12th International Conference

on

Education and Training in Optics and Photonics

Faculty of Sciences of the University of Porto, Portugal

July 23 to 26, 2013

ABSTRACTS' BOOKLET

12th International Conference on Education and Training in Optics and Photonics

ETOP 2013

July 23 to 26, 2013
Faculty of Sciences of the University of Porto
Porto, Portugal.

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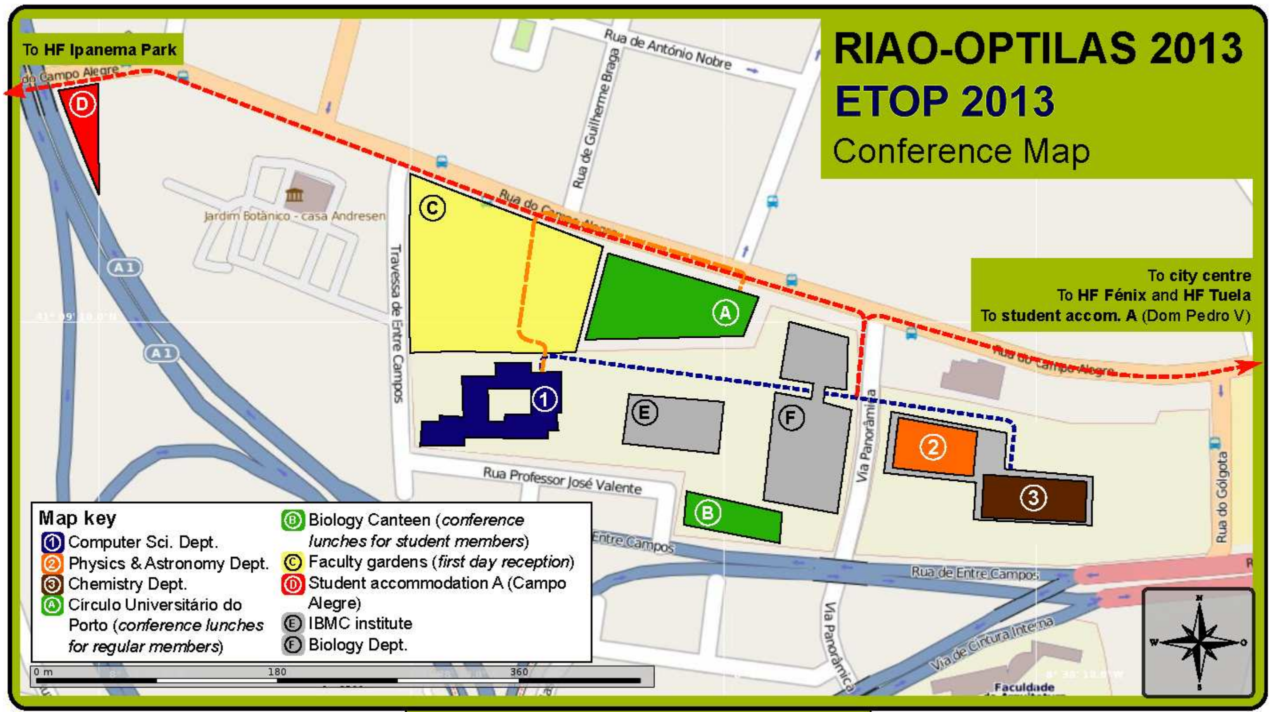
ETOP'2013

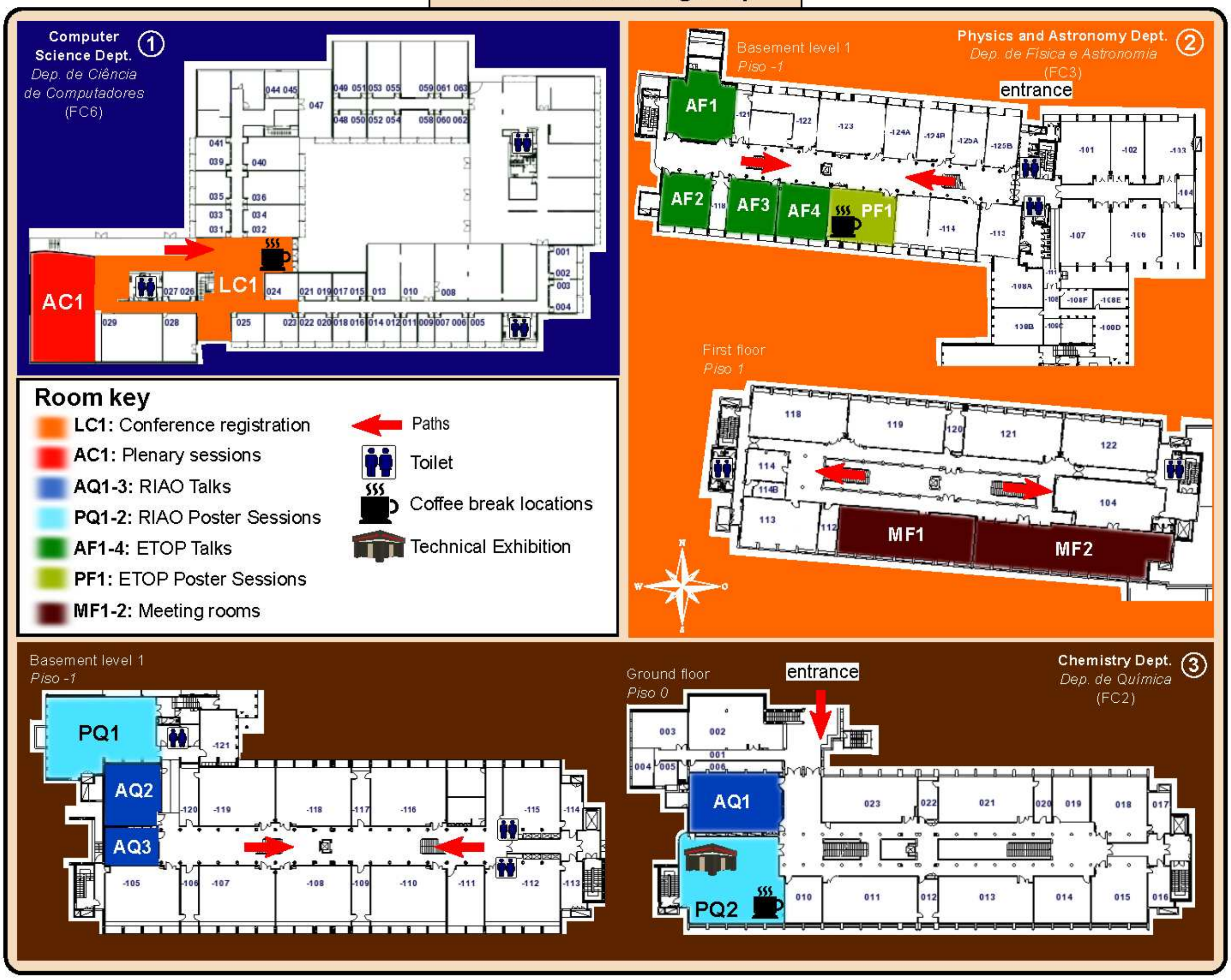
July 23 to 26, 2013, Faculty of Sciences, University of Porto

Day / Time	*Sunday* *July 21*	*Monday* *July 22*	**Tuesday** **July 23**	**Wednesday** **July 24**	**Thrusday** **July 25**	**Friday** **July 26**	*Saturday* *July 27*
8:00		*Registration*	Registration	Registration	Registration	Registration	*Optional Post-Conference Tour "Douro Vignards River Cruise"*
9:00				**Parallel Sessions (VI, VII, VIII, IX)/ Amrita Prasad** *Photonics Explorer workshop*	**Parallel Sessions (XII, XIII, XIV, XV)/ Stephen M. Pompea** *Workshop on teaching with the galileoscope*	**Parallel Sessions (XXI, XXII, XXIII)/ Souad Lahmar and Vasudevan Lakshminarayanan** *ALOP workshop*	
9:30			**Openning Session**				
10:00			Invited lecture **Session I**				
10:30			Coffee break /posters	Coffee break /posters	Coffee break /posters	Coffee break /posters	
11:00			Invited lectures **Session II**	Joint Special Session ETOP2013 RIAO/OPTILAS2013 **Entrepreneurship in Optics & Photonics**	Invited lectures **Session XVI**	Invited lectures **Session XXIV**	
12:45			Lunch	Lunch	Lunch	Lunch *Portuguese Folk Music and Dances*	
14:45			Invited lectures **Session III**	Poster Session/ **Session XI** **Pedro Pombo** *Hands-on Holography* **Carlos Florensa** *"The magic of light!" – An entertaining optics and photonics awareness program* **Stephen M. Pompea** *The Hands-on Optics project*	Invited lectures **Session XVII**	Joint Special Session ETOP2013 RIAO/OPTILAS2013 **Women & Optics**	
16:30			Coffee break /posters	City and three bridges River Tour and visit to Porto Wine Cellars	Coffee break /posters	Coffee break	
17:00 / **18:00**	*Student's Welcome Reception* *(open to all conference participants)* *UPorto' Science Museum (at city center)*		**Parallel Sessions (IV, V)/ Judith Donnelly** *Workshop on Problem Based Learning (PBL) Submarine Lighting: A PBL Challenge in Fiber Optics*		**Parallel Sessions (XVIII, XIX, XX)/ Shahrul Kadri** *Student Activity : Verification on Malus's Law of Polarization at low cost*	**Closing Session Joint ETOP2013 RIAO/OPTILAS2013**	
19:00		*Porto Wine Reception* *Gardens of FCUP*	*Portuguese Music*				
20:30					*Conference Dinner* *Hotel HF Ipanema Park*		



Campo Alegre campus map

Detailed building map



Special Sessions

Opening Session (Tuesday, July 23)

Rector of the University of Porto and FCUP President (representative), DFA-FCUP Director (representative); ICO' President; OSA' President; SPIE' President (representative); IEEE' President (representative); Conference co-Chairperson -STO' President (ICO' Territorial Committee of Tunisia); Conference co-Chairperson -SPOF' President (ICO' Territorial Committee of Portugal).

Joint Special Session RIAO/OPTILAS2013 - ETOP2013
"Entrepreneurship in Optics & Photonics" (Wednesday, July 24)

"Entrepreneurship for Scientists and Engineers", Duncan Moore, University of Rochester, USA.

"Research, entrepreneurship and the virtue of limits", Gerd Haeusler, Friedrich-Alexander-University Erlangen-Nürnberg, Germany.

