GIREP–ICPE–EPEC–MPTL CONFERENCE 2019

Programme and Book of Abstracts

Budapest, 1–5 July, 2019

Celebration of Eötvös Year 2019

MPTL
Multimedia in Physics Teaching and Learning

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GIREP-ICPE-EPEC-MPTL 2019 CONFERENCE

Celebration of Eötvös Year 2019

Teaching-learning contemporary physics, from research to practice

1st July – 5 th July 2019

Budapest University of Technology and Economics

in Budapest, Hungary

CONFERENCE PROGRAMME
BOOK OF ABSTRACTS

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Teaching-learning contemporary physics, from research to practice

Programme and Book of Abstracts

Hosted by:
**Budapest University of Technology
and Economics in Budapest, Hungary**

Editors:
Beata JAROSIEVITZ – Chair & Csaba SÜKÖSD – Co-Chair

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Leader: Attila Szathmáry

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Multimedia in Physics Teaching and Learning

Chair: Marisa MICHELINI

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Room No.: K193/95

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Jupyter technology of interactive multimedia notebooks in teaching flipped calculus for physicists

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Abstract. We present our pedagogical experience from teaching calculus for physicists at the university level in the form of flipped learning using Jupyter interactive notebooks (http://jupyter.org). Our multi-year results indicate not only better-prepared, motivated students during teaching, but also earlier and faster introducing key concepts of single variable and multivariate calculus with better conceptual mastery as it is in the case of traditional approaches.

1 Teaching calculus for physicists

Higher mathematics courses for physicists at universities, single variable and multivariate calculus, are still taught by the standard deductive scheme: definition, theorem, proof, and example. Such approach typically leads to the lack of conceptual understanding, incorrect mental representations, and problems with recognizing and applying math ideas in introductory physics.

The calculus reform [3, 4] addressed these issues in the US during the ’80s and ’90s of the twentieth century. Similarly, as in physics education research [8], the reform completely re-thought the calculus curriculum for non-majors in math. The reform brought two key ideas for math education of physicists. The first one, *calculus must be a pump, not a filter*, consists in less details in logical rigor, but clear and transparent presenting key ideas in the form of active and inductive learning with substantially more real applications and interdisciplinary connections. The second one, *using technology*, relates to “Rule of Four” for presenting the ideas at the same time graphically, numerically, symbolically and verbally, which results in better mental models of students.

2 Flipped learning and Jupyter multimedia notebooks in calculus

To get an extra in-class time for more complex, interdisciplinary applications, stronger students’ motivation with less information overloading, we apply flipped learning [2, 5, 10] of calculus in the spirit of the calculus reform with combination of innovative introductory mechanics and electromagnetism textbooks [1, 9].

As for technology, we decided for *Jupyter notebooks technology* ([6, 7, 11], https://jupyter.org/). This technology is an open source, free interactive computing environment, accessible through a modern web browser, that enables teachers and students to use, modify or create interactive multimedia educational documents, which include live code (e.g. Python, SageMath, Javascript), interactive computations, equations, simulations, plots, images, narrative texts, annotations, audios or videos (see an example in fig. 1).

Regarding didactical research, our multi-year experience shows that the proper integration of Jupyter technology in the frame of flipped calculus leads to better results as in the case of the traditional approach. To be more specific, in our contribution we will provide more detailed answers to the following research questions: *Is the Jupyter technology directly and easily applicable in real conditions? What typical difficulties are faced by students in that case? What quality of conceptual understanding, motivation, and metacognition can be achieved?*

