quite possible that many would actually be opposed to receiving a letter grade which might lower their academic average.

In summary, the elimination of the precalculus course from the reconceptualized degrees in the Faculty of Natural Sciences has not been adequately justified. In addition, until all the above issues are adequately clarified, we strongly recommend that the Faculty refrain from making any changes to the existing grading policy, so

as to maintain the quality and reputation of Natural Sciences courses and to avoid the possibility of endorsing educational and scientific fraud.

3.7. The First Year Seminar

The new degree includes a first year seminar CINA 3050. According to the April 2003 draft, **Exhibit 3**, the purpose of this seminar is to introduce the role which science and technology play in our society. It includes discussions of the history of science, the role of technology in the solution of current problems, information skills, the management of information, how to use the library, multidisciplinary analysis of a “problem” (unspecified), ethical analysis of the said problem, collaborative search for solutions to the “problem”, discussion of possible “quantitative” aspects of the “problem” and possible mathematical models. It incorporates competencies of critical analysis, linguistic and “quantitative” skills as well as political and economic aspects of research. Also included are a description and analysis of philosophical aspects of science such as the question of truth, the limits of creation, and science as “parallel model”[sic]. In addition, the student is expected to develop research skills by means of a “project” and “to contribute effectively” to the inclusion of students with disabilities.

After covering basic linguistic and “quantitative” skills, internet, use of library, “research” on a “problem”, etc., little time will be left for anything more than a superficial treatment of the profound and difficult subjects mentioned in this syllabus. Ethics is an ocean. Philosophy of Science is an ocean. The History of Science is an ocean. These areas, if done well, are much deeper and therefore harder to teach (properly) than say Chemistry I or Precalculus which have fairly standard and well trodden syllabi. Even assuming that some kind of coherent path can be found through the mass of material in the Seminar, many questions arise. Who exactly will teach this seminar? How many professors have the training to properly discuss this myriad of subjects? How many are available and willing to do this? Is the budget available to pay them? What is the relation between the Physical Science course in General Studies and the proposed seminar? What is the opportunity cost of the Seminar? Which first year or other course will be sacrificed to make space for this interloper?

At least 32 of the 45 hours of this seminar are devoted to the discussion of a “Problem”. This is a problem. There are problems and there are problems. To fully judge the adequacy of this seminar it is essential to examine possible problems that a student may study. No examples are provided in the syllabus. Since the more transcendental problems of science cannot adequately be discussed in a first year seminar, students could well be engaged in trivial pursuits.

In short, the First Year Seminar attempts to be all things to all people. It is so broad that it inevitably lacks any depth –a kind of Science Lite. The serious danger exists that students will be left with an impression of superficiality. For example, realistic mathematical models in science are often very sophisticated. A microscopic physical system may be modelled by a vector in an infinite dimensional Hilbert space, an adiabatic process by a nonlinear differential equation, a wave by a partial differential equation, the spectrum of hydrogen by homomorphisms from a symmetry group into a group of linear transformations, etc. Such models can only be taught to students who have substantial mathematical and scientific training. Thus the type of mathematical modelling that can realistically be covered with first year students is limited to such activities as fitting curves to laboratory data -better taught in context. More realistic mathematical models are currently taught in such courses as Differential Equations and Physics. Unfortunately, these have been made optional in the proposed BS in Mathematics. This is a major part of the opportunity costs referred to above.

The confusion concerning the level and content of this course is well illustrated by the “bibliography”. With the exception of the widely criticized *Un Nuevo Bachillerato para el Recinto de Río Piedras*, the main section of the bibliography consists entirely of unspecified newspapers, journals, texts, manuals, and “internet resources”. A separate section is entitled “(LITERATURE RECOMMENDED BY THE FACULTY OF HUMANITIES)”. Why this section is separate and in parentheses is not clear. What is clear is that the recommendations made by the Humanities faculty are at least specific. They include a classic work *The Logic of Scientific Discovery* by Karl Popper, which contends that science tests hypotheses whose falsehood is in principle verifiable, *The Structure of Scientific Revolutions* by Thomas Kuhn, which introduces the somewhat controversial notion that science advances by paradigm shifts, and the postmodern work *Against Method: Outline of an anarchistic theory of knowledge* by Paul Feyerabend which questions the very existence of “the” scientific method. Thus each of these three books advocates a very different philosophy of science. Will first year students, with little or no scientific training, be academically mature enough to adequately appreciate and understand these very different philosophical viewpoints? Another recommended book is *The Philosophy of Physics* by Roberto Torretti. Torretti discusses a range of topics including geometry, the twins-paradox in special relativity, the “Many Worlds” interpretation of quantum physics, the Einstein-Podolsky-Rosen Paradox, etc., all of which require a certain level of mathematical maturity. Recognizing this, the book contains supplements on vectors, lattice theory, and topology. What real benefit can first year students, with little or no scientific or mathematical training, derive from a book at this level? The last book recommended by the Humanities faculty is Ernest Cassirer’s *The Logic of the Cultural Sciences*. This is a philosophical treatise on, as the title suggests, the logical foundations and structure of the “sciences” of **culture**.