"Strategies for an efficacious entrepreneurship in iberoamerican countries: a proposal" Guillermo Baldwin, Pontificia Universidad Católica de Peru, Peru.

Round table "Entrepreneurship in Optics & Photonics"

Alexandra Xavier, INESC Porto, Portugal (*moderator*), Eric Rosas, RIAO & CIO, Mexico; Duncan Moore, University of Rochester, USA; Gerd Haeusler, Friedrich-Alexander-University Erlangen-Nürnberg, Germany; Guillermo Baldwin, Pontificia Universidad Católica de Peru, Peru; Eugene Arthurs, SPIE, USA; Barry Shoop, U.S. Military Academy West Point, New York, USA; Francisco Araújo, FiberSensing, Portugal; João José Pinto Ferreira (MIETE, Faculdade de Engenharia da Universidade do Porto, Portugal).

Joint Special Session RIAO/OPTILAS2013 - ETOP2013

"Women & Optics" (Friday, July 26)

Chair: Prof. María Josefa Yzuel Giménez (Universitat Autònoma de Barcelona, Spain)

With presentations from: Prof. Maria L. Calvo, Prof. Maria J. Yzuel, Prof Donna Strickland, Prof. Cristina Solano, Susana Silva and Raquel Queirós, and Prof. Anna Consortini.

Round table discussion with the participation of: Prof. Angela Guzman, Prof. Maria S. Millan, Prof. Souad Lahmar, and Prof Patricia Forbes.

Closing Session (Friday, July 26)

Rector of the University of Porto (representative) ICO' President; OSA' President, SPIE' President (representative); IEEE' President (representative); European Commission unit G5 "Photonics" representative, RIAO' President; Conference co-Chairperson -STO' President (ICO' Territorial Committee of Tunisia); Conference co-Chairperson -SPOF' President (ICO' Territorial Committee of Portugal).

Presentation by Bart Van Caenegem, EC' unit G5 "Photonics" on EC' program **Horizon2020**.

RIAO/OPTILAS2013 SPIE student' awards ceremony

RIAO/OPTILAS2013 OSA student' awards ceremony

RIAO/OPTILAS2013 APLO/SPOF "Best RIAO/OPTILAS2013 communication on Optometry and Vision Sciences" award ceremony

SPOF "Best PhD Thesis in Optics and Photonics in Portugal in 2012" award ceremony.

Session Chairs

Tuesday, July 23

- Opening Session : ETOP2013 co-chairs
- Session I : Vasudevan Lakshminarayanan, University of Waterloo, Canada
- Session II : Bahaa E. A. Saleh, CREOL, The College of Optics and Photonics, University of Central Florida, USA
- Session III : Toyohiko Yatagai, Center for Optical Research and Education, Utsunomiya University, Japan
- Session IV : Manuel Melgosa-Latorre, University of Granada, Granada, Spain

Wednesday, July 24

- Session VII : Enrique J. Galvez, Department of Physics and Astronomy, Colgate University, USA
- Session VIII : Andrew Forbes, CSIR National Laser Centre, South Africa
- Session IX : Anna Consortini, Universita' degli Studi di Firenze Dipartimento di Fisica e Astronomia, Italy

Thursday, July 25

- Session XIII : Manuel Joaquim Marques, Univ. Porto, Portugal
- Session XIV : Joe Niemela, ICTP, Italy
- Session XV : Alan K. Shore, Photonics Academy of Wales, Bangor University, Wales, UK
- Session XVI : Vanderlei Bagnato, IFSC/USP, Brazil
- Session XVII : Angela M. Guzmán, CREOL, The College of Optics and Photonics, University of Central Florida, Orlando, USA
- Session XIX : Dan Curticapean, University of Applied Sciences Offenburg, Germany
- Session XX : Paulo Simeão, Univ. Porto, Portugal

Friday, July 26

- Session XXII : Cristina Elizabeth Solano Soza, Centro de Investigaciones en Óptica (CIO), Léon, Mexico
- Session XXIII : Pedro Pombo, Physics Department, University of Aveiro, Portugal
- Session XXIV : Maria L. Calvo, Universidad Complutense de Madrid (UCM), Spain
- Women in Science session Maria J. Yzuel, Universidad Autónoma de Barcelona, Spain
- Closiing Session: ETOP2013' co-chairs

08:00			*Registration*	
09:30	09:55		**Opening Session (room AC1)**	
			Session I: Invited Session (room AC1)	Chair: Vasudevan Lakshminarayanan
09:55	10:30	Keynote	Critical Issues Facing Physics Education: Participation, Engagement, and Relevance	Theodore Hodapp, American Physics Society, USA
			Session II: Invited Session (room AF1)	Chair: Bahaa E. A. Saleh
11:00	11:25	Keynote	First Optical Education Center in Japan, Established by Cooperation between Academia and Industry	Toyohiko Yatagai, Center for Optical Research and Education, Utsunomiya University, Japan
11:25	11:50	Keynote	Optics activities in ICTP	Joe Niemela, ICTP, Italy
11:50	12:15	Keynote	The High Education of Optical Engineering in East China,	Xu Liu, Zhejiang University, China
12:15	12:40	Keynote	UNESCO's ALOP recognized for IGIP International Engineering Educator certification	Angela M. Guzmán, CREOL, The College of Optics and Photonics, University of Central Florida, Orlando, USA
12:40	13:05	Keynote	Developing intra-curricular photonics educational material for secondary schools in Europe	Amrita Prasad, Vrije Universiteit Brussel, Pleinlaan 2, Belgium
			Session III: Invited Short Course (room AF2)	
14:45	16:30	Short course	Dihedral Fourier Analysis (room AF2)	Marlos Viana, University of Illinois at Chicago Eye Center, Chicago, Illinois, USA
			Session III: Invited Session (room AF1)	Chair: Toyohiko Yatagai
14:45	15:10	Keynote	The Evolution of Optics Education at the U.S. National Optical Astronomy Observatory	Stephen M. Pompea, National Optical Astronomy Observatory, USA
15:10	15:35	Keynote	Adaptive optics	Vasudevan Lakshminarayanan, University of Waterloo, Canada
15:35	16:00	Keynote	Image Science in the Optics and Photonics Curriculum	Bahaa E. A. Saleh, CREOL, The College of Optics and Photonics University of Central Florida, USA
16:00	16:25	Keynote	Inspiring future experimental scientists through questions related to color	Manuel MelgosaLatorre, Department of Optics, Faculty of Sciences, University of Granada, Granada, Spain

Parallel session, Session IV: Invited Session (room AF1)

Chair: Manuel Melgosa Latorre

17:00	17:25	Keynote	An Educational Kit in optics for broad use	Vanderlei Bagnato, IFSC/USP, Brazil
17:25	17:50	Keynote	Shedding the light on spectrophotometry: The SpecUP educational spectrophotometer	Patricia Forbes, Department of Chemistry, University of Pretoria, Lynnwood Road, Pretoria, South Africa
17:50	18:15	Keynote	Outreach activities in Guanajuato México	Cristina Elizabeth Solano Soza, Centro de Investigaciones en Óptica (CIO), Léon, Mexico
18:15	18:40	Keynote	Unesco Active Learning approach in Optics and Photonics leads to significant change in Morocco	Khalid Berrada, Cadi Ayyad University – Faculty of Sciences Semlalia Department of Physics, Marrakech, Morocco

Session V: Workshop (room AF4)

17:00	19:00	Workshop	Workshop on Problem Based Learning (PBL) Submarine Lighting: A PBL Challenge in Fiber Optics	Judith Donnelly, Three Rivers Community Technical College

Session VI: Workshop (room AF4)

09:00	10:30	Workshop	Photonics Explorer workshop	Amrita Prasad, Vrije Universiteit Brussel, Brussels, Belgium	

Parallel session, Session VII: Special Session on "educational laboratories with single photon" (room AF3) — Chair: Enrique J. Galvez

09:00	09:25	Keynote	Single-photon laboratories to rethink how we quantum mechanics	Enrique J. Galvez	Department of Physics and Astronomy, Colgate University, U.S.A.
09:25	09:50	Keynote	Looking at experiments first: Curricular and technical approaches to teaching elementary quantum physics	Jan-Peter Meyn	Physics Institute, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany
09:50	10:15	Keynote	Quantum Optics Laboratories for Undergraduates	Mark Beck	Department of Physics, Whitman College, USA
10:15	10:40	Keynote	The Hong–Ou–Mandel interferometer: an undergraduate experience	Víctor Velázquez	Facultad de Ciencias, Universidad Nacional Autónoma de México, México

Parallel session, Session VIII: Hands-On & outreach (room AF2) — Chair: Andrew Forbes

09:00	09:15	Oral	The "LuNa" Project: experimental didactic modules exploiting portable setups to teach optics in Primary and Secondary Schools	Maria Bondani[1,2], Alessia Allevi[1], Luca Nardo[1,3] and Fabrizio Favale[1]	1- Dipartimento di Scienza e Alta Tecnologia – Università degli Studi dell'Insubria, Como, Italy 2- Istituto di Fotonica e Nanotecnologie – Consiglio Nazionale delle Ricerche, Como, Italy 3- Dipartimento di scienze della salute – Università degli Studi di Milano Bicocca,Milano, Italy
09:15	09:30	Oral	Light on the Waves – Science, music, poetry… and light!	Marta García-Matos	ICFO – The Institute of Photonic Sciences, Mediterranean Technology Park, Av. Carl Friedrich Gauss Castelldefels (Barcelona), Spain.
09:30	09:45	Oral	The Galileoscope Project: Community-Based Technology Education in Arizona	Stephen M. Pompea[1] , Leonard W. Fine[2], Constance E. Walker[1], Robert T. Sparks[1], Chuck Dugan[1] and Erin F. C. Dokter[3]	1- National Optical Astronomy Observatory 2- Science Foundation Arizona 3- The University of Arizona
09:45	10:00	Oral	Following the path of light: recovering and manipulating the information about an object	Maria Bondani[1,2], and Fabrizio Favale[1]	1- Dipartimento di Scienza e Alta Tecnologia – Università degli Studi dell'Insubria, Como, Italy 2- Istituto di Fotonica e Nanotecnologie – Consiglio Nazionale delle Ricerche, Como, Italy
10:00	10:15	Oral	The PHOTON Explorations: Sixteen Activities, Many Uses	Judith Donnelly[1], Kathryn Amatrudo[2], Kathleen Robinson[3], and Fenna Hanes[4]	1-Three Rivers Community College, New London Turnpike, Norwich, CT 2-The Optical Society of America, Washington, DC 3-SPIE, Bellingham, WA 4-New England Board of Higher Education, Boston, MA
10:15	10:30	Oral	HANDS-ON OPTICS AND PHOTONICS OUTREACH IN RIGA	Natalija Lesina, Janis Spigulis	Institute of Atomic Physics and Spectroscopy, University of Latvia, Riga, Latvia

