



# LATIN AMERICAN JOURNAL OF PHYSICS EDUCATION

[www.lajpe.org](http://www.lajpe.org)

Volume 12

Number 2

June 2018



A publication sponsored by the Latin American Physics Education Network  
and the Institute of Science Education



---

---

# LATIN AMERICAN JOURNAL OF PHYSICS EDUCATION

---

---

Electronic version of this journal can be downloaded free of charge from the web-resource:

<http://www.lajpe.org>

## Production and technical support

Enrique Martínez Roldán  
eroldan@gmail.com  
Isabel Contreras Arredondo  
isaconarr1@yahoo.com.mx

Latin American Journal of Physics  
Education is indexed in:

DOAJ

Dialnet

latindex

EBSCO  
PUBLISHING

INDEX COPERNICUS  
INTERNATIONAL

## EDITORIAL POLICY

Latin American Journal of Physics Education (LAJPE) is a peer-reviewed, electronic international journal for the publication of papers of instructional and cultural aspects of physics. Articles are chosen to support those involved with physics courses from introductory up to postgraduate levels.

Papers may be comprehensive reviews or reports of original investigations that make a definitive contribution to existing knowledge. The content must not have been published or accepted for publication elsewhere, and papers must not be under consideration by another journal.

This journal is published quarterly (March, June, September and December), by the Latin American Physics Education Network (LAPEN) and the Institute of Science Education. Manuscripts should be submitted to [boubarkic@gmail.com](mailto:boubarkic@gmail.com) or [lajpe@lapen.org.mx](mailto:lajpe@lapen.org.mx). Further information is provided in the "Instructions to Authors" on [www.lajpe.org](http://www.lajpe.org)

Direct inquiries on editorial policy and the review process to: C. Bourbaki, Editor in Chief, Instituto Pedagógico Latinoamericano y Caribeño (Cuba), calle 154 No. 12906 entre 129 y 133 Reparto Reynold Garcia, Matanzas, Cuba CP 40100. Phone: 53 45 265794

ISSN 1870-9095

Copyright © 2018 Latin American Physics Education Network. ([www.lajpe.org](http://www.lajpe.org))

## INTERNATIONAL ADVISORY COMMITTEE

Ann-Marie Pendrill, Göteborgs University (Sweden)  
Bayram Akarsu, Erciyes University (Turkey)  
Carl Wenning, Illinois State University (USA)  
Diane Grayson, Andromeda Science Education (South Africa)  
David Sokoloff, University of Oregon (USA)  
Dean Zollman, Kansas State University (USA)  
Edward Redish, University of Maryland (USA)  
Freidrich Herrmann, University of Karlsruhe (Germany)  
Hiroshi Kawakatsu, Kagawa University (Japan)  
Jorge Barojas Weber, Universidad Nacional Autónoma de México (México)  
Jorge Valadares, Universidade Aberta de Lisboa, (Portugal)  
Laurence Viennot, Université Paris 7 (France)  
Lillian C. McDermott, University of Washington (USA)  
Marisa Micheli, University of Udine (Italy)  
Marco Antonio Moreira, Universidade Federal do Rio Grande do Sul (Brazil)  
Minella Alarcón, UNESCO (France)  
Orhan Karamustafaoğlu, Amasya University, (Turkey)  
Pratibha Jolly, University of Delhi (India)  
Priscilla Laws, Dickinson College (USA)  
Ton Ellermeijer, (Netherlands)  
Verónica Tricio, University of Burgos (Spain)  
Vivien Talisayon, University of the Philippines (Philippines)

## EDITORIAL BOARD

Deise Miranda, Universidade Federal do Rio de Janeiro (Brasil)  
Eduardo Moltó, Instituto Superior Pedagógico José Varona (Cuba)  
Eduardo Montero, Escuela Superior Politécnica del Litoral (Ecuador)  
Josefina Barrera, Universidade do Estado do Amazonas (Brasil)  
Julio Benegas, Universidad Nacional de San Luis (Argentina)  
Leda Roldán, Universidad de Costa Rica (Costa Rica)  
Celso Ladera, Universidad Simón Bolívar (Venezuela)  
Manuel Reyes, Universidad Pedagógica Experimental Libertador (Venezuela)  
Mauricio Pietrocola Universidad de Sao Paulo (Brasil)  
Nelson Arias Ávila, Universidad Distrital, Bogotá (Colombia)  
Octavio Calzadilla, Universidad de la Habana (Cuba)  
Ricardo Buzzo Garrao, Pontificia Universidad Católica de Valparaíso (Chile)  
Zulma Gangoso, Universidad Nacional de Córdoba (Argentina)

## EDITOR-IN-CHIEF

Cesar Mora, Instituto Politécnico Nacional (México)

## ASSOCIATED EDITOR

Josip Slisko, Benemérita Universidad Autónoma de Puebla (México)