Physics Education: Approaches from ICPE-IUPAP C14 Community

Organized by International Commission on Physics Education (ICPE) IUPAP-C14
Coordinator: Jenaro GUISASOLA (1)
Participants: Angela FÖSEL (2), Eilish MCLOUGHLIN (3), Elizabeth Jane ANGSTMANN (4), Tetyana ANTIMIROVA (5)

(1) School of Dual Engineering. Institute of Machine Tool (IMH). Spain
(2) Physics Department. Friedrich-Alexander-University of Erlangen-Nürnberg. Germany
(3) School of Physical Sciences & CASTel. Dublin City University. Ireland
(4) School of Physics. University of New South Wales. Australia
(5) Department of Physics. Toronto Metropolitan University. Canada

Abstract. The physics outreach and teaching activities undertaken by members of the International Commission of Physics Education (ICPE- IUPAP C14) involve a wide range of perspectives, populations and methods. A unifying theme is that the problems investigated by ICPE arise from the teaching and learning of physics, including its concepts, principles, epistemology and culture. In this Symposium, the activities of physics teacher education and the dissemination of effective approaches to teaching physics provide a context for illustrating the kind of activities ICPE engages in.

Introduction

The International Commission on Physics Education, one of the twenty IUPAP commissions, was founded in 1960 to promote the exchange of information and expectations on problems of physics teaching and learning among members of the international scientific community. ICPE, with the support of IUPAP, promotes, organises and supports international conferences, workshops and other actions aimed at improving physics education worldwide, mainly in the 60 countries associated with IUPAP [1].

The physics outreach and teaching activities undertaken by members of the International Commission of Physics Education (ICPE- IUPAP C14) involve a wide range of perspectives, populations and methods. A unifying theme is that the problems investigated by ICPE- IUPAP C14 arise from the teaching and learning of physics, including its concepts, principles, epistemology and culture. In this Symposium, the activities of physics teacher education and the dissemination of effective approaches to teaching physics provide a context for illustrating the kind of activities ICPE-C14 engages in. The activities and training programmes represented here are diverse in terms of their focus and the context in which they take place. The themes that are common within ICPE-C14 can be summarised as: (1) Promoting the exchange of information and views among members of the international physics community in the field of physics teaching and learning; (2) Suggesting ways to improve physics teaching at all levels, stimulating active teaching approaches that have repeatedly achieved significant learning gains; (3) The distribution and evaluation of information relating to the teaching and learning of physics at all levels. These topics range from the fundamental representations of the discipline, through the cognitive processes involved in learning, to the interaction between students and curricular interventions, and finally to the demands that guide students through their intellectual development on teachers and teacher educators. All of this will be presented and discussed in the four talks of the symposium.

Research activity in physics learning and teaching has accelerated in recent decades with the incorporation of physics education research into university physics departments in several countries. This trend, already well established in countries such as the United States, is growing in countries such as Australia, Japan and throughout Europe. The recent growth makes it foreseeable that in the next decade, PER findings will increase in quantity and quality, addressing new topics not yet considered or not yet widespread: such as, for example, problems and developments in non-formal education, or issues related to scientific literacy in current socio-scientific problems related to the so-called Post-Truth Era. The growing body of evidence-based information currently available about the process of teaching and learning physics, makes ICPE's role of informing, debating and bringing together the international physics education community in conferences all the more necessary. In this symposium ICPE-IUPAP C14 tries to share its efforts to get teachers and researchers to discuss teaching experiences and results in order to achieve more and better student learning. Thus, the ICPE has published a number of ICPE hanbooks to summarise and disseminate these problems and possible solutions and support International Conferences [2,3].

The symposium presents four types of actions developed by ICPE-IUPAP C14 with the aim of disseminating and sharing with the physics education community the results and advances in research and innovation in Physics Education. This symposium also wants to be a call for members of the community to collaborate and make proposals to the committee, we believe that collaboration between teachers, researchers and institutions is necessary to advance and accumulate knowledge in physics education.

