Zeitschrift: Bulletin / Vereinigung der Schweizerischen Hochschuldozierenden = Association Suisse des Enseignant-e-s d’Université

Herausgeber: Vereinigung der Schweizerischen Hochschuldozierenden

Band: 48 (2022)

Heft: 1

Artikel: CAMaL : an online mathematics bridging course at the physics section of the University of Geneva

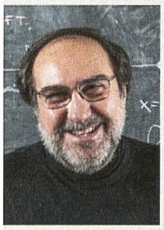
Autor: Giamarchi, Thierry / Müller, Andreas / Sfyrla, Anna

DOI: https://doi.org/10.5169/seals-1050026

CAMaL – an online mathematics bridging course at the physics section of the University of Geneva

Thierry Giamarchi*, Andreas Müller, Anna Sfyrla*****

* Université de Genève, DQMP, 24, quai Ernest Ansermet, 1211 Genève.
E-mail: *Thierry.Giamarchi@unige.ch*
https://giamarchi.unige.ch/
ORCID: 0000-0001-7409-5071



Thierry Giamarchi, Dr. ès Sc., is Full Professor of Physics at the University of Geneva since 2002. He graduated from Ecole Normale Supérieure (Paris) 1982–1986, and obtained his doctoral degree from Paris-Sud University (now Paris-Saclay) in 1987, became Permanent member of CNRS (1986) and was Postdoc at Bell Laboratories (1990–1992). Member of the French academy of Sciences and Fellow of the American Physical Society (2013), Director of the department of Quantum Matter Physics (2013–2019), President of the Swiss Association on Materials with Novel Electronic Properties (MaNEP) (2021–). Scientific interests: Strongly correlated quantum systems, Low dimensional systems, disordered classical and quantum systems (for more see *https://en.wikipedia.org/wiki/Thierry_Giamarchi*).

Foto: Thierry Giamarchi

** Institut Universitaire de Formation des Enseignants (IUFE), Pavillon d'Uni Mail (IUFE), Boulevard du Pont d'Arve 40, 1211 Genève.
E-mail: *andreas.mueller@unige.ch*
www.researchgate.net/profile/Andreas-Mueller-13
(currrently under reconstruction)
ORCID: 000-0001-8556-2333

Andreas Müller, Dr. rer. nat., is full professor of science education at the Faculty of Science at the University of Geneva. Studies in Heidelberg, Grenoble, and Göttingen (Ger, F), Doctoral degree at Max-Planck-Institute of Nuclear Physics, Heidelberg, 1990. Habilitation at Institute of Physics Education/University of Gießen (Ger) 1996. Former positions: 10/1997–11/1999 Postdoc at the Institut für Pädagogik der Naturwissenschaften (IPN), Kiel, 12/1999–7/2010 Chair of Physics and Physics Education, University Koblenz-Landau (Ger). Member of: Swiss Physical Society (Board Member for Physics Education), Swiss Association of Science Education (DiNat), European Physical Society/Physics Education Board. Editorial and reviewer activities in international peer-reviewed journals, Expertise and Interest in science (especially: physics) education and science teacher education, physics/science of everyday phenomena, improvement of general interest for and understanding of physics/science.

Foto: Andreas Müller

*** Université de Genève, DPNC, Rue de l'Ecole-De-Médecine 20, 1205 Genève.
E-mail: *anna.sfyrla@unige.ch*
https://dpnc.unige.ch/~sfyrla/index.html
ORCID: 0000-0002-3003-9905

Anna Sfyrla, Dr. ès Sc., is a high energy physicist and associate professor at the University of Geneva. She works at the ATLAS and FASER experiments of the CERN LHC and searches for physics beyond the Standard Model. Besides her research, she is engaged in actions related to education, outreach and promotion of equal opportunities in academia.

Foto: Anna Sfyrla

1. Background

The transition from the "Gymnasium" or "Collège" to university (secondary level II to tertiary level) is a critical step for students; in fact, all transitions (also between primary and secondary school, between secondary level I and II, and others) are considered as critical in the "educational trajectory" of an individual, in the sense of challenges and opportunities.[1] Regarding the first semesters at university, inadequate expectations and preparation have been found to be among the major reasons of frustration and dropout.[2] For these and other questions, a commission and a series of conferences concerning the transition Gymnasium-University has been established on the Swiss level.[3]

Mathematics, in particular, is known to be a main "stumbling block" for the study of physics (and of other disciplines).[4] For instance, a recent study found high correlations of first semester course success and mathematical knowledge for physics ($r = 0.66$) and chemistry ($r = 0.65$), i.e. math alone accounts for more than 40% of the variance of successfully completing introductory courses in physics and chemistry.[5]

A specific obstacle is encountered by female students. On one hand, it is well-known that many

1 Pallas, A. (2003): Educational Transitions, Trajectories, and Pathways. In: Mortimer, J. T., & Shanahan, M. (eds.), Handbook of the Life Course, Boston: Springer US; OECD (ed.) (2011): *Reviews of National Policies for Education 2011.* Paris: OECD Publishing; Bellenberg, G., Forell, M. (2013). Forell (Hg.): *Bildungsübergänge gestalten. Ein Dialog zwischen Wissenschaft und Praxis.* Münster: Waxmann; see in particular ch. 6 for the transition to university.