The books suggested by the Humanities Faculty would be more suitable for courses in the Philosophy of Science than for the proposed First Year Seminar. Ironically, the Philosophy Department is one of the departments whose very existence is threatened by the Reconceptualization Project which has given birth to this strange seminar. In reality, for a seminar which seems to be based on the dubious notion that content is a pretext, no specific bibliography can possibly be adequate.

The last two items in the bibliography, included in response to Circular 9 (2002-2003) of the Associate Dean of Academic Affairs, deal with issues related to disabled students. Clearly, the disabled, as do all classes of students, have inalienable rights to be treated properly and fairly and in a manner appropriate to their specific situation. Indeed, existing state and University statutes specify in detail the norms and regulations concerning the rights of all students. However, it is not logical to include general information pertaining to all students in **every** course syllabus. To be consistent one would have to also include information related to the rights of students of different races, creeds, cultures, and social classes, etc., in **every** course syllabus. It is less costly and more logical to provide students and professors with this necessary and important information in a separate official document.

3.8. Irregularities in Approval Procedure

At the campus level some of the promoters of the Reconceptualization of the baccalaureate have repeatedly proclaimed that the university community has accepted this proposal with enthusiasm. They have proclaimed that the nine years elapsed since the beginning of this process and the consultations that were made are sufficient reasons to confer quality, legitimacy and guarantee consensus. In reality, during this “process” of consultation numerous important questions were raised concerning both the implementation and the content of the reconceptualization. The absence of proper justification and critical analysis, the poor articulation between the Project’s assumptions and components, the ambiguous definition of the seminars, the failure to analyze the impact on the budget, on orientation processes, on transfer students, on registration, on academic load, and on administrative structure, etc., have been widely commented by the academic community. The final version of the project which the Academic Senate approved in May 2001, “Un Nuevo Bachillerato para el Recinto de Río Piedras de la Universidad de Puerto Rico”, completely ignored these worries and most faculties never even saw the final version until after its approval. In a real “*comunidad de aprendizaje*”, to use the expression so favored by the proponents of this scheme, these questions would have been carefully considered, answered, and either taken as recommendations or, if lacking substance, refuted by solid arguments. To ignore them contradicts both University policy as well as the very spirit of every University. Faced with this reality, one faculty has recently resolved to “abolish the project”, another to “ignore the dispositions of the Project”,

others have questioned the desirability of complying with it, and in the Academic Senate a motion to repeal the Project has been made by the Caucus of Student Senators. In the Campus Faculty Meeting of May 5, 2003, an overwhelming majority voted to annul the Project.

The irregularities and deficiencies in the process of reconceptualization of the baccalaureate in the Department of Mathematics parallel closely the problems of the homologous process at the campus level. The following is a chronology of events surrounding the Reconceptualization of the Baccalaureate in Mathematics from 2001 to March 2003.

3.8.1. Chronology of Recent Events Surrounding the Reconceptualization of the Baccalaureate in the Department of Mathematics

- April 9, 2001. The Student Mathematical Circle wrote to Dr. Keyantuo, Chairman of the Curriculum Committee, to express concern about “*the proceedings of the Bachelors’ Curriculum Committee*” and requested student representation with, at least, the right to speak.