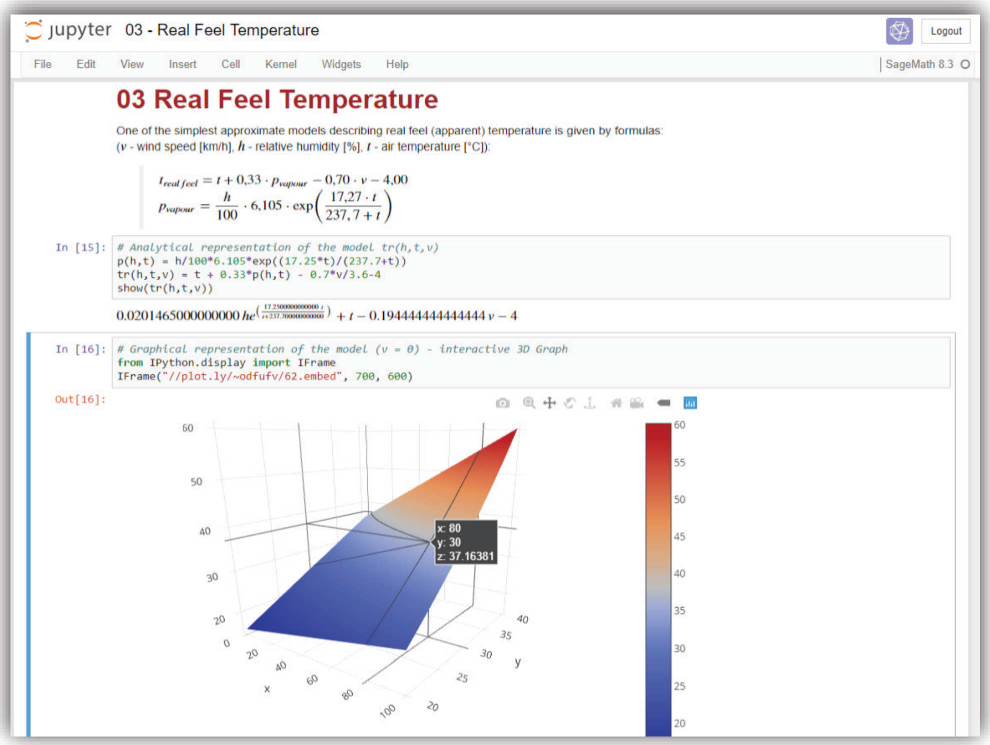

Fig. 1 Excerpt from a Jupyter Sage notebook with a narrative text, formulas and 3D interactive graph

References

[1] Chabay, R. W., Sherwood, B. A. (2015). *Matter and Interactions* (4 edition). Hoboken: Wiley.

[2] Hanč, J. (2013). Application of the flipped classroom model in science and math education in Slovakia. In *HSCI 2013: Proceedings of the 10th International conference on Hands-on Science* (pp. 229–234). Košice, Slovakia: P.J. Šafárik University.

[3] Haver, W. E. (Ed.). (1999). *Calculus: Catalyzing a National Community for Reform: Awards 1987-1995*. Washington: The Mathematical Association of America.

[4] Hughes-Hallett, D. et al (2016). *Calculus: Single and Multivariable* (7th Ed). New York: Wiley.

[5] Jared, K., & Onchwari, G. (Eds.). (2015). *Handbook of Research on Active Learning and the Flipped Classroom Model in the Digital Age*. Hershey: IGI Global.

[6] Project Jupyter, Bussonnier, M. et al (2018). Binder 2.0 - Reproducible, interactive, sharable environments for science at scale. *Proceedings of the 17th Python in Science Conference*, 113–120.

[7] Kluyver, T. et al (2016). Jupyter Notebooks-a publishing format for reproducible computational workflows. In F. Loizides & B. Schmidt (Eds.), *Proceedings of the 20th International Conference on Electronic Publishing*. Amsterdam: Ios Press.

[8] McDermott, L. C. (2001). Oersted Medal Lecture 2001: "Physics Education Research—The Key to Student Learning." American Journal of Physics, 69(11), 1127–1137.

[9] Moore, T. (2016). *Six Ideas That Shaped Physics - All Units* (3rd Ed). Boston: McGraw-Hill Education.

[10] Paňková, E., Štrauch, P., Hanč, J. (2016). Practical strategies in formative and summative assessment of the flipped math and physics education. In R. Santiago Campión (Ed.), *Actas del II Congreso de Flipped Classroom* (pp. 308–327). Zaragoza: MT Servicios Educativos

[11] Thiéry, N. M. et al (2015-2019). OpenDreamKit: Open Digital Research Environment Toolkit for the Advancement of Mathematics. A project funded by Horizon 2020, https://opendreamkit.org/index.html

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