

# Mathematics + Cancer: An Undergraduate “Bridge” Course in Applied Mathematics\*

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**Abstract.** Most undergraduates have limited experience with mathematical modeling. In an effort to respond to various initiatives, such as the recommendations outlined in [S. Glasfuchs and M. Montgomery, eds., *GAJMMB: Guidelines for Assessment of Instruction in Mathematical Modeling Education*, SIAM, 2016], this paper describes a course on the mathematical models of cancer growth and treatment. Among its aims is to provide a template for a “bridge” course between the traditional calculus and differential equations sequence and more advanced courses in mathematics and statistics. Prerequisites include a course in ordinary differential equations. Linear algebra is a useful companion but no previous programming experience is required. The content includes classical models of tumor growth as well as models for the growth of specific cancer types. Relevant research articles are provided for further study. Material for student projects and effective communication is supplied, as well as suggestions for homework assignments and computer labs. This paper aims to assist instructors in developing their own “Mathematics + Cancer” course.

**Key words.** mathematical modeling, cancer, differential equations, undergraduate education

**AMS subject classifications.** 97M60, 92C70, 34A99

**DOI.** 10.1137/19M1190865

**1. Introduction.** This paper describes an undergraduate course, accessible to students who have completed a standard sequence of calculus and ordinary differential equations, on the mathematical modeling of cancer. The content and format of the course are derived from the authors’ experiences in advising undergraduates in a program funded by the National Science Foundation’s Mentoring through Critical Transition Points (MCTP) initiative. Our objectives in developing this course are threefold. First, we are interested in providing a model of a “bridge” course between the traditional calculus sequence and higher-level courses besides the typical “introduction to proof” class. Second, our effort is an attempt to develop an introductory course in applied mathematics that addresses a compelling scientific and social prob-

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# Mathematics For Cancer Education

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## **Mathematics For Cancer Education:**

**Advancing Cancer Education and Healthy Living in Our Communities** Yuri Quintana, Aubrey Van Kirk Villalobos, Dorothy May, 2012 Over half the deaths from disease in the world are now due to just four chronic conditions: diabetes, lung diseases, some cancers, and heart disease. Health and education are inextricably linked. Developing and delivering effective, scalable, and sustainable education programs which lead to real behavioral change would influence some of the common risk factors for these diseases, such as smoking, poor diet, and lack of physical activity. This book contains the selected papers from the St. Jude Cure4Kids Global Summit held in June 2011 at St. Jude Children's Research Hospital in Memphis, Tennessee, USA. The aim of this three-day conference was to improve health and science education in classrooms and communities around the world. Leading educators, innovators, and pioneers in the field of public health came together in a multidisciplinary forum to explore examples of successful education programs, analyze the challenges in designing effective, scalable, and cost-efficient public health education programs, and identify strategies, methodologies, and incentives for developing future programs capable of yielding large-scale improvements in health outcomes for diverse communities. The papers presented here provide a foundation in the key topics necessary to create future innovative health promotion programs and will be of interest to all those whose work involves improving health outcomes by means of better and more effective health education.

**Mathematics as an Educational Task** Hans Freudenthal, 2012-12-06 Like preludes or prefaces, are usually composed last. Putting them in the front of the book is a feeble reflection of what, in the style of mathematics treatises and textbooks, I usually call the didactical inversion: to be fit to print, the way to the result should be the inverse of the order in which it was found. In particular, the key definitions which were the finishing touch to the structure are put at the front. For many years, I have contrasted the didactical inversion with the thought experiment. It is true that you should not communicate your mathematics to other people in the way it occurred to you, but rather as it could have occurred to you if you had known then what you know now, and as it would occur to the student if his learning process is being guided. This, in fact, is the gist of the lesson Socrates taught Meno's slave. The thought experiment tries to find out how a student could reinvent what he is expected to learn. I said about the preface that it is a feeble reflection of the didactical inversion. Indeed, it is not a constituent part of the book. It can even be torn out. Yet it is useful. Firstly, to the reviewer who then need not read the whole work, and secondly, to the author himself who, like the composer, gets an opportunity to review the leitmotifs of the book.

**Resources in Education**, 2001-04 Departments of Labor, Health and Human Services, Education, and Related Agencies Appropriations for 2006: National Institutes of Health United States. Congress. House. Committee on Appropriations. Subcommittee on the Departments of Labor, Health and Human Services, Education, and Related Agencies, 2005 *Departments of Labor, Health and Human Services, Education, and Related Agencies Appropriations for 2006* United States. Congress. House. Committee on Appropriations. Subcommittee on the Departments of Labor, Health and