Parallel session, Session IX: General concepts (room AF1) — Chair: Anna Consortini

09:00	09:15	Oral	Study History of Optics: Achievements of Middle Ages	S.K. Stafeev, M.G. Tomilin	St.-Petersburg National Research University of Information Technologies, Mechanics and Optics, Physics Department, St.-Petersburg, Kronverksky, Russia
09:15	09:30	Oral	Astronomical phenomena: Events with high impact factor in teaching Optics and Photonics	Dan Curticapean	Offenburg University of Applied Sciences

09:30	09:45	Oral	Towards a Research Pole in Photonics in Western Romania	Virgil-Florin Duma[1], Meda L. Negrutiu[2], Cosmin Sinescu[2], Mihai Rominu[2], Eftimie Miutescu[3], Amelia Burlea[3], Miomir Vlascici[4], Nicolae Gheorghiu[5], Octavian Cira[1], Gheorghe Hutiu[1], Corina Mnerie[1], Dorin Demian[1], Corina Marcauteanu[2], Florin Topala[2], Jannick P. Rolland[6], Ioana Voiculescu[1,7], and Adrian Gh. Podoleanu[8]	1-3OM Optomechatronics Group, Aurel Vlaicu University of Arad, Arad, Romania 2-School of Dentistry, Victor Babes Medicine and Pharmacy University of Timisoara, Timisoara, Romania 3-Arad County Emergency University Hospital, Calea Victoriei, Arad, Romania 4-S.C. Inteliform S.R.L., Calea Mosnitei, Timisoara, Romania 5-S.C. Bioclinica S.A., Cetatii Ave., Timisoara 6- Institute of Optics, University of Rochester, 275 Hutchison Rd., Rochester, NY, USA 7-City College Nanofabrication Facility, Mechanical Engineering Department, City University of New York, N.Y., USA 8-School of Physical Sciences, University of Kent, Canterbury, U.K.
09:45	10:00	Oral	The Puerto Rico Photonics Institute	Jonathan S. Friedman	Department of Environmental Sciences Universidad Metropolitana San Juan
10:00	10:15	Oral	Concept of the International Project University "Learning without boarders"	Irina Livshits, and Vladimir Vasilyev	National Research University of Information Technologies, Mechanics and Optics, Saint Petersburg, Russia
10:15	10:30	Oral	Formulation of didactic interest of the laws of refraction of light	Guadalupe Martínez[1], Ángel Luis Pérez[2], María Isabel Suero[2], Francisco L. Naranjo[2]	1- Dept. of Didactic of Experimental Sciences and Mathematics, Faculty of Education, University of Extremadura, Badajoz, Spain; 2- Dept. of Physics, Faculty of Sciences, University of Extremadura, Badajoz, Spain

Joint Special Session ETOP2013 RIAO/OPTILAS2013

Enterpreneurship in Optics & Photonics (room AC1)

11:00	12:45	Keynote	Entrepreneurship in optics and photonics session	Duncan Moore	University of Rochester, USA

Session XI: Hands-On Session (rooms AF4, AF3, AF1)

14:45	16:30	Hands-On	Hands-on Holography	Pedro Pombo	Physics Department, University of Aveiro, Portugal
14:45	16:30	Hands-On	"The magic of light!" – An entertaining optics and photonics awareness program	Carlos Florensa	ICFO-The Institute of Photonic Sciences, Mediterranean Technology Park, Spain
14:45	16:30	Hands-On	The Hands-on Optics project	Stephen M. Pompea	National Optical Astronomy Observatory, USA

14:45 16:30 **Poster Session** **(room PF1)**

N°	Title	Authors	Affiliation
1	Predicting scientific oral presentation scores in a high school photonics program	Pamela Olivia Gilchrist[1*], Eric D. Carpenter[2], Asia Gray-Battle[1], Tuere Bowles[3]	[1]The Science House, North Carolina State University, 909 Capability Dr., Raleigh, NC USA 27695 [2]Dept. Of Psychology, North Carolina State University, Box 7650, Raleigh NC USA 27695 [3]Dept. Of Leadership, Policy, and Adult Higher Education, North Carolina State University, Box 7801, Raleigh, NC USA 27695
2	Piloting a fiber optics and electronic theory curriculum with high school students	Pamela Olivia Gilchrist[1*], Brandon Conover[2], Eric Carpenter[3], Tuere Bowles[4], Asia Gray-Battle[1]	[1]The Science House, North Carolina State University, 909 Capability Dr., Raleigh, NC USA 27695 [2]Bennett Aerospace, Incorporated [3]Dept. Of Psychology, North Carolina State University, Box 7650, Raleigh NC USA 27695 [4]Dept. Of Leadership, Policy, and Adult Higher Education, North Carolina State University, Box 7801, Raleigh, NC USA 27695

3	Graduate Studies on Optoelectronics in Argentina: An experience	Fernández, Juan C.*, Garea, María T., Isaurralde, Silvia, Perez, Liliana I., Raffo, Carlos A.	Facultad de Ingeniería, Universidad de Buenos Aires Paseo Colón 850, 2º P., (C1063ACV) Ciudad de Buenos Aires, Argentina
4	ALOP-Active Learning In Optics and Photonics - A UNESCO's program spreading in Colombia through the National University.	Catalina Ramírez*, and Freddy Monroy	Universidad Nacional de Colombia
5	DIFFRACTION OPERATORS IN PARAXIAL APPROACH	William Lasso[1], Marianela Navas[2], Liz Añez[2], Romer Urdaneta[2], Leonardo Diaz*[3] and Cesar O. Torres[3]	1- Estudiante de Ingeniería de Sistemas Universidad Popular del Cesar- Valledupar- Colombia 2- Universidad del Zulia- Maracaibo – Venezuela 3- Laboratorio de Óptica e informática, Universidad Popular del Cesar- Valledupar- Colombia
6	Top Lateral Refraction and Reflection of Polarized Light in Lenses. Coplanar Lens System. Applications.	Lázaro J. Miranda Díaz	Electronic Design, Center of Technological Applications and Nuclear Development (CEADEN), Ciudad Habana, Cuba
7	Contribution from optical course for the educational guidance of engineering careers students	R. Serra Toledo[1], I. Alfonso Pérez[1], A. Moreno Yeras[1], J. J. Llovera González[1], D. Zottola Pareja[1], D. S. F Magalhães[2], J.B. Lemus Alarcón[3], and M. Muramatsu[4]	[1]Instituto Superior Politécnico José Antonio Echeverría, Habana, Cuba; [2]Universidade Estadual de Campinas, SP, Brasil; [3]Universidad Libre de Colombia, Bogotá, Colombia; [4]Instituto de Física da Universidade de São Paulo, SP, Brasil.
8	On-Light: Optical Social Network	Rogério Dionísio	UTC de Engenharia Electrotécnica e Industrial Escola Superior de Tecnologia, Instituto Politécnico de Castelo Branco, Avenida do empresário S/N, 6000-767 Castelo Branco - Portugal
9	TEACHING OPTICAL DIMENSIONAL METROLOGY OF SURFACES AND INTERNATIONAL STANDARDS	Manuel F. M. Costa	Departamento de Física da Universidade do Minho, Portugal
10	Investigating shadows. A pedagogical intervention project with primary school children	Silvana Noversaa[1]; Cátia Abreu[1]; Paulo Varela[1]; Manuel F. M. Costa[2]	1- Institute of Education, University of Minho, Campus de Gualtar, 4710-057 Braga, Portugal, 2- Centro de Física, University of Minho, Campus de Gualtar 4710-057 Braga, Portugal
11	Light. An experiments based learning approach with primary school children	Cátia Abreu[1]; Silvana Noversa[1]; Paulo Varela[1]; Manuel Filipe Costa[2]	1- Institute of Education, University of Minho, Campus de Gualtar, 4710-057 Braga, Portugal, 2- Centro de Física, University of Minho, Campus de Gualtar 4710-057 Braga, Portugal
12	Advanced experiments with an Erbium doped fiber laser	Paulo V. S. Marques, Manuel B. Marques*, and Carla C. Rosa	Faculdade de Ciências da Universidade do Porto – Departamento de Física e Astronomia, and Instituto de Engenharia de Sistemas e Computadores do Porto Rua do Campo Alegre 687, 4169-007 Porto, Portugal
13	Learning Optics using a smart-phone	Amparo Pons*, Juan Carlos Barreiro, Pascuala García-Martínez	Departament d'Òptica, Universitat de València, 46100 Burjassot (Valencia), Spain