In the first contribution Angela Fössel will explain the objectives and characteristics of the Conferences organised in recent years by the International Commission on Physics Education IUPAP C14. In particular, she will focus on the ICPE 2022 Congress. The ICPE 2019 and 2018 will also be discussed. Jenaro Guisasola and Eilish McLoughlin, in the second contribution, will summarize the tradition of IUPAP C14 in publishing and diseminate handbooks on research and innovation in teaching and learning physics. In the third contribution, E. Angstmann and Manjula D. Sharma will describe some contributions and changes of the ICPE newsletter over the years. The ICPE newsletter is the main medium used by the IUPAP education commission (C14) to share activities and calls on Physics Education.
The Chair of the Commission, Tetyana Antimirova will report on the initiatives and actions undertaken by the Commission's members during the current Commission's mandate (2021-2024). The presentation will also outline the future directions that will be pursued by the Commission.

[1] C14: Physics Education. See: https://iupap.org/who-we-are/internal-organization/commissions/c14-physics-education/
[2] C14: Sponsored publication. See: https://iupap.org/who-we-are/internal-organization/commissions/c14-physics-education/c14-sponsored-publication/
[3] C14: Conferences and meetings: https://iupap.org/who-we-are/internal-organization/commissions/c14-physics-education/c14-conferences-and-meetings/

International Conferences on Physics Education organized or carried out by C14

Angela FÖSEL

Physics Education, Physics Department. Friedrich-Alexander-University of Erlangen-Nürnberg. Germany

Abstract. International Conferences on Physics education offer an opportunity to meet peer, to gather, to discuss current issues, to learn from each other, to share experiences and to envision collaboration. In this contribution, we will give a summary on the international conferences on physics education organized or carried out by C14 within the past years. Highlights and special aspects of each of those conference will be outlined exemplary.

Introduction

One of the main goals of ICPE-C14 is to create and strengthen a wordwide community and network of contacts in the field of physics education. International Conferences on Physics education in fact offer a great opportunity to meet peer, to gather, to discuss current issues, to learn from each other, to share experiences and to envision collaboration.

Within the past years, C14 organized and carried out the International Conference on Physics education ICPE-2022 in december 2022 as an huge online event due to COVID-19 [1]. C14 made a big impact on the 2019-GIREP-ICPE-EPEC-MPTL 2019 at Budapest/Hungary in july 2019 [2]. In october 2018, physics education commission C14 made important input on 2018-International Conference on Physics Education 2018 in Johannesburg [3].

In the symposium, we will outline content and goals of GIREP-ICPE-EPEC in 2019 with focus on those contributions made by C14. Using the example of ICPE 2018 in Johannesburg, we will show up the diversity of learning and physics education worldwide.

Especially the ICPE 2022 with its theme “physics education – preparing for the future” might be an excellent example, how conferences help in sharing experience and discussing current issues. A variety of subthemes, for example modes of delivery, physics in schools and universities, physics outreach and of research in physics education had been content of ICPE 2022. Most of the contributions will be published in the journal “International Journal of Innovation of in Science and Mathematics Education” by the end of year 2024 [4]. In this symposium, we will present the highlights of the subthemes of ICPE-2022 and we will discuss the relevance for the physics education community each. Problems and challenges with respect to cultural diversities will be considered as well.

References

[1] ICPE Australia-Indonesia-Thailand Online 2022. https://icpe2022physicseducation.com (26.02.2024)
[2] GIREP-ICPE-EPEC-MPTL 2019. https://girep2019.hu (26.02.2024)
[3] ICPE 2018 Johannesburg. https://events.saip.org.za/event/93/images/590-ICPE-SAIP-WITS_2018_-_Book_of_abstracts-v5.pdf

Global Perspectives on Physics Education: contributions from IUPAP C14 Handbooks

Jenaro GUISASOLA (1), Eilish MCLOUGHLIN (2)

(1) School of Dual Engineering. Institute of Machine Tool (IMH). Spain
(2) School of Physical Sciences & CASTel. Dublin City University. Ireland

Abstract. We explain here the aims of the sponsored publications by ICPE and in particular, the last volume of the handbook "Connecting Research in Physics Education with Teacher Education 3". The publications aim provide a structured documented and critical review of extant Physics Education Research and serving as an important platform for discussion and debate on appropriate strategies and innovations in physics education.