- May 7, 2001. The Student Mathematical Circle again wrote to express in greater detail its concerns about the proposed BS (**Exhibit 4**). They complained that attempts to obtain student representation had “*for the most part been ignored*”. According to the students’ letter:

“In a conversation some weeks ago with the chairman of the Department Prof. David Pastor, some students learned that there are plans to eliminate precalculus as a requirement for Mathematics majors ... All of us know the generally poor level of rigor of most high schools in Puerto Rico. We students know this fact all the better: it is often a shock for a student new to mathematics and proofs to find that the precalculus course he or she took in the high school does not compare even slightly to the one offered by our department. Yet students will now be deprived of this course, perhaps in order to “save time”. We believe time would be better saved following our previous suggestions or in other ways which would not harm the student.”

- May 8, 2001. Mathematics professors received from the Curriculum Committee a “draft” of the Reconceptualized BS (**Exhibit 5**).
- May 9, 2001. A Mathematics departmental meeting was held for the purpose of approving both the reconceptualized BS and the Rules and Regulations of the new Ph.D. proposal. Unfortunately, the discussion concerning the new BS was not conducted at an appropriate level of civility; it rapidly degenerated into *ad hominem* attacks. One professor who requested information about a course was told by a member of the Curriculum Committee:

“there is no course in Discrete Mathematics because you have problems communicating with people”

Despite the purported urgency of the reconceptualized BS, discussion on this issue was deferred to a “future” meeting and attention diverted to the more urgent approval of the Ph.D. Regulations. There would be no further discussion of the reconceptualized baccalaureate in a Departmental meeting until September 2002.

- May 21, 2001. Final version of the project “*Un Nuevo Bachillerato para el Recinto de Río Piedras de la Universidad de Puerto Rico*” was approved by the Academic Senate. As mentioned previously, most faculties were not given the opportunity to see and discuss the final version before its approval.

Subsequent to this event the Curriculum Committee issued a report (undated) entitled **Report of the Mathematics Department Curriculum Committee on the BS Proposal** which states:

As of May 24, 2001, the discussion of the Math BS proposal is at a very early stage. A draft has been approved by the Curriculum Committee but that was before the new guidelines were fully known to the Committee. A revision will be necessary.

The problem of admission (that of Pre-calculus) seems to be of a great concern to the Department. Most faculty members believe that Mate 3018 should be included in the regular course offerings. In fact, even at the level of the Faculty of Natural Sciences, this should be examined. We feel that unless it can be demonstrated that all (incoming) high school students in the country have a real opportunity to take this course in their schools, then this course should be kept.

The possible flow chart for various tracts will be discussed at a future committee meeting. A previous one was left obsolete by the recent changes to the Reconceptualization Scheme.

- Thursday September 5, 2002. After a lapse of 15 months, the Curriculum Committee completed a revised version of the reconceptualized BS.
- September 6, 2002 (Friday afternoon). The revision was distributed. Due to the intervening weekend, professors had in effect only two working days to study the document and give their comments to the Curriculum Committee—that is, if they were lucky enough to check their mailboxes late on a Friday afternoon.
- September 12, 2002. Nine faculty members wrote a letter (**Exhibit 6**) to the Curriculum Committee pointing out that the revised BS Proposal, which

consisted of only two and one half pages of text, and a page and a half of tables, did not contain anything like enough information to enable a proper and careful analysis. The letter requested that the Curriculum Committee provide the necessary course descriptions and syllabi which, among many other essential items, were lacking in the **Proposal**. According to this letter:

*There are profound and complex problems at all levels of the educational system in Puerto Rico. The situation in the high schools is catastrophic. Many students arriving at the universities have (through no fault of their own) huge gaps in their academic preparation which require extensive remediation. This is especially true in languages and mathematics. Concomitant with this situation, there is a pressing need to reform many aspects of the baccalaureate degree. However, because of the serious and almost irreversible consequences of mistaken policies, proposers of radical change should proceed with due caution. In particular, at least an objective and rigorous analysis of the problems and the proposed solutions should be provided. The document **BS in Mathematics** of September 5, 2002 outlining the reconceptualized baccalaureate fails totally in this respect. It contains only two and one half pages of text and a page and a half of tables. It contains references to courses that are not in the catalogue. It includes **no** course descriptions, and **no** syllabi. It does not explain how the proposed scheme correlates with that proposed by the Senate. Mathematics is a vertically structured knowledge domain in which theorems follow each other in a logical order. It is not a supermarket of courses. Thus proper analysis requires knowledge of course content. Without detailed course syllabi, no serious analysis is possible.*

This letter was completely ignored.