14	Teaching methodologies to promote creativity in the professional skills related to optics knowledge	Alicia Fernández-Oliveras[1]*, Paz Fernandez[2], Antonio Peña-García[2], María Luisa Oliveras[3]	[1]Departamento de Óptica, Universidad de Granada, Spain [2]Departamento de Ingeniería Civil, Universidad de Granada, Spain [3]Departamento de Didáctica de las Matemáticas, Universidad de Granada, Spain
15	Slip-lamp management in Contact Lenses laboratory classes: learning upgrade with monitor visualization of webcam video recordings	Justo Arines, and Ana Gargallo*	Departamento de Física Aplicada (Área de Óptica), Universidad de Santiago de Compostela, Spain
16	MATLAB GUI (Graphical User Interface) for the design of GRIN components for optical systems as an educational tool	C. Bao Varela* and A. I. Gómez Varela	Grupo de Microóptica y Óptica GRIN, Facultade de Física y Facultade de Óptica y Optometría, Universidade de Santiago de Compostela, Campus Vida s/n 15782, Santiago de Compostela
17	Development of Matlab GUI Educational Software to Assist a Laboratory of Physical Optics	Elena Fernández*, Rosa Fuentes, Celia García and Inmaculada Pascual,	Departamento de Óptica, Farmacología y Anatomía Instituto Universitario de Física Aplicada a las Ciencias y las Tecnologías, Universidad de Alicante, Apartado 99, E-03080 Alicante, Spain
18	NEMO Educational Kit on Micro-Optics at the Secondary School	M.T.Flores-Arias*, and C.Bao	“Microoptis and Optis Group”, Applied Optics Department, Faculty of Physics, Campus Vida, University of Santiago de Compostela, E15701, Santiago de Compostela, Spain
19	Optics in the Physics Degree at the USC: The use of the Moodle platform	Maria Teresa Flores-Arias*	Departamento de Física Aplicada (Area de Optica), Facultade de Física, Campus Vida, Universidade de Santiago de Compostela. 15782 Santiago de Compostel
20	Master on “Photonics and Laser Technologies”: on-line teaching experience	Ángel Paredes[1], Humberto Michinel[1], Jose Ramón Salgueiro[1], Benito Vazquez-Dorrio[2], Armando Yáñez[3], Justo Arines[4], and M.Teresa Flores Arias[4]*	1- Departamento de Física Aplicada, Universidade de Vigo. Facultade de Ciencias, Campus de As Lagoas, 32004 Ourense, Spain 2- Applied Physics Department, University of Vigo, Campus Universitario, 36310 Vigo, Spain 3- Departamento de Ingeniería Industrial II. Universidade da Coruña. Escola Politécnica Superior, Campus de Esteiro s/n, 15403 Ferrol, Spain 4- Departamento de Física Aplicada (Area de Optica), Facultade de Física, Campus Vida, Universidade de Santiago de Compostela. Santiago de Compostela, Spain
21	Incorporating active-learning techniques into the photonics-related teaching in the Erasmus Mundus Master in “Color in Informatics and Media Technology”	Antonio M. Pozo*, Manuel Rubiño, Javier Hernández-Andrés, Juan Luis Nieves	Departamento de Óptica, Facultad de Ciencias, Universidad de Granada, Granada 18071, Spain
22	Measuring the image quality of digital-camera sensors by a ping-pong ball	Antonio M. Pozo*, Manuel Rubiño, José J. Castro, Carlos Salas, Francisco Pérez-Ocón	Departamento de Óptica, Facultad de Ciencias, Universidad de Granada, Granada 18071, Spain
23	A proposal on teaching methodology: cooperative learning by peer tutoring based on the case method	Antonio M. Pozo*, Juan José Durbán, Carlos Salas, Mª del Mar Lázaro	Departamento de Óptica, Facultad de Ciencias, Universidad de Granada, Granada 18071, Spain
24	Naked-eye Astronomy: Optics of the starry night skies	Salvador Bará*	Universidade de Santiago de Compostela, Optics Area, Applied Physics Dept, Faculty of Optics and Optometry, 15782 Santiago de Compostela, Galicia

25	Optics in engineering education: stimulating the interest of first-year students	Jesús Blanco-García, Benito V. Dorrío*	Applied Physics Department, University of Vigo, Campus Universitario,36310 Vigo, Spain
26	A teaching resource using the GUIDE environment: simplified model of the eye for secondary school students	A. I. Gómez-Varela[1]*, F. Salvado-Vara[2] and C. Bao-Varela[1]	1- Grupo de Microóptica y Óptica GRIN, Facultade de Física y Facultade de Óptica y Optometría, Universidade de Santiago de Compostela, Campus Vida s/n 15782, Santiago de Compostela 2- Colegio Hogar de Santa Margarita, C/ Valle-Inclán 1-3 15011, A Coruña, España
27	The USC-OSA Student Chapter: goals and benefits for the Optics community	Ana Isabel Gómez-Varela,* Ana Gargallo, Héctor González-Núñez, Tamara Delgado-García, Citlalli Almaguer-Gómez and María Teresa Flores-Arias	Departamento de Física Aplicada (Área de Óptica), Facultade de Física, Campus Vida s/n, Universidade de Santiago de Compostela, 15782 Santiago de Compostela, Spain
28	Using ray matrices to derive analytical expressions of optical aberrations	Ignacio Moreno*, Pascuala García-Martínez, Carlos Ferreira	1- Departamento de Ciencia de Materiales, Óptica y Tecnología Electrónica, Universidad Miguel Hernández de Elche, 03202 Elche (Alicante), Spain 2- Departament d'Optica, Universitat de València, 45100 Burjassot (Valencia), Spain
29	COURSE FOR UNDERGRADUATE STUDENTS: ANALYSIS OF THE RETINAL IMAGE QUALITY OF A HUMAN EYE MODEL	María del Mar Pérez*, Ana Yebra, Alicia Fernández-Oliveras, Razvan Ghinea, Ana M. Ionescu, Juan de la Cruz Cardona	Department of Optics. Faculty of Sciences. University of Granada.18071 Spain
30	Motivational activities based on previous knowledge of students	J.A. García[1], L. Gómez-Robledo[1], R. Huertas[1], and F.J. Perales[2]	1- Departmento de Óptica. Campus Fuentenueva, Faculty of Sciences, University of Granada, Granada, Spain. 2- Departamento de Didactica de las Ciencias Experimentales University of Granada, Granada, Spain.
31	"Pick it up with light!"- An Advanced Summer Program for Secondary School Students	Alejandra Valencia, S.Chaitanya Kumar*, Manoj Mathew, Giorgio Volpe, and Giovanni Volpe	ICFO-The Institute of Photonic Sciences, Mediterranean Technology Park, Av. Carl Friedrich Gauss, num. 3, 08860 Castelldefels (Barcelona), Spain
32	The design of partially coherent sources	F. Gori and M. Santarsiero*	Dipartimento di Ingegneria, Università Roma Tre Via della Vasca Navale, 84; 00146 Rome
33	Single-photon interference experiment for High Schools	Maria Bondani*	Istituto di Fotonica e Nanotecnologie – Consiglio Nazionale delle Ricerche, Como, Italy Dipartimento di Scienza e Alta Tecnologia – Università degli Studi dell'Insubria, Como, Italy
34	Scientific evaluation of an intra-curricular educational kit to foster inquiry-based learning (IBL)	Nathalie Debaes[1], Nina Cords[2], Amrita Prasad[1]*, Robert Fischer[1], Manfred Euler[2], and Hugo Thienpont[1]	1- Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium 2- Leibniz-Institut für die Pädagogik der Naturwissenschaften und Mathematik an der Universität Kiel, Olshausenstr. 62, 24098 Kiel, Germany
35	Building an Optomechatronics Group in a young university in Western Romania	Virgil-Florin Duma*, Gheorghe Hutiu, Octavian Cira, Dorin Demian, Corina Mnerie, Iosif Kaposta, Alexandru Schitea, and Marius Tuef	3OM Optomechatronics Group, Aurel Vlaicu University of Arad, 77 Revolutiei Ave., 310130 Arad, Romania

36	Expansion of student chapters in Africa: from south to north	Rim Cherif[1*], Amine Ben Salem[1], Mourad Zghal[1], Darryl Naidoo[2], Andrew Forbes[2], Alexander M. Heidt[3], and Erich .G. Rohwer[3]	[1]Engineering school of communications of Tunis; University of Carthage [2]CSIR National Laser Centre, SA [3]Laser Research Institute, University of Stellenbosch, SA
37	Active Learning in Optics and Photonics. Hands on in wave optics	Z. Ben Lakhdar, H. Ghalila*, S. Lahmar, Z. Dhouaidi, Y. Majdi	Société Tunisienne d'Optique (STO)
38	Numerical Simulation of Optically Trapped Particles	Giorgio Volpe[1] and Giovanni Volpe[2]*	1- Institut Langevin, ESPCI ParisTech, CNRS UMR7587, 1 rue Jussieu, 75005 Paris, France 2- Physics Department, Bilkent University, Cankaya, 06800 Ankara, Turkey
39	APPLICATION OF COMPUTERIZED MODELS IN THE UNIVERSITY COURSE OF OPTICS	Nishchev Konstantin N.	Mordovian State University, Russia
40	Virtual-Reality-Based Educational Laboratories in Fiber Optic Engineering	Dana Hayes, Craig Turczynski, Jonny Rice and Michael Kozhevnikov*	Department of Engineering, Norfolk State University, VA, USA
41	Development of an Optics Based Approach to Record the Acoustic Fingerprints of Molecules	F. Yehya and A.K. Chaudhary*	Advance Centre of Research in High Energy Materials, University of Hyderabad, Hyderabad-500046(A.P.), India
42	Laser Light Scattering for Investigation of Particle Size Dependency of Quality and Flavour of Coffee Samples Grown in Ethiopia	Endris Taju and A, V, Gholap*	Department of Physics, Addis Abeba University, Addis Abeba, Ethiopia
43	OPTICS EDUCATION AND TRAINING IN PAKISTAN	Imrana Ashraf*	Department of Physics, Quaid-I-Azam University, Islamabad. 45320, Pakistan
44	Diversiform and Practice-connected Class-teaching in Fourier Optics for Undergraduate Students	Yuhong Wan[1,2]*, Shiquan Tao[1,2], Zhuqing Jiang[1,2], and Dayong Wang[1,2]	1- College of Applied Sciences, Beijing University of Technology 2- Institute of Information Photonics Technology, Beijing University of Technology
45	Understanding the Fourier transform	Qian Kemao*	School of Computer Engineering, Nanyang Technological University, Singapore 639798
46	Training on the thin anti-reflection within the curriculum of the optical optometry professional license: Optique Optométrie	E.L. Ameziane*, M. Azizan, K. Hafidi	Université Cadi Ayyad Faculté des Sciences Semlalia Département de Physique, Marrakech,
47	Modulation of Optical Pulse Shape Using Electrical Signals	Vrushali V Kharat, Shrikrushna S Raut, and Kamlesh Alti*	Department of Physics, Sant Gadge Baba Amravati University, Amravati-444602
48	Sculpting of Optical Fiber: Classroom Experiment	Shrikrushna S Raut, Vrushali V Kharat and Kamlesh Alti*	Department of Physics, Sant Gadge Baba Amravati University, Amravati-444602
49	An introductory approach to the concept of spatial coherence	Marcelo Trivi	Centro de Investigaciones Ópticas, Departamento Ciencias Básicas, Facultad Ingeniería, Universidad de La Plata, Argentina

Session XII: Workshop (room AF4)

09:00	12:45	Workshop	Workshop on teaching with the galielescope	Stephen M. Pompea	National Optical Astronomy Observatory, USA

Parallel session, Session XIII: Training and laboratory demonstrations I (room AF1) Chair: Manuel Joaquim Marques