Human Services, Education, and Related Agencies, 2005      Computer Supported Qualitative Research António Pedro Costa, Luís Paulo Reis, Francislê Neri de Souza, António Moreira, 2017-06-19 This book includes a selection of the articles accepted for presentation and discussion at the second International Symposium on Qualitative Research ISQR2017 held in Salamanca Spain July 12 14 2017 ISQR2017 is part of the Iberian American Congress on Qualitative Research CIAIQ and featured four main application fields Education Health Social Sciences and Engineering and Technology and seven main subjects Rationale and Paradigms of Qualitative Research Systematization of approaches with Qualitative Studies Qualitative and Mixed Methods Research Data Analysis Types Innovative Processes of Qualitative Data Analysis Qualitative Research in Web Contexts Qualitative Analysis with the Support of Specific Software This book is a valuable resource for academics researchers teachers and students who need information on the above topics as well as on the use of Computer Assisted Qualitative Data Analysis CAQDAS      **Mathematical and Statistics Anxiety: Educational, Social, Developmental and Cognitive Perspectives** Kinga Morsanyi, Irene Cristina Mammarella, Denes Szűcs, Carlo Tomasetto, Caterina Primi, Erin Anne Maloney, 2017-01-19 Mathematical anxiety is a feeling of tension apprehension or fear which arises when a person is faced with mathematical content The negative consequences of mathematical anxiety are well documented Students with high levels of mathematical anxiety might underperform in important test situations they tend to hold negative attitudes towards mathematics and they are likely to opt out of elective mathematics courses which also affects their career opportunities Although at the university level many students do not continue to study mathematics social science students are confronted with the fact that their disciplines involve learning about statistics another potential source of anxiety for students who are uncomfortable with dealing with numerical content Research on mathematical anxiety is a truly interdisciplinary field with contributions from educational developmental cognitive social and neuroscience researchers The current collection of papers demonstrates the diversity of the field offering both new empirical contributions and reviews of existing studies The contributors also outline future directions for this line of research      *Handbook of Research on Educational Communications and Technology* J. Michael Spector, M. David Merrill, Jan Elen, M. J. Bishop, 2013-07-03 The 4th edition of the Handbook of Research on Educational Communications and Technology expands upon the previous 3 versions providing a comprehensive update on research pertaining to new and emerging educational technologies Chapters that are no longer pertinent have been eliminated in this edition with most chapters being completely rewritten expanded and updated Additionally new chapters pertaining to research methodologies in educational technology have been added due to expressed reader interest Each chapter now contains an extensive literature review documenting and explaining the most recent outstanding research including major findings and methodologies employed The Handbook authors continue to be international leaders in their respective fields the list is cross disciplinary by design and great effort was taken to invite authors outside of the traditional instructional design and technology community      **Register of Educational Research in the United Kingdom,**

**1992-1995** National Foundation For Educational Research,1995 This latest volume of the Register of Educational Research in the United Kingdom lists all the major research projects being undertaken in Britain during the latter months of 1992 the whole of 1993 and 1994 and the early months of 1995 Each entry provides names and addresses of the researchers a detailed abstract the source and amount of the grant where applicable the length of the project and details of published material about the research

**Catalog of Federal Programs for Individual and Community Improvement** ,1998 *Update to the ... Catalog of Federal Domestic Assistance* ,1999 **AEC Technical Information Bulletin** ,1962 Catalog of Federal Domestic Assistance ,1997 Identifies and describes specific government assistance opportunities such as loans grants counseling and procurement contracts available under many agencies and programs *Economics and Mathematical Modeling in Health-Related Research* ,2022-09-26 The definition of a healthcare system evolves continuously becoming broader and more complex with each rendering Healthcare systems can consist of many different elements including but not limited to access to comprehensive medical care health promotion disease prevention institutional framework financing schemes government responsibility over health etc In light of its broad classification of healthcare this book focuses on a wide spectrum of health related issues ranging from risk factors for disease to medical treatment and possible frameworks for healthcare systems Aging populations increasing costs of healthcare advancing technology and challenges created by the COVID 19 pandemic require an innovative conceptual and methodological framework By combining the experience and effort of researchers from a variety of fields including mathematics medicine and economics this book offers an interdisciplinary approach to studying health related issues It contributes to the existing literature by integrating the perspective of treatment with the economic determinants of health care outcomes such as population density access to financial resources and institutional frameworks It also provides new evidence regarding the pharmaceutical industry including innovation international trade and company performance Contributors are Sayansk Da Silva Joe Feinglass Scott W Hegerty Joseph E Hibdon Jr Arkadiusz Micha Kowalski Ma gorzata Stefania Lewandowska Dawid Majcherek Ewelina Nojszewska Izabela Pruchnicka Grabias Agata Sielska and Julian Sm ka *Testimonios: Stories of Latinx and Hispanic Mathematicians* Pamela E. Harris,2021-08-16 Testimonios brings together first person narratives from the vibrant diverse and complex Latinx and Hispanic mathematical community Starting with childhood and family the authors recount their own individual stories highlighting their upbringing education and career paths Their particular stories told in their own voices from their own perspectives give visibility to some of the experiences of Latinx Hispanic mathematicians Testimonios seeks to inspire the next generation of Latinx and Hispanic mathematicians by featuring the stories of people like them holding a mirror up to our own community It also aims to provide a window for mathematicians and aspiring mathematicians from all ethnicities with the hope of inspiring a better understanding of the diversity of the mathematical community Monthly Catalogue, United States Public Documents ,1995 **Research Awards Index** ,1977 **Qulaity Education for All** SEAMEO Regional

Center for Educational Innovation and Technology. International Conference,1993      *Journal of the Senate of the United States of America* United States. Congress. Senate,2012      Educational Review ... ,1910

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