Introduction

One of the principals aims of the IUPAP Commission for Physics Education (ICPE) is to disseminate Physics Education Research findings and promote their relevance to physics teacher education and classroom practice. In particular, the ICPE objectives include (but not limited to) suggesting ways in which physics learning and teaching at all levels might be improved and publishing handbooks, where feasible. In accordance with these objectives, the ICPE published a handbook in 1998 entitled "Connecting Research in Physics Education with Teacher Education 1"[1]. The editors of this handbook, A. Tiberghien, E. L. Jossem and J.Barojas, commented that "research results in any field, their transfer into practice is not necessarily straightforward. We consider this book as a starting point of an international cooperative effort to transfer the results of research in physics education to teacher educators". In 2008, ICPE decided to continue this project and edit a second handbook, "Connecting Research in Physics Education with Teacher Education 2" [2]. The Commission observed that research in physics education had evolved over the ten-year period and many new findings had been reported on the learning and teaching of physics. The editors of the second volume, M. Vicentini and E. Sassi, addressed the objectives of the initial project and commented that "The overall goal is to gather significant experiences and viewpoints from different areas around the world that are expressed in plain language, in order also to encourage the implementation of innovative class practices and the starting of PER initiatives". Both ICPE handbooks have been made freely available online and have been widely read and cited by the physics education community. In 2020, the project was continued by the Commission and a third handbook was proposed that would reflect on significant developments of research in physics education and their implications for educational innovation. ICPE considered it important to inform the international community of physics teachers about research findings and innovations over the preceding decade. The Commission appointed J. Guisasola and E. McLoughlin to edit the third volume of this handbook.

The purpose of this handbook, "Connecting Research in Physics Education with Teacher Education 3" [3], is to provide a structured, documented and critical review of extant Physics Education Research (PER) and serve as an important platform for discussion and debate on appropriate strategies and innovations in physics education. Reflecting on reported research and initiatives in learning and teaching physics is also the central theme of the third ICPE Handbook. Facilitating student learning in physics is complex and requires teachers to have

knowledge and understanding from across the disciplines of physics and its epistemology, to cognitive theory of learning and to design of pedagogical approaches. Some of these aspects were already covered in the two previous volumes: i.e., knowledge of physics and its epistemology, student learning difficulties, challenges faced by teachers of physics, and appropriate teaching strategies in physics. Handbook 3 highlights novel and innovative approaches that have emerged in the past decade to improve physics teacher professional learning and their classroom practice. This handbook examines the role of student knowledge in the learning and teaching of physics and explores innovative approaches to learning and teaching physics in the laboratory and reflects on the use of multimedia tools. The opportunities and experiences of learning and teaching physics across formal and non-formal contexts reviewed in this handbook share successful strategies for widening participation and engagement in physics and enhancing scientific literacy.

References

[1] A. Tiberghien, E. L. Jossem and J. Barojas, *Connecting Research in Physics Education with Teacher Education 1*, An I.C.P.E. Book © International Commission on Physics Education, 2008. 2. In https://zenodo.org/records/6463545#.Y_y8-hPMLAM

[2] M. Vicentini and E. Sassi, *Connecting Research in Physics Education with Teacher Education 2*, An I.C.P.E. Book © International Commission on Physics Education, 2018. In https://zenodo.org/records/6463599#.ZAoUU3bMK3B.

[3] J. Guisasola and E. McLoughlin, *Connecting Research in Physics Education with Teacher Education 3*, An I.C.P.E. Book © International Commission on Physics Education, 2022. In https://zenodo.org/records/5792968#.Y_y9PRPMLAM

International Commission on Physics Education (C14) Newsletters

Elizabeth ANGSTMANN (1), Manjula D. SHARMA (2)

(1) School of Physics, University of New South Wales, NSW, Australia, 2052
(2) School of Physics, University of Sydney, NSW, Australia, 2006