09:00	09:15	Oral	New Frontiers in Color Management by using modern Spectrometers	Oliver Vauderwange, Heinz-Hermann Wielage, Ulrich Haiss, Paul Dreßler, Dan Curticapean	Offenburg University of Applied Sciences
09:15	09:30	Oral	Teaching Optics with the centennial universal lantern	M. João Carvalhal[1], Marisa Monteiro[1], and Manuel B. Marques[2]	1- Museu de Ciência da Universidade do Porto, Reitoria da Universidade, Portugal; 2- Faculdade de Ciências da Universidade do Porto – DFA and INESC Porto, Portugal
09:30	09:45	Oral	Development of an undergraduate optics laboratory based on the analysis of digital images	A. Ramil[1], A. J. López[1], M.P. Fiorucci[1], F. Vincitorio[2]	1- Centro de Investigacións Tecnolóxicas (CIT), Universidade da Coruña, España. 2- Facultad Regional Paraná, Universidad Tecnológica Nacional, Almafuerte 1033, Paraná -Entre Ríos – Argentina
09:45	10:00	Oral	A Laboratory Module on Radiometry, Photometry and Colorimetry for an Undergraduate Optics Laboratory Course	Robert Polak	Loyola University Chicago
10:00	10:15	Oral	Pre-design and implementation of spectrometers in Peru	R. Sánchez, G. Baldwin, R. Coello	Pontificia Universidad Católica del Perú Departamento de Ciencias, Sección Física

Parallel session, Session XIV: Conceptual understanding assessment (room AF2) Chair: Joe Niemela

09:00	09:15	Oral	Lighting the way: Photonics Leaders II (PL2) optics and photonics teacher professional development	Pamela Olivia Gilchrist[1], Joyce Hilliard-Clark[1], Tuere Bowles[2], Eric Carpenter[3]	1-The Science House, North Carolina State University, 909 Capability Dr., Raleigh, NC USA 2-Dept. Of Leadership, Policy, and Adult Higher Education, North Carolina State University, Raleigh, NC USA 3-Dept. Of Psychology, North Carolina State University, Raleigh NC USA
09:15	09:30	Oral	Student Reactions to Problem-Based Learning in Photonics Technician Education	Nicholas Massa[1],Judith Donnelly[2] and Fenna Hanes[3]	1- Springfield Technical Community College, One Armory Square, Springfield, MA 2- Three Rivers Community College, 7 Mahan Drive, Norwich, CT 3- New England Board of Higher Education, 45 Temple Place, Boston, MA
09:30	09:45	Oral	Light & Optics Conceptual Evaluation Findings From First Year Optometry Students	Damber Thapa[1] and Vasudevan Lakshminarayanan[1,2,3]	1- School of Optometry and Vision Science, 2- Department of Physics, 3- Department of Electrical & Computer Engineering, University of Waterloo, Waterloo, Ontario, Canada.
09:45	10:00	Oral	Misconceptions about optics: an effect of misleading explanations?	Favale F.[1] and Bondani M.[1,2]	1- Dipartimento di Scienza e Alta Tecnologia – Università degli Studi dell'Insubria, Como, Italy 2- Istituto di Fotonica e Nanotecnologie – CNR, Como, Italy
10:00	10:15	Oral	Active learning in optics & photonics: sustaining its benefits	Minella C. Alarcon*, Ivan B. Culaba, Patricio T. Dailisan, Nofel DLC. Lagrosas, Joel T. Maquiling	Department of Physics, School of Science and Engineering, Ateneo de Manila University, Quezon City, Philippines 1108

			Parallel session, Session XV: Computer assisted learning I (room AF3)	Chair: Alan Shore	
09:00	09:15	Oral	Learning about light and optics in on-line general education classes using at-home experimentation	Mark F. Masters, Jacob Millspaw, and Gang Wang	Department of Physics Indiana University Purdue University Fort Wayne (IPFW) Fort Wayne IN, USA
09:15	09:30	Oral	An internet-based, post-graduate course in Spectacle Lens Design.	Mo Jalie	University of Ulster
09:30	09:45	Oral	HoloNet: a network for training holography	Pedro Pombo[1,2], and Emanuel Santos[1]	1- Physics Department, University of Aveiro 2- Fábrica Ciência Viva Science Center
09:45	10:00	Oral	Interdisciplinary Education in Optics and Photonics based on Microcontrollers	Heinz-Hermann Wielage, Oliver Vauderwange, Ulrich Haiss, Paul Dreßler, and Dan Curticapean*	Offenburg University of Applied Sciences
10:00	10:15	Oral	Laws of Reflection and Snell's Law revisited by Video Modeling	M. Rodrigues[1,2] , and P. Simeão Carvalho[2,3]	1- Middle and High School Rodrigues de Freitas, Porto, Portugal 2- IFIMUP, University of Porto, Rua do Campo Alegre s/n, Porto, Portugal 3- Department of Physics and Astronomy, Faculty of Sciencies, University of Porto, Rua do Campo Alegre s/n, Porto, Portugal
10:15	10:30	Oral	A correlation of thin lens approximation to thick lens design by using context based method in optics education	O. Faruk FARSAKOGLU[1], Ipek ATIK[2], Hikmet KOCABAS[3]	1,2- Kilis 7 Aralik University, Faculty of Engineering and Architecture, Electrical Electronics Engineering Department, Kilis, Turkey 3- İstanbul Technical University. Faculty of Mechanical Engineering, CAD CAM Center, Gumussuyu, Istanbul, Turkey
			Session XVI: Invited Session (room AF1)	Chair: Vanderlei Bagnato	
11:00	11:25	Keynote	Advantages and disadvantages of using computers in education and research	Anna Consortini	Universita' degli Studi di Firenze Dipartimento di Fisica e Astronomia, Italy
11:25	11:50	Keynote	m-Learning and holography: compatible techniques?	Maria L. Calvo	Departamento de Óptica, Facultad de Ciencias Físicas, Universidad Complutense de Madrid (UCM), Spain
11:50	12:15	Keynote	Phase derivative estimation in digital holographic interferometry	Pramod Rastogi	Swiss Federal Institute of echnology Lausanne, Switzerland
12:15	12:40	Keynote	Photonics And Scientoonics: We Can Create A New Light	Pradeep K. Srivastava	Council of Scientific & Industrial Research, India
12:40	13:05	Keynote	Evolution of the Centre for Optical and Laser Engineering in Singapore	Anand Asundi	COLE, Nanyang Technological University Singapore
			Session XVII: Invited Session (room AF1)	Chair: Angela M. Guzmán	
14:45	15:10	Keynote	Developing The Critical Thinking, Creativity And Innovation Skills Of Undergraduate Students	Barry L. Shoop	Department of Electrical Engineering and Computer Science U.S. Military Academy West Point, New York, USA
15:10	15:35	Keynote	CApability Matrix for Photonics Up-Skilling – CAMPUS	Alan Shore,	Photonics Academy of Wales, Bangor University, School of Electronic Engineering, Bangor, Wales, UK
15:35	16:00	Keynote	Hands-On Physics Displays for Undergraduates	Carl W. Akerlof	Physics Department, University of Michigan, Ann Arbor, Michigan, USA
16:00	16:25	Keynote	Hands-on optics for active and cooperative learning	Jose Benito Vazquez Dorrío	University of Vigo, Spain

Session XVIII: Hands-On Session (room AF4)

17:00	18:45	Hands-On	Student Activity : Verification on Malus's Law of Polarization at low cost	Shahrul Kadri	Photonics Laboratory, Faculty of Science and Technology, Universiti Pendidikan Sultan Idris, Malaysa

Parallel session, Session XIX: Training and laboratory demonstrations II (room AF1) Chair: Dan Curticapean

17:00	17:15	Oral	Learning to teach Optics through experiments and demonstrations	Jesús Lancis, Mercedes Fernández-Alonso, Lluís Martínez-León, Enrique Tajahuerce, and Gladys Mínguez-Vega	Physics Department / Institute of New Imaging Technologies, Universitat Jaume I, Castelló de la Plana, SPAIN
17:15	17:30	Oral	Multicolour LEDs in Educational Demonstrations of Physics and Optometry	Paulis Paulins[1], and Maris Ozolinsh[2]	1- Faculty Physics and Mathematics, University of Latvia, Riga, Latvia 2- Institute of Solid State Physics University of Latvia, Riga, Latvia
17:30	17:45	Oral	Laser Spectroscopy Education and Development in Biophotonics Research at Nairobi	K. H. Angeyo, A. Dehayem-Massop and K. A. Kaduki.	Department of Physics, University of Nairobi, Nairobi, Kenya.
17:45	18:00	Oral	Visualization of light beams in liquid crystal layers for demonstration of basic optical phenomena.	Pasechnik S.V., and Shmeliova D.V.	Moscow State University of Instrument Engineering and Computer Science, Moscow, Russia
18:00	18:15	Oral	Optical demonstrations with spatial light modulators	Andrew Forbes	1-CSIR National Laser Centre, South Africa; 2-Stellenbosch University, South Africa; 3-School of Physics, University of KwaZulu-Natal, South Africa
18:15	18:30	Oral	Variable retarders by modified twisted nematic liquid crystal keychain for education purpose	D.Prapertchob, and R. Chitaree	Department of Physics, Faculty of Science, Mahidol University, Bangkok, Thailand

Parallel session, Session XX: Computer assisted learning II (room AF2) Chair: Paulo Simeão

17:00	17:15	Oral	Learning in the cloud: A new challenge for a global teaching system in optics and photonics	Andreas Christ[1], Markus Feisst[2], Razia Sultana[1], and Dan Curticapean[1]	1- University of Applied Sciences Offenburg, Germany 2-University of Nottingham, UK
17:15	17:30	Oral	Web based interactive educational software introducing semiconductor laser dynamics: Sound Of Lasers (SOL)	Antonio Consoli, Jorge Rodero Sanchez, Paloma R. Horche and Ignacio Esquivias	ETSI Telecomunicación - Universidad Politécnica de Madrid, Spain
17:30	17:45	Oral	Design, development, testing and validation of a Photonics Virtual Laboratory for the study of LEDs	Francisco L. Naranjo[1], Guadalupe Martínez[2], Ángel Luis Pérez[1], and Pedro J. Pardo[3]	1- Dept. of Physics, Faculty of Sciences, University of Extremadura, Avda. de Elvas s/n, Badajoz, Spain; 2- Dept. of Didactic of Experimental Sciences and Mathematics, Faculty of Education, University of Extremadura, Badajoz, Spain; 3- Dept. of Computer and Networks Systems Engineering, Merida University Center, University of Extremadura, C/ Santa Teresa de Jornet, Spain
17:45	18:00	Oral	Graphical User Interfaces for Teaching and Research in Optical Communications	Telmo Almeida, Rogério Nogueira, and Paulo André	Instituto de Telecomunicações, Campus Universitário de Santiago, Aveiro, Portugal, and Departamento de Física, Universidade de Aveiro, Campus Universitário de Santiago, Aveiro, Portugal
18:00	18:15	Oral	Diversity of devices along with diversity of data formats as a new challenge in global teaching and learning system	Andreas Christ[1], Patrick Meyrueis[2], and Razia Sultana[1]	1- University of Applied Sciences Offenburg, Germany 2- Strasbourg University, France