- September 18, 2002. A slightly expanded (now three pages of text + tables) version of the reconceptualized BS Proposal was distributed by the Curriculum Committee.
- September 19, 2002. A departmental meeting was held to approve a new mission and the revised BS. Despite the fact that **zero discussion** had been held in a Departmental meeting for over 15 months, prior to the meeting, the new Chairman Dr. Pericchi told one professor:

Some people are trying to undermine this (BS) proposal. We cannot have infinite discussion.

To limit the so called “**infinite discussion**” during the meeting, Dr. Pericchi “suggested” *three minutes maximum for the first intervention and one minute for each subsequent one* in the meeting. Despite objections to the effect that these were issues which have an impact on generations of students, Dr. Jorge

López made a motion for two turns of three minutes for and against each motion ³.

Incredibly, this was agreed to by a majority of the Department. Due to lack of time, discussion on the main items of a new mission and a reconceptualized BS were deferred to a subsequent meeting.

- October 8, 2002. Four of the professors who signed the letter of September 12, 2002 wrote another letter, reiterating their request for information and complaining that a new mission and a new BS are too important to be sandwiched between multiple other issues. This letter was also ignored.
- October 10, 2002. Departmental Meeting to approve new mission and reconceptualized BS An alternative mission (**Exhibit 7**) was submitted by Professors Kelmans, Pasnicu, Teleman, and Pennance before the meeting. This alternative mission was totally ignored. Prof. Ana Helvia Quintero proposed a motion to vote on the new Mission without discussion of either mission. This was approved, so the “**infinite discussion**” feared by the Chairman turned out to be zero discussion. This absence of debate based on discussion and sound argument is the antithesis of the alleged pillar of the reconceptualization, the “**community of learning**”. The new BS was then considered. Unfortunately the atmosphere in the meeting was one of incivility in which *ad hominem* attacks and appeals to questionable authority replaced solid argument as the main form of debate. As already described, information which was requested in writing prior to the meeting was not provided. There was no discussion of syllabi, mathematical content, etc. The atmosphere was intimidating and unpleasant for many professors. For example, when Dr. Teleman tried to make an intervention concerning some issue, one member of the Curriculum Committee actually shouted “*S...t! shut up!*” (expletive deleted). ⁴ In this atmosphere, the **Proposal** was passed and the education of future generations of students was decided.

3.9. Closing Remarks

According to the alternative mission submitted to the Department by Professors C. Pasnicu, A. Kelmans, P. Pennance and S. Teleman the BS in Mathematics should be broad enough to enable the student to:

³One can only imagine the reaction if a woman were to give her husband exactly three minutes to discuss a serious marital issue.

⁴Mathematics Departmental minutes usually present a sanitized version of events. However a tape of this meeting is available in the Department. The listener can verify for himself that events were actually worse than described herein.

1. be prepared to carry out research or independent work in the area of Mathematics and its applications,
2. be able to successfully pursue graduate studies in Mathematics and its applications,
3. have the ability to successfully enter and become professionals in the various areas of mathematics and its applications,
4. have the ability to improve their professional level gradually by mastering (even on their own) the new developments in their speciality and become life long learners,
5. have the flexibility to choose in their future between multiple career paths,
6. be able to compete successfully in the job market of mathematical professionals and researchers.

Neither the new mission nor, as explained herein, the proposed BS come close to meeting these aims. The Department of Mathematics has approved a proposal which in effect lowers the academic level of the current baccalaureate. This contradicts the role of Río Piedras as the flagship Campus of the University of Puerto Rico and its aspirations as a doctoral level research institution. Cognizant of this, and the fact that there is virtually no hope of correcting this unfortunate situation from within the Department, we have no recourse but to appeal to our colleagues of the Faculty of Natural Sciences and to those University authorities with jurisdiction over this Proposal to withhold approval until corrective action is taken. This intervention is essential to ensure that the University of Puerto Rico, Río Piedras Campus, has a Baccalaureate in Mathematics which is worthy of the institution, which meets the above goals and of which the holder may be proud.

Philip Pennance et al.
May 25, 2003

4. References

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