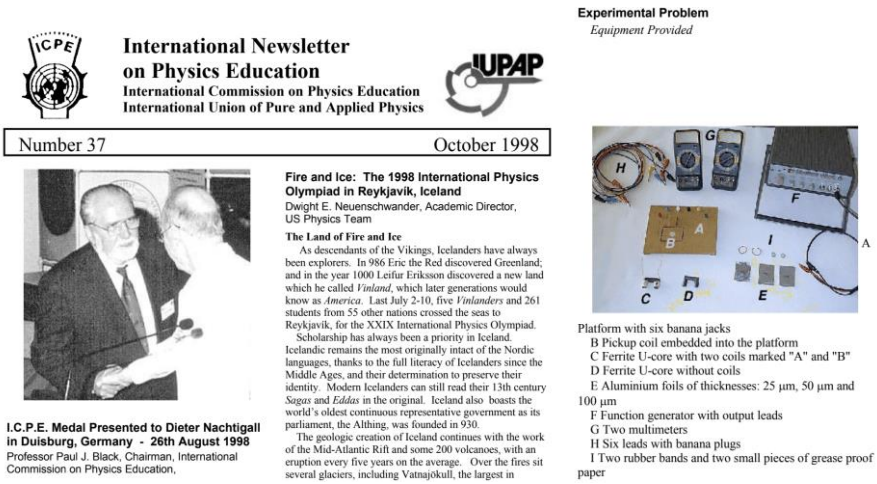
Abstract. The ICPE newsletter is the primary means the education commission (C14) of IUPAP uses to keep the physics education community abreast of activities and opportunities, such as the opportunity to apply for the ICPE medal. We will outline the history of the ICPE newsletter considering some interesting contributions and changes over the years.

Introduction

IUPAP gave approval for the establishment of Commision C14: Physics Education on 6 September 1960. Its remit is the international sharing of ideas on the teaching and learning of physics. The intention was to support those seeking to enhance, improve as well as investigate the teaching and learning of physics, through which to advance physics studies as a discipline in itself, and in service to other disciplines. As discussed by my peers, the sharing occurs through conferences, the publication of books and other engagements as well as interactions. To complement these, a Newsletter provides an avenue to acccess information on physcis teaching as well as a way of connecting with the broader community. This led to the production of the ICPE Newsletters.

The early days

The early days saw the production of the C14 Newsletters in paper form and its distributed amongst membership. Professor Edward (Joe) Redish was the Editor for several years, including issue number 37. The issue featured the ICPE Medal Awardee alongside information about the 1998 International Physics Olympiad including the problems from the exam.



International Newsletter on Physics Education
International Commission on Physics Education
International Union of Pure and Applied Physics

Number 37 October 1998

I.C.P.E. Medal Presented to Dieter Nachtigall in Duisburg, Germany - 26th August 1998
Professor Paul J. Black, Chairman, International Commission on Physics Education,

Fire and Ice: The 1998 International Physics Olympiad in Reykjavik, Iceland
Dwight E. Neuenschwander, Academic Director, US Physics Team

The Land of Fire and Ice

As descendants of the Vikings, Icelanders have always been explorers. In 986 Eric the Red discovered Greenland; and in the year 1000 Leifur Eriksson discovered a new land which he called *Vinland*, which later generations would know as *America*. Last July 2-10, five *Vinlanders* and 261 students from 55 other nations crossed the seas to Reykjavik, for the XXIX International Physics Olympiad.

Scholarship has always been a priority in Iceland. Icelandic remains the most originally intact of the Nordic languages, thanks to the full literacy of Icelanders since the Middle Ages, and their determination to preserve their identity. Modern Icelanders can still read their 13th century *Sagas* and *Eddas* in the original. Iceland also boasts the world's oldest continuous representative government as its parliament, the Althing, was founded in 930.

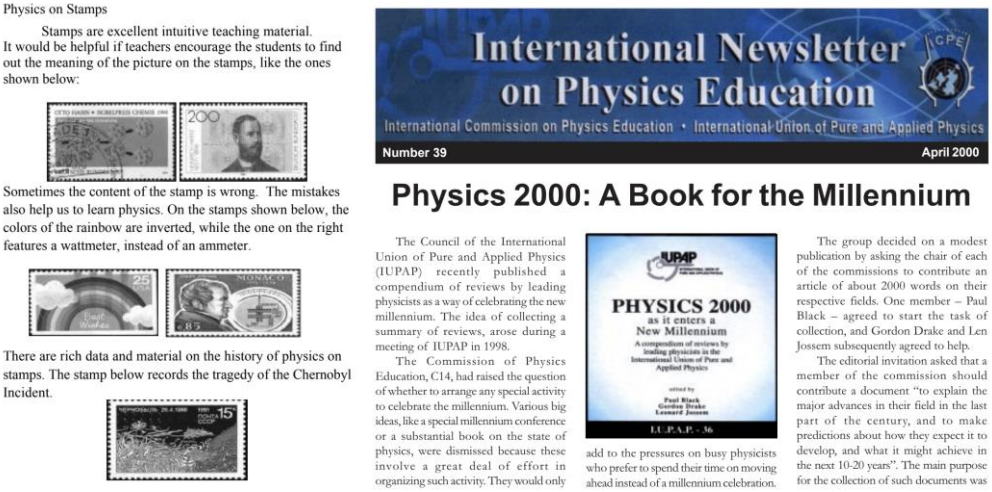
The geologic creation of Iceland continues with the work of the Mid-Atlantic Rift and some 200 volcanoes, with an eruption every five years on the average. Over the fires sit several glaciers, including Vatnajökull, the largest in