Session XXI: Workshop (room AF4)

09:00	12:45	Workshop	Active Learning in Optics workshop	Souad Lahmar* and Vasudevan Lakshminarayanan**	*Optical Society of Tunisia, Tunisia **University of Waterloo, Canada

Session XXII: Curriculum development (room AF1) Chair: Cristina Elizabeth Solano Soza

09:00	09:15	Oral	Integrating Undergraduate Research into the Electro-Optics Program	Andrew Feng Zhou	Physics Department, Indiana University of Pennsylvania
09:15	09:30	Oral	Interdisciplinary High-School Curriculum in Electro-Optics as a Tool to Enhance Students' Interest in Optics and Electronics	Aharon Gero, and Efrat Zach	Department of Education in Technology and Science, Technion - Israel Institute of Technology, Haifa, Israel
09:30	09:45	Oral	Advanced Optics in an Interdisciplinary Graduate Programme	Síle Nic Chormaic	Light-Matter Interactions Unit, OIST Graduate University, Onna-son, Japan
09:45	10:00	Oral	Photonics and Holography through Delight and Enthusiasm Itinerary of Discovery	M.Grosmann, D.Kayser	ADEPHOT L.Pasteur University Strasbourg, France
10:00	10:15	Oral	Optics and Communication Technology Major of Physics Undergraduate Degree at King Mongkut's Institute of Technology Ladkrabang	Prathan Buranasiri	King Mongkut's Institute of Technology Ladkrabang, Physics Department, Faculty of Science, Lat Krabang Bangkok, Thailand

Session XXIII: Training in collaboration with industry (room AF2) Chair: Pedro Pombo

09:00	09:15	Oral	DEFI Photonique : a French national training project for optics and photonics industry	E. Boeri[1,3], and E.Cormier[1,2]	1- PYLA platform, 2- Bordeaux University, 3- French Cluster « Route des Lasers » Bordeaux, France
09:15	09:30	Oral	Getting Light to Work – photonics upskilling for industry	Ray Davies, and K. Alan Shore	Photonics Academy of Wales @ Bangor Bangor University, School of Electronic Engineering, Bangor, Wales, UK
09:30	09:45	Oral	MSc degree in Color Technology for the Automotive Sector	Francisco M. Martínez-Verdú, Esther Perales, Elisabet Chorro, and Valentín Viqueira	Color & Vision Group, University Institute of Physics Applied to Sciences and Technologies, University of Alicante, Spain
09:45	10:00	Oral	ANSI Laser Standards, Education (Z136.5), Research & Development (Z136.8)	Ken Barat	Lawrence Berkeley National Laboratory, USA
10:00	10:15	Oral	Optical inspection methods and their applications in the manufactured industrial sector: Knowledge transfer to Panamanian industry	Abdiel O. Pino[1], Josep Pladellorens [2]	1- Natural Sciences Department, Technological University of Panama, Technological University of Panama Avenue, Betania, Panama, 2- CD6 Optics and Optometry Department, Polytechnic University of Catalonia Rambla de Sant Nebridi 10, Terrassa, Spain

			Session XXIV: Invited Session (room AF1)	Chair: Maria L. Calvo	
11:00	11:25	Keynote	Using Concept Building in Optics to Improve student Research Skills	Mark F. Masters	Department of Physics, Indiana University Purdue University Fort Wayne (IPFW) Fort Wayne IN, USA
11:25	11:50	Keynote	A course on Foundations of Optical System Analysis and Design (FOSAD)	Lakshminarayan Hazra	Department of Applied Optics and Photonics University of Calcutta, India
11:50	12:15	Keynote	Calculation of reflected and transmitted powers of a metamaterial waveguide structure using MAPLE software	Mohammed M. Shabat	Department of Physics, Faculty of Science, Islamic University of Gaza, Palestinian Authority
			Joint Special Session ETOP2013 RIAO/OPTILAS2013 **Women & Optics (room AC1)**	Chair: Maria J. Yzuel	
14:45	16:30	Keynote	Women in Science session	Maria J. Yzuel	Universidad Autónoma de Barcelona, Spain

Critical Issues Facing Physics Education: Participation, Engagement, and Relevance

Theodore Hodapp

American Physics Society, USA

Advances in physics education have made remarkable progress over the past few decades in improving student learning, increasing retention, and understanding how the classroom environment impacts how different groups succeed in learning physics. In the United States, as elsewhere, there remain significant challenges including low participation by women and some racial/ethnic groups, few well-trained secondary education teachers, and deterioration of attitudes about physics as a result of introductory courses we reinforce a dislike for physics partly by the way we teach the subject. This presentation will discuss current data on these issues, and review current research and programs that have made significant progress on addressing these and related issues.

First Optical Education Center in Japan, Established by Cooperation between Academia and Industry

Toyohiko Yatagai

Center for Optical Research and Education, Utsunomiya University

At the present of the 21st century, optical technology became what must be in our life. If there is no optical technology, we cannot use optical equipments such as the camera, microscopes, DVD, LEDs and laser diodes (LDs). Optics is also the leading part in the most advanced scientific field. It is clear that the organization which does education and research is required in such a very important area. Unfortunately, there was no such organization in Japan. The education and research of light have been individually done in various faculties of universities, various research institutes, and many companies. However, our country is now placed in severer surroundings, such as the globalization of our living, the accelerated competition in research and development. This is one of the reasons why Utsunomiya University has established Center for Optical Research and Education (CORE) in 2007. To contribute to optical technology and further development of optical industry, "Center for Optical Research and Education (CORE), Utsunomiya University" promotes education and research in the field of the optical science and technology cooperatively with industry, academia and the government. Currently, 6 full professors, 21 cooperative professors, 2 visiting professors and 7 post-doctoral researchers and about 40 students are joined with CORE. Many research projects with industries, the local government of Tochigi as well as Japanese government. Optical Innovation Center has established in CORE by supporting of Japan Science and Technology Agency in 2011 to develop advanced optical technologies for local companies.

The High Education of Optical Engineering in East China

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The history and the development of the high education in the field of optical engineering in the area of East China will be presented in the paper. The overall situation of research and human resource training in optics and photonics will also be reviewed; it shows that China needs lots of talents and experts in this field to support the world optical industry in East China.

UNESCO's ALOP recognized for IGIP International Engineering Educator certification

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We face a great challenge on disseminating the Active Learning in Optics and Photonics (ALOP) workshops in Central America, where Physics as a discipline is weak, but Engineering schools have a long tradition, as well as a large impact in the society. In search for better channels to spread the UNESCO initiative in Central America and the Caribbean, A. Guzmán --the UNESCO coordinator for ALOP in Latin America -- decided to partner with the Latin American and Caribbean Consortium of Engineering Institutions (LACCEI, see www.laccei.org), in the organization of ALOP co-located with the LACCEI annual conference that attracts engineers from all countries in the region. LACCEI has been approved by IGIP, the International Gesellschaft für Ingenieurpädagogik (see www.igip.org), to offer courses that count toward the IGIP's International Engineering Educator Certification (ING-PAED IGIP, see http://www.igip.org/pages/aboutigip/ing-paed.html). The ING-PAED IGIP certification is open to teachers and professors who have taught for at least one year in an engineering program, including those that teach sciences, mathematics and technology in support of the program, and who complete the required modules in institutions accredited by IGIP. LACCEI obtained approval for UNESCO's ALOP to count as an IGIP module in Laboratory Methodology within the Engineering Pedagogy Curriculum. Two ALOP Workshops have been conducted during LACCEI conferences (Perú and Colombia), with plans to offer it annually. In this way, optics and active learning are now part of a curriculum leading to a certification as International Engineering Educator. The ING-PAED IGIP credits transfer towards a EUR ING diploma.

Developing intra-curricular photonics educational material for secondary schools in Europe

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There is an imminent shortage of skilled workforce facing Europe's hi-tech industries mainly due to the declining interest of young people in science and engineering careers. To avert this trend the EU funded the development of the 'Photonics Explorer' – an intra-curricular educational kit designed to engage, excite and educate students about the fascination of working with optics hands-on, in their own classrooms! Each kit equips teachers with class sets of experimental components provided within a supporting didactic framework based on guided inquiry based learning techniques. The material has been specifically designed to integrate into the curriculum and enhance and complement the teaching and learning of science in the classroom. The kits are provided free of charge to teachers, in conjunction with teacher training courses. The main challenge of this program was the development of educational material that seamlessly integrates into the various national curricula across Europe. To achieve this, the development process included a preparatory EU wide curricula survey and a special 'Review and Revise' process bringing together the expertise of over 35 teachers and pedagogic experts. This paper reports on the results of the preparatory study which identified two specific age groups at secondary schools for photonics educational material, the didactic content of the Photonics Explorer kit resulting from a pan-European collaboration of key stakeholders, EU wide dissemination and sustainability of the program.

Dihedral Fourier Analysis

Marlos Viana

University of Illinois at Chicago Eye Center Chicago, Illinois, USA

The objective of this tutorial is offering an introduction to the analytic methods and applications of Fourier analysis over the dihedral groups. The topics to be discussed include: Classical commutative harmonic analysis and its role in optics and vision studies; Experimental results indexed by dihedral symmetries (rotations and reversals); Dihedral orbits, arbitrariness, and orbit invariants; Resolution of orbit arbitrariness; Dihedral representations and irreducible characters (overview); Classical Fourier analysis and Fourier analysis over a finite group; Determination and interpretation of the orbit invariants as Fourier transforms; Statistical and probabilistic interpretations; Decompositions of total intensities; Canonical projections. The applications to be discussed include: The analysis of curvature and power surfaces for vision models; Polarimetric-enhanced retinal imaging methods; Dihedral polynomial methods for wave-front aberration analysis; Visual field decompositions; Symmetry perception studies. The theory and methods of dihedral analysis can be applied in studies of symbolic sequences in structural biology, vibrational spectroscopy, experimental designs in statistical inference, and several other fields, so that the tutorial is of potential interest to students and professional in physics in general, applied mathematics (algebra in particular), and statistics. Therefore, the broader objective of the tutorial is developing a reciprocal understanding of these disciplines (optics, algebra and statistics) leading to an effective collaboration among scientists in these fields.