2 Heublein, U., *et al.* (2017): Zwischen Studienerwartungen und Studienwirklichkeit. Hannover: Deutsches Zentrum für Hochschul-und Wissenschaftsforschung (DZHW); Bailey, Th., Hughes, K., & Karp, M. (2002): What role can dual enrollment programs play in easing the transition between high school and postsecondary education? In: «Preparing America's Future: The High School Symposium». Washington: Office of Vocational and Adult Education; *https://files.eric.ed.gov/fulltext/ED465090.pdf.*

3 see Hartmann, L., & Hungerbühler, N., p. 3ff. in this issue, and *https://kgu.vsg-sspes.ch/aktivitaeten/index.php?la=fr*

4 Yeatts, F. R., & Hundhausen, J. R. (1992): Calculus and physics: Challenges at the interface. *American Journal of Physics* **60**(8), 716–721; Burkholder, E. W., Murillo-Gonzalez, G., & Wieman, C. (2021): Importance of math prerequisites for performance in introductory physics. *Physical Review Physics Education Research* **17**(1), 010108.

5 Müller, J., Stender, A., Fleischer, J., Borowski, A., Dammann, E., Lang, M., & Fischer, H. E. (2018): Mathematisches Wissen von Studienanfängern und Studienerfolg. *Zeitschrift für Didaktik der Naturwissenschaften* **24**(1), 183–199.

young women have lower 'self-beliefs'[6] ("how well does a certain discipline fit to me?"; "what do I think I am capable of in the discipline?") related to mathematics and physics, even if their performance in these areas is (very) good.[7] On the other hand, there is broad evidence of a considerable impact of self-beliefs on learning success[8] as well as on interest, academic effort, and persistence in the face of difficulty in a given field.[9] In the words of Hattie, *"a sense of confidence is [...] particularly powerful in the face of adversity – when things do not go right, or when errors are made. Having high levels of confidence —"can do", "want to do"— can assist in getting through many roadblocks"*,[10] which, of course, applies to all students, but is of particular importance for female students, which, for the mere effect of (internalized) stereotypes, do not feel 'at home' in mathematics and physics.

A promising approach to this constellation of problems are pre-university "bridging" (remedial) courses.[11] The OMB+ consortium of about 50 universities initiated and based in Germany has developed the contents and an online platform for such courses over more than a decade.[12] We present the implementation of a mathematics bridging course at the section of physics, University of Geneva, based on the OMB+ platform. The programme was proposed for the first time to students starting university classes in the academic year 2021–2022.

2. A brief description and first experiences

The mathematics tutoring course (cours d'accompagnement en mathématiques en ligne, CAMaL[13] [20]) helps students at the end of secondary school or freshmen at university to consolidate and test their knowledge of school mathematics necessary for the first-year university physics courses. Various means of self-assessment are included. The course is online and free. Participation is entirely voluntary, anonymous, and will have no impact on course assessment or on registration at the University.

The platform covers the mathematical background necessary for first year physics courses, before dedicated university courses on advanced mathematics are taken. It starts with elementary arithmetic, power and proportionality, it proceeds to equations and inequalities with one variable and moves on to linear systems of equations. Basic notions of geometry are treated that are necessary in physics, such are triangles and circles. An overview of elementary functions, such as polynomial and logarithmic functions, follows. Derivatives and integrals are introduced and explained, very important in physics from the start and often a hurdle for many. The basic chapters end with an overview of the coordinate systems and vector geometry. There are additional advanced modules on complex numbers and probability, which the students are encouraged to go through, but which are taught in the first year of physics. Self-evaluation tests are available for all the modules.

The students were contacted about 6 weeks before the start of the semester and encouraged to self-evaluate using the OMB+ site. Besides the tutoring offered by OMB+ itself, the physics section offered 8 two-hour tutoring sessions (due to the Covid pandemic via Zoom), supported by senior physics students. This additional local offer has the following advantages: (*i*) tutoring in the language of students (French; additionally in English); (*ii*) adaptation to the local study program; (*iii*) possibility of a first personal contact at the new university.

6 'Self-beliefs' are an umbrella term used in the literature for a variety of related concepts (self-concept, self-efficacy, etc.), see, e.g., OECD. (2007): PISA 2006 science competencies for tomorrow's world, Volume 1: Analysis. Paris: OECD; Trautwein, U., Lüdtke, O., Roberts, B. W., Schnyder, I., & Niggli, A. (2009): Different forces, same consequence: conscientiousness and competence beliefs are independent predictors of academic effort and achievement. *Journal of Personality and Social Psychology* **97**(6), 1115–1128.

7 Gehrig, M., Gardiol, L., & Schaerrer, M. (2010): Der MINT-Fachkräftemangel in der Schweiz. Bern: Staatssekretariat für Bildung und Forschung SBF, *http://www.sbf.admin.ch/htm/dokumentation/publikationen/uni/MINT_Schlussbericht.pdf*; Mujtaba, T., & Reiss, M. J. (2013): Inequality in experiences of physics education: Secondary school girls' and boys' perceptions of their physics education and intentions to continue with physics after the age of 16. *International Journal of Science Education* **35**(11), 1824–1845.

8 Hattie, J. (2009): Visible Learning – A Synthesis of Over 800 Meta analyses relating to achievement. London, New York: Routledge; Richardson, M., Abraham, C., & Bond, R. (2012): Psychological correlates of university students' academic performance: a systematic review and meta-analysis. *Psychological Bulletin* **138**(2), 353.

9 Trautwein, U., Lüdtke, O., Roberts, B. W., Schnyder, I., & Niggli, A. (2009): Different forces, same consequence: conscientiousness and competence beliefs are independent predictors of academic effort and achievement. *Journal of Personality and Social Psychology* **97**(6), 1115–1128; Möller, J., Pohlmann, B., Köller, O., & Marsh, H. W. (2009): A meta-analytic path analysis of the internal/external frame of reference model of academic achievement and academic self-concept. *Review of Educational Research* **79**(3), 1129–1167.

10 Hattie, J. (2009): *loc. cit.*

11 Poladian, L. & Nicholas, J. (2013): Mathematics bridging courses and success in first year calculus. In: D. King, B. Loch & L. Rylands (eds.): Proceedings of the 9th DELTA Conference on the Teaching and Learning of Undergraduate Mathematics and Statistics (pp. 150–159). Melbourne, Australia: University of Western Sydney; Bausch, I., Biehler, R., Bruder, R., Fischer, P. R., Hochmuth, R., Koepf, W., Schreiber, S., & Wassong, T. (2014): Mathematische Vor- und Brückenkurse. Konzepte, Probleme und Perspektiven. Wiesbaden: Springer Spektrum.

12 OMB+, Online Mathematics Bridging Course: *https://www.ombplus.de.*

13 CAMaL, Cours d'Accompagnement en Mathématiques en Ligne: *https://www.unige.ch/sciences/physique/enseignement/cours-daccompagnement-en-mathematiques-en-ligne-camal/.*

The tutoring sessions extended to both before and after the start of the semester. The attendance to these tutoring sessions was initially sparse (CAMaL was not yet well-known among students) but became more important after the start of the semester, when the students got a first-hand experience of the mathematical background required.

3. Perspectives

The programme CAMaL will be essential for all students of the faculty of science that attend in the first year of university a class that requires mathematical background. Introductory general physics, a class attended by first-year students in chemistry, biochemistry, biology, geology, informatics and pharmacy, is a typical example, concerning hundreds of students, typically about 400 new first-year students yearly.

Based on the first-year experience, tutoring by senior physics students will be extended in the following way: Dedicated tutoring sessions will be offered *after* the first few weeks of the semester, when students will have seen in practice, from the first phase of university attendance, the areas they wish or need to strengthen, in order to succeed in their studies.

While CAMaL was so far offered only to students in physics, it will from this year on be proposed also to students from other disciplines attending a first-year general physics course. A similar offer is now also being proposed at the faculty level, addressed for the first time to students starting their university studies in the academic year 2022–2023, for courses in other disciplines than physics requiring a mathematical background.

From the first experiences and these perspectives we would conclude that CAMaL is a valuable offer to support the transition to university regarding mathematics prerequisites,[14] and that it might be worthwhile for other institutions of higher education to consider local implementations of the excellent OMB+ platform.

Acknowledgements. *Most helpful support by OMB+, in particular by Prof. Alois Krieg (RWTH Aachen), is gratefully acknowledged.*

14 A complementary approach to support the high school – university transition is described in the contribution by Müller, A., Bonvin, C., & Sfyrla, A. on p. 70ff. of this issue, on a programme of anticipated studies ("Athéna") at the University of Geneva.