Experimental Problem
Equipment Provided

Platform with six banana jacks
B Pickup coil embedded into the platform
C Ferrite U-core with two coils marked "A" and "B"
D Ferrite U-core without coils
E Aluminium foils of thicknesses: 25 μm, 50 μm and 100 μm
F Function generator with output leads
G Two multimeters
H Six leads with banana plugs
I Two rubber bands and two small pieces of grease proof paper

Fig. 1. Imges from the ICPE Newsletter Number 37 featuring Professor Dieter Nachtogall receiving the ICPE Medal together with questions from the 1998 Physics Olympiad.

The issue also contained a list of physics education papers from a range of journals such as American Journal of Physics and Interantional Journal of Science Education and Physics Education.



Physics on Stamps

Stamps are excellent intuitive teaching material. It would be helpful if teachers encourage the students to find out the meaning of the picture on the stamps, like the ones shown below:

Sometimes the content of the stamp is wrong. The mistakes also help us to learn physics. On the stamps shown below, the colors of the rainbow are inverted, while the one on the right features a wattmeter, instead of an ammeter.

There are rich data and material on the history of physics on stamps. The stamp below records the tragedy of the Chernobyl Incident.

International Newsletter on Physics Education

International Commission on Physics Education • International Union of Pure and Applied Physics

Number 39 April 2000

Physics 2000: A Book for the Millennium

The Council of the International Union of Pure and Applied Physics (IUPAP) recently published a compendium of reviews by leading physicists as a way of celebrating the new millennium. The idea of collecting a summary of reviews, arose during a meeting of IUPAP in 1998.

The Commission of Physics Education, C14, had raised the question of whether to arrange any special activity to celebrate the millennium. Various big ideas, like a special millennium conference or a substantial book on the state of physics, were dismissed because these involve a great deal of effort in organizing such activity. They would only add to the pressures on busy physicists who prefer to spend their time on moving ahead instead of a millennium celebration.

PHYSICS 2000 as it enters a New Millennium

A compendium of reviews by leading physicists in the International Union of Pure and Applied Physics

I.U.P.A.P. - 36

The group decided on a modest publication by asking the chair of each of the commissions to contribute an article of about 2000 words on their respective fields. One member – Paul Black – agreed to start the task of collection, and Gordon Drake and Len Jossem subsequently agreed to help.

The editorial invitation asked that a member of the commission should contribute a document "to explain the major advances in their field in the last part of the century, and to make predictions about how they expect it to develop, and what it might achieve in the next 10-20 years". The main purpose for the collection of such documents was

Fig. 2. ICPE Newsletter issue number 38 and 39 had Dr. Vivien M. Talisayon as Editor and included content on the use of culture in physics education, 39 shifted to colour printing.

Number 38 was published in 1999 and was truly international in scope with contributions from Japan, China, Norway, South Korea, Germany alongside reports from members of C14. Topics covered included: Developements in physics education; Teaching and Learning Physics in a Cultural Context; Physics in Stamps; and Anamorphic Images – a Combination of Art, Physics and Mathematics. In this issue Dr. Vivien M. Talisayon took over as editor from Professor Redish who had been editor since 1995. Issue number 39 in 2000 saw the introduction of colour printing.

Editors

Over the years editors have come from a number of countries and a range of institutions. Professor Redish from University of Maryland was the editor from 1995-1999. Dr. Vivien M. Talisayon from University of the Philippines served from 1999 all the way until 2005. Profesor Ian Johnston from The University of Sydney took over in 2006 Issue 51 and contiued till issue 63, 2012. Zulma Gangoso from Universidad Nacional de Córdoba in Argentina edited issue 64 in 2013. This was followed by a hiatus until 2017 when Professor Manjula Sharma from the University of Sydney became editor for issues 65 all the way up to issue 75. Professor Sharma handed it over to Professor Elizabeth Angstmann from the University of NSW in 2024.