Viana, M. *Symmetry Studies*, Cambridge Press, New York, NY (2005)
Viana, M. and Lakhsminarayanan, V. *Dihedral Fourier Analysis*, Springer Lecture Notes in Statistics No. 206, Springer, New York, NY.

The Evolution of Optics Education at the U.S. National Optical Astronomy Observatory

Stephen M. Pompea, Constance E. Walker, and Robert T. Sparks

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The last decade of optics education at the U.S. National Optical Astronomy Observatory will be described in terms of program planning, assessment of community needs, identification of networks and strategic partners, the establishment of specific program

goals and objectives, and program metrics and evaluation. A number of NOAO's optics education programs for formal and informal audiences will be described, including our Hands-On Optics program, illumination engineering/dark skies energy education programs, afterschool programs, adaptive optics education program, student outreach, and Galileoscope program. Particular emphasis will be placed on techniques for funding and sustaining high-quality programs. The use of educational gap analysis to identify the key needs of the formal and informal educational systems will be emphasized as a technique that has helped us to maximize our educational program effectiveness locally, regionally, nationally, and in Chile.

Adaptive optics

Vasudevan Lakshminarayanan

University of Waterloo, Canada

Adaptive optics is a powerful technique to sharpen images that are blurred for example due to atmospheric turbulence or aberrations of the eye. Originally developed for defence applications over a period of 40 years or so, they have found enormous applications in the astronomical and vision research communities. In this talk I will provide an overview of adaptive optics techniques and applications.

Image Science in the Optics and Photonics Curriculum

Bahaa E. A. Saleh,

Dean CREOL, The College of Optics and Photonics, University of Central Florida, Orlando, FL, USA

Image formation has been a core component of optics long before the laser was invented and the word photonics was coined. Optical instruments such as cameras, telescopes, and microscopes, which are standard entries in the optics textbook classics, have motivated lens design engineers for many decades. With the development of new technologies such as laser scanning, LED and optical fiber illumination, LCD displays, CCD detectors and multi-spectral sensors, and MEMs devices for adaptive optics, the imaging technology has undergone a great transformation. New paradigms for image formation, including 3D and 4D imaging, have emerged: holography (optical and digital) and lensless imaging, diffraction tomography, computational imaging, optical coherence tomography, and hyperspectral imaging. With nonlinear optics techniques such as stimulated emission-depletion, and with powerful signal processing tools, super-resolved image formation has become a reality and the sacred Abbe resolution limit has been surpassed. Imaging instruments that cover the electromagnetic spectrum, from THz to X-rays, are now commercially available. Applications are broad: medical, biological, geophysical, environmental, and industrial. Although some of these topics are taught in various courses in science and engineering programs, it is rare to see a single course devoted to a systematic presentation of image science and engineering in its full breadth, but with a set of unified underlying principles. In this talk, I will present the basic structure and underlying principles of such a course.

Inspiring future experimental scientists through questions related to colour

Manuel Melgosa[1], Mark D. Fairchild[2]

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In general, it can be stated that unfortunately in most countries the number of students interested in traditional scientific disciplines (e.g. physics, chemistry, biology, mathematics, etc.) for his/her future professional careers has considerably decreased during the past years. It is likely that among the reasons of this trend we can find that many students feel that these disciplines are particularly difficult, complex, abstract, and even boring, while they consider applied sciences (e.g. engineering) as much more attractive options to them. Here we aim to attract people of very different ages to traditional scientific disciplines, and promote scientific knowledge, using a set of colour questions related to everyday experiences. From our answers to these questions we hope that people can understand and learn science in a rigorous, relaxed and amusing way, and hopefully they will be inspired to continue exploring on their own. Examples of such colour questions can be found at the free website http://whyiscolor.org from Mark D. Fairchild. For a wider dissemination, most contents of the website have been recently translated into Spanish language by the authors, and published in the book entitled "La tienda de las curiosidades sobre el color" (ISBN: 9788433853820). Colour is certainly multidisciplinary, and while it can be said that it is mainly a perception, optics is a key discipline to understand colour stimuli and phenomena. The classical first approach in colour science as the result of the interaction of light, objects, and the human visual system will be also reviewed.

An Educational Kit in optics for broad use

Vanderlei S. Bagnato

Instituto de Física de São Carlos - USP – Brazil

With the purpose to provide a better educational tool in optics, we have produced a KIT composed of light source and many component that allow the demonstration of the main laws of optics. The basic principle of the set is based on the projection of rays in a white paper and the observation of the rays as they interact with a variety of optical components. The first part constitutes the study of reflection and refraction including up to 66 possible experiments, from the basic laws up to demonstrations of optical instruments. The second part is composed of physic optics including diffraction, interference, determination of light wavelength, principle of spectroscopy and many others . The kits were produced within the economic reality to be available for a broad part of the students of Brazil. The idea is to complement the formal education, providing a vast opportunity of experimentation at home and at the classroom. During this presentation we shall provide a demonstration of the experiments composed in this educational optics kit and how the Brazilian Government is taking action towards the implementation of a massive science education.

This work is carried on together with a group of Brazilian scientists within a program named Science Adventures in collaboration with CAPES (Moyses Nussenzweig, Mayana Zatz, Eliana B. Dessen, Henrique E. Toma, Beatriz Barbuy , Eduardo Colli and Carlos H. Brito Cruz).

Shedding the light on spectrophotometry: The SpecUP educational spectrophotometer

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Students often regard laboratory instruments as “black boxes” which generate results, without understanding their principles of operation. This is a concern, as the correct interpretation of analytical results and the limitations thereof is invariably based on an understanding of the mechanism of measurement. Moreover, a number of tertiary institutions in Africa have very limited resources and access to laboratory equipment, including that related to the field of photonics, which prevents students from getting hands-on practical experience. This paper addresses both of these challenges, by allowing students to assemble a low cost spectrophotometer, called the SpecUP, which is then used in a range of chemistry-related experiments. Students can vary instrumental parameters to observe the effects these changes have on their experimental results. The SpecUP costs less than 50 euro to build, as compared to ~3 000 euro for commercial systems. Results obtained using the SpecUP in three applied chemistry experiments will be presented and demonstrated by means of videos.

Outreach activities in Guanajuato México

Cristina Solano, Antonio Campos y Eleonor León

Outreach Coordination, Centro de Investigaciones en Óptica (CIO), León, Guanajuato, Mexico

The Optics Research Center, CIO, has included the science outreach activities in its institutional objectives, with the purpose to increase the scientific and technological culture between young students and the general public. The outreach activities are organized to include groups with different interest within the society. For scholar groups, primary and high school, we have organized a Science Museum, where the main principles and application of optics, are shown. To promote recurrent visits to our center, once a year we organized special exhibitions with optics related themes. To increase the interest in science we started with a Science Club for kids and teenagers, for students from 5 to 15 years old with monthly sessions. It is attended by about 60 students where different subjects are discussed, in these sessions the students received a brief explanation and perform different activities. We emphasized the hands on experience with experiments that they can take home and share with their peers. The coverage of these workshops has been extended to many schools within the state by training social service students and teachers to give the workshops. We have found that people are really interested in astronomy and the astronomical observations can help to attract different public toward science. We include scientific talks and workshops during these activities. For other parts of the population we organize competitions as scientific graffiti, light sculpture, video experiments, etc. Our experience has shows us that there are many ways to teach science and that any effort is enough to change the perception in science and technology, therefore a continuous innovation is necessary to maintain interest between the students.

UNESCO Active Learning approach in Optics and Photonics leads to significant change in Morocco

Khalid Berrada

Cadi Ayyad University – Faculty of Sciences Semlalia, Department of Physics, BP: 2390 – Marrakech Morocco

There are many difficulties in teaching science and technology in developing countries. Many different teaching strategies have to be applied in these cases. More specifically, for developing countries competencies in teaching science in the introductory classroom has attracted much attention. As a specific example we will consider the Moroccan system. In most developing countries everything is moving so slowly that the progress stays static for development. Also the change creates trouble for people since it needs time, effort and engagement. In our case we discovered that many teachers feel uncomfortable when introducing new teaching methods and evaluation in classes at introductory physics. However introduction of an Active Learning in our curricula shows us how students have difficulties in understanding physics and especially concepts. Students were interested in having Active Learning courses much more than passive and traditional ways. Changing believes on physical phenomena and reality of the world students become more attractive and their way of thinking Science changed. The main philosophy of fostering modern hands-on learning techniques -adapted to local needs and availability of teaching resources- is elaborated. The Active Learning program provides the teachers with a conceptual evaluation instrument, drawn from relevant physics education research, giving teachers an important tool to measure student learning. We will try to describe the UNESCO Chair project in physics[1] created in 2010 at Cadi Ayyad University since our first experience with Unesco ALOP[2] program. Many efforts have been done so far and the project helps now to develop more national and international collaborations between universities and Regional Academies of Education and Training. As a new result of these actions and according to our local needs, the translation of the ALOP program into Arabic is now available under the auspice of Unesco and encouragement of international partners SPIE, ICTP, ICO and OSA.

[1]http://www.unesco.org/fr/university-twinning-and-networking/access-by-region/arab-states/morocco/unesco-chair-in-physics-904/
[2] Active Learning in Optics and Photonics

Workshop on Problem Based Learning (PBL)

Submarine Lighting: A PBL Challenge in Fiber Optics

Judith Donnelly

Three Rivers Community Technical College

How would you design an ergonomic and energy efficient system for lighting a submarine interior workstation?

This PBL Industry Challenge is used to illustrate the innovative teaching approach of Problem Based Learning. The workshop, conducted by an instructor experienced in PBL, will give participants the opportunity to assume the role of student and to use the PBL *Engineer's Problem Solving Toolbox.* Using this approach, participants can see how PBL works to facilitate learning in students of optics/photonics engineering. Attendees will be provided with classroom implementation strategies, Challenge passwords and resources needed to use field-tested Problem Based Learning Challenges in their own classrooms. Problem Based Learning has reached enormous popularity all over the world as evidenced by UNESCO's establishment of a PBL Chair. It has been shown to be an effective framework for educating engineers and scientists capable of solving complex tasks in a collaborative framework. Attend this workshop to learn valuable tips on how to apply this method to the teaching of optics and photonics.

