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

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

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

Press:
OOK-Press Kft., Veszprém
Leader: Attila Szathmáry

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Contemporary Physics and Modern Physics in School

Chair: Marisa MICHELINI

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Room No.: K134

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Feynman's quantum mechanics with smartphones in the framework of flipped learning

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Abstract. One hundred years after the birth of Richard Feynman, Nobel prize and Oersted medal laureate, the research-based pedagogical approach in teaching Feynman's sum-over-paths quantum theory, as an alternative to the traditional approach, is constantly being developed and tested under various school conditions. In this context, we investigate the use of Feynman's approach with Geogebra simulations on smartphones at secondary schools in the framework of flipped learning. Our preliminary results show the chosen pedagogical approach is viable, more motivating and not more abstract for students in comparison with in other areas of physics.

1 Teaching Feynman's version of quantum mechanics

Approximately in 1941, Richard Feynman, the Nobel prize and Oersted medal laureate, developed a third alternative version of quantum mechanics, mathematically equivalent with the Schrödinger and Heisenberg formulation. The formulation is called the *amplitude formulation* and it is also known as "the sum-over-paths theory", "the many paths approach", "space-time approach", "path integral formulation".

We recognize two important events in the pedagogy of teaching Feynman's formulation. At the end of 1970-s Feynman prepared and delivered a series of public lectures about quantum theory for non-physicists (http://www.vega.org.uk/video/subseries/8, [5]). The second important event was Edwin Taylor's idea to use interactive computer software for modeling quantum behavior in terms of Feynman's approach [11]. Taylor's didactic transformation of Feynman's ideas was so significant that it led to the teaching of Feynman's quantum mechanics at the first years of university study and also at secondary schools in the world – e.g. in the UK [3, 9], Slovakia [6], Argentina [4], Italia [7], Australia [8] or US [12].

2 Our mixed methods research at a secondary school

In our research-based flipped learning course [1,10] taught at Slovak secondary schools, we developed teaching materials of Feynman's quantum mechanics supplemented by a set of own Geogebra simulations (www.geogebra.org) designed for smartphones. To get a better idea, we mention two examples: (1) Planck's curve simulation for the blackbody radiation (the upper simulation in fig. 1), where a student can set any temperature. By moving points A, B he can investigate what fraction of energy is emitted within any finite range of photon energies. (2) The second example presents Feynman's many-path model at work in the case of a mirror reflection. The simulation allows to move a source, detector, to choose any photon's path reflected from the mirror and any photon wavelength. In several situations, we also use some simulations from Advancing Physics [8] and from PhET (https://phet.colorado.edu/).

Using mixed method research [2], we tried to answer to the following pedagogical problems: *How do smartphones affect the teaching and learning process? How simulations in context of flipping learning contributes to visualization, motivations and students' mental models?* Our preliminary evaluated results show that the chosen pedagogical approach seems viable, more motivating and not more abstract for students in comparison with in other areas of physics. More detailed answers will be presented at the conference.

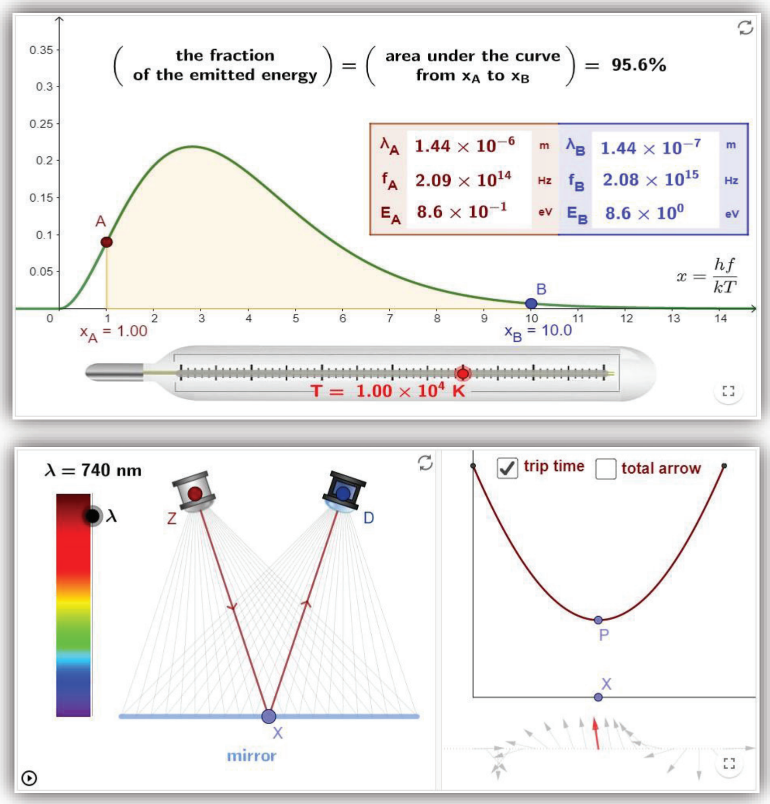

Fig. 1 Two screenshots of Geogebra simulations for quantum physics running on current smartphones

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