Recent Actions and Future Directions of The International Commission on Physics Education of IUPAP

Tetyana ANTIMIROVA

Department of Physics. Toronto Metropolitan University, Canada

Abstract For more than six decades the International Commission of Physics Education (ICPE-C14) has been contributing to worldwide improvements of physics teaching and learning at all levels. The Chair of the Commission will report on the initiatives and actions undertaken by the Commission's members during the current Commission's mandate (2021-2024). The presentation will outline the future directions that will be pursued by the Commission.

Introduction

The ICPE-C14 mission is to promote the exchange of information and views among the members of the international scientific community in the field of Physics Education. Physics pedagogy (including assessment of the standards of teaching and learning), physics curriculum for 21st century, today's physics graduates' skills set sufficient to address societal needs are the themes widely discussed by the Physics Education community. ICPE-C14 emphasizes pedagogical innovations that are informed by research and are proven to result in better learning outcomes. Physics Education Research (PER) is an established and evolving field of research. However, in order to maximize the practical gains from these research findings, the advances in the field need to be disseminated among the physics education practitioners.

Effective communication is a key function of the ICPE-C14, and sponsoring, co-organizing, participating in relevant conferences, workshops, schools, and symposia is a significant part of the commission's core activities. The talk will report on the ICPE-C14 participation in the international events that took place during 2021-2024, with particular emphasis on IUPAP Centennial Symposium held in July 2022, for which the commission prepared and organized a Physics Education Panel. The C14 fosters collaboration with other Commissions and Working Groups of IUPAP, and, in particular, with Women in Physics Working Group (WG5). The C14 and WG5 collaborated in development and delivery of Education Workshops for the 7th and 8th Internation Women in Physics Conferences (ISWIP2021 and ISWIP2023). ICPE-C14 commissioners contributed significantly to the International Conference on Physics Education held virtually in December 2022, providing one of the keynote speakers and organizing and delivering several workshops. The C14 also fostered collaboration with the Working Group on Ethics (WG18).

In the aftermath of the Covid pandemic, a hybrid delivery mode remains essential for: teaching, learning and research communications in many corners of the world. The Commission is working on compiling the resources for online/virtual/remote laboratory resources.

In 2023 the Commission reviewed and made a significant revision of its webpage hosted at the IUAP website [1]. An important tool of communication for the commission is its ICPE Newsletter which is featured separately in one of the contributions of this Symposium.

The Commission administers the ICPE Medal that was instituted to recognize “outstanding contributions to physics teaching of a kind that transcends national boundaries”. The Medal qualification rules were fine-tuned in 2022. Two Medals were awarded during the current mandate of the Commission, with up to two medals expected to be awarded by the end of the current term of the Commission.

Future directions of the Commission will also be outlined in the talk. Two General Assemblies of IUPAP were held during the term of the current commission (in July 2022 and October 2023). The ideas and initiatives undertaken by the current Commission will continue to be implemented by the next Commission that will take over after the elections during the next General Assembly (to be held in October 2024).

The ICPE-C14 is committed to promoting active learning. The IUPAP page on Physics Education [2] (not to be confused with the C14 webpage) will be redesigned according to the Commission's vision. The materials and IUPAP resolutions pertaining to issues of active learning will be assembled and posted on that page.

A former member of the Commission recently got hold of a complete archive starting from the early years of the Commission. An archive of ICPE-C14 Commission will be digitized and studied, with the ultimate goal of producing a publication on the history of ICPE-C14 and its role in advancing Physics Education worldwide.

To conclude, the IUPAP issued a call for all its Commissions to review and re-imagine the Commissions’ missions and mandates. Future directions of ICPE-C14 will ultimately depend on the decisions taken by the next Commission that will take over after the next General Assembly.

References

[1] C14: Physics Education. See: https://iupap.org/who-we-are/internal-organization/commissions/c14-physics-education/

[2] IUPAP Physics Education page https://iupap.org/strategic-plan/physics-education/