Photonics Explorer Workshop

Amrita Prasad

Vrije Universiteit Brussel, Brussels, Belgium

The Photonics Explorer is an intra-curricular educational kit developed in a European project with a pan-European collaboration of over 35 teachers and science education professors. Unlike conventional educational outreach kits, the Photonics Explorer is specifically designed to integrate seamlessly in school curricula and enhance and complement the teaching and learning of science and optics in the classroom. The kit equips teachers with class sets of experimental components, provided within a supporting didactic framework and is designed for lower and upper secondary students (12-18 years). The kit is provided completely free of charge to teachers in conjunction with teacher training courses. The workshop will provide an overview of the Photonics Explorer intra-curricular kit and give teachers the opportunity to work hands-on with the material and didactic content of two modules, 'Light Signals' (lower secondary) and 'Diffraction and Interference'(upper secondary). We also aim to receive feedback regarding the content, components and didactic framework from teachers from non-European countries, to understand the relevance of the kit for their teaching and the ability for such a kit to integrate into non-EU curricula.

Single-photon laboratories to rethink how we quantum mechanics

Enrique J. Galvez

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Quantum optics experiments with single photons can be used to teach the fundamentals of quantum mechanics and of light itself. Key ingredients: a pump laser, a crystal, single-photon detectors, and data acquisition systems, are now more affordable than ever. Optical equipment that fits on an optical breadboard can be set up to steer the light from a blue laser pointer onto a commercially available crystal to produce photon pairs via spontaneous parametric down-conversion. Educational-grade single-photon detectors, now very affordable, in conjunction with low-cost FPGA-based electronics allow the detection of photon events that can only be explained by quantum mechanical arguments. This allows simple optical arrangements to become laboratories that test fundamental principles of quantum mechanics that until recently were relegated to back-chapters of textbooks, or as mere curiosities of an effective quantum theory. With these experiments, fundamental tenets of quantum mechanics, such as superposition, entanglement and determinism, can be brought up to the forefront of the discussion. A linear-optical treatment of optical elements yields vivid applications of quantum-mechanical operations, and an entry into experimental quantum information. On the fundamental side, experiments can be set up to understand fundamental non-intuitive questions that essential philosophical aspects of the theory, and bring topics such as delayed choice, non-locality and Bell inequalities to a central level in teaching quantum mechanics or quantum optics.

Looking at experiments first: Curricular and technical approaches to teaching elementary quantum physics

Jan-Peter Meyn

Physics Institute, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

Teaching quantum physics should be based on genuine quantum phenomena which are not expected in classical physics. Quantum optical experiments for advanced student laboratories have been developed by several research groups and have become a methodologically sound teaching method. Simplified optical components allow for experiments in a lecture hall or classroom. The option to show quantum phenomena as the origin of teaching opens up a new curricular path. Our approach is to comprehend quantum optics as a natural extension of classical optics by introducing the temporal relation of certain detector signals. Quantum physics appear as an extension of continuing valid physics rather than as a complete new world like in the case of mechanics, where fundamental concepts like the particle path have to be abandoned.

Quantum Optics Laboratories for Undergraduates

Mark Beck

Department of Physics, Whitman College, USA

We have developed as series of undergraduate teaching laboratories that explore some of the fundamentals of quantum mechanics. All of the experiments involve performing measurements on individual photons, or entangled-photon pairs. The experiments include: "Proving" that light consists of photons, single-photon interference, and tests of local realism. I will describe the experiments, and also describe how we have integrated the experiments with our upper-level undergraduate quantum mechanics course.

The Hong–Ou–Mandel interferometer: an undergraduate experience.

Víctor Velázquez[1], Jorge Cravioto-Lagos[1], Gustavo Armendáriz[1], Enrique López-Moreno[1], M Grether[1] and E J Galvez[2]

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The Hong–Ou–Mandel interferometer is an optical device that allows us to prove the quantum nature of light experimentally via the quantum amplitude superposition of two indistinguishable photons. We have implemented this experiment as an advanced undergraduate laboratory experience. We were able to overcome well-known difficulties using techniques reported recently [1,2]. This experiment represents a discussion tool in the teaching of quantum mechanics.

1. Thomas et al. Rev. Sci. Instrum. 80 036101 (2009).
2. Jorge Cravioto-Lagos et al. Eur. J. Phys. 33 (2012) 1843–1850

The "LuNa" Project: experimental didactic modules exploiting portable setups to teach optics in Primary and Secondary Schools

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[c]Dipartimento di scienze della salute – Università degli Studi di Milano Bicocca,Milano, Italy

The "LuNa" (La natura della Luce nella luce della Natura – The nature of Light in the light of Nature) Project is devoted to the experimental teaching of optics in the different school grades.The Project has been financed by both private and public sponsors in the years 2009 and 2010 that supported the acquisition of the experimental equipment. The Project has involved about 200 classes (more than 4000 students till now. The basic idea of the Project is that the history of optics and the debate about the nature of light are a meaningful example of how science proceeds in the development of a physical model. Moreover optical phenomena can be presented at different levels of complexity in order to be accessible to students of different age. The core of the Project are several portable setups that support experimental and partially interactive lectures that cover all the aspects of optical phenomena, from geometrical optics to single-photon interference passing through atmospheric optics, spectroscopy, holography and theory of perception. When possible, the setups are realized with simple and easy to find materials so as to be reproducible for teachers and students. Of course, for the most complicated setups (interferometers and holography) research materials are used. Each module is calibrated to fit teachers' requirements either to be included in the curricula of their classes or to be used as an expansion of the optics program.

Light on the Waves – Science, music, poetry… and light!

Marta García-Matos

ICFO – The Institute of Photonic Sciences, Mediterranean Technology Park, Av. Carl Friedrich Gauss 3 08860 Castelldefels (Barcelona), Spain.

"Light on the waves" is a literary contest-with a very special prize- launched by ICFO to promote the interplay of science, poetry and music. The contest was aimed at high-school students at centers across **Catalonia**. The results were beyond our expectations, and we would like to have the opportunity to share the experience with the outreach community in ETOP 2013.We are launching a new edition this year, in which teachers are also welcome to participate.Students were invited to submit science fiction texts inspired by light. We received contributions ranging from short stories, to philosophical essays, to poems about the double-slit experiment. The ten winning selections were given to musical groups around Barcelona to compose a song inspired by these lyrics. A CD was recorded with the songs and a concert was celebrated at Barcelona. The objectives were twofold: To raise awareness of photonics among secondary students and their teachers, and to explore the capacity of humanities in science teaching and outreach. We are ready to present a detailed account of the activity, with data on participation; impact; (crucial) involvement of other institutions of the city; and feedback from teachers, musicians, and students. We are also preparing a documentary about the process. "Light on the waves" is still resonating in Barcelona: On March 15 and 16 we are presenting at Kosmopolis, a prestigious literary fest-this year devoted to science and literature- a couple of events about our program: Around table and a small concert, to be included in our contribution to ETOP, provided this submission is successful.

The Galileoscope Project: Community-Based Technology Education in Arizona

Stephen M. Pompea (National Optical Astronomy Observatory)

Leonard W. Fine (Science Foundation Arizona)

Constance E. Walker, Robert T. Sparks, and Chuck Dugan) National Optical Astronomy Observatory)

Erin F. C. Dokter (The University of Arizona)

A program model has been developed and implemented over the last three years to provide a robust optical technology-based science education program to students aged 9-11 years (5th grade),a formative time in the development of a student's interest in science and engineering. We have created well-tested and evaluated teaching kits for the classroom to teach about the basics of image formation and telescopes. In addition we provide professional development to the teachers of these students on principle of optics and on using the teaching kits. The program model is to reach every teacher and every student in a number of mid-sized rural communities across the state of Arizona. The Galileoscope telescope kit is a key part of this program to explore optics and the nature of science. The program grew out of Module 3 of the NSF-Supported Hands-On Optics project (SPIE, OSA, and NOAO). Our program has taken place in Flagstaff, Yuma, Globe, and Safford, Arizona and has now been expanded to sites across the entire state of Arizona (295,254 square kilometers). We describe the educational goals, evaluations, and logistical issues connected to the program. In particular, we proposed that this model can be adapted for any rural or urban locations in order to encourage interest in optics.

Following the path of light: recovering and manipulating the information about an object

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The light diffused by an illuminated object contains information about it but, as the light propagates, the information changes its appearance and sometimes seems even lost. The more conventional way to retrieve this information is to make an image of the object by means of some optical device, like a lens or a mirror. Nevertheless this is not the only way to proceed: pin-hole photography, for instance, recovers some part of the information by simply selecting a single light ray from each point of the object, on the other hand, holography recovers the largest part of information about an object by registering an interference pattern. On the other hand, propagating light can be manipulated in such a way that the final recovered information results dramatically different from the original one. The only way not to get confused in the description of all these phenomena in the didactic practice with High-School students is to follow the path of light asking how the information is present during the propagation of the light. We tested this approach experimentally by realizing 2D images with pin-hole cameras and photo-cameras, 3D images with a holographic setup and implementing spatial filtering in the focal plane of a lens: the result was a deeper understanding by students. Of course a complete description of the phenomena requires the discussion of the complete diffraction theory including all the properties of Fourier analysis, but some part of it can be easily proposed also to High-School students, provided they know some trigonometry.

The PHOTON Explorations: Sixteen Activities, Many Uses

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The PHOTON Explorations wereadapted from favorite demonstrations of teacher participants in the PHOTON projects of the New England Board of Higher Education as well as Hands-on-Optics activities and interesting demonstrations found on the web. Since the end of project PHOTON2 in 2006, the sixteen inquiry-based activities have formed the basis of a hands-on "home lab" distance-learning course that has been used for college students, teacher professional development and corporate training. With the support of OSA, they have been brought to life in a series in of sixteen short videos aimed at a middle school audience. The Explorations are regularly used as activities in outreach activities for middle and high school students and are introduced yearly to an international audience atan outreach workshop at SPIE's Optics and Photonics meeting. In this paper we will demonstrate the Explorations, trace their origins and explain the content. We will also provide details on the development of the Exploration videos, the online course,and outreach materials and give statistics on their use in each format. Links to online resources will be provided.

Hands-On Optics and Photonics Outreach in Riga

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A long-term exposition focused on optics and photonics was created and approbated in Institute of Atomic Physics and Spectroscopy at University of Latvia during the academic year 2010/2011 on 43 students from 8thto 10th grades. Considering unpopularity of science in Latvia and lack of broadly accessible hands-on outreach activities for school children, as well as rapid development of advanced photonic technologies, this exposition was meant to involve more students to the natural sciences and modern technologies. Exposition covers 9 topics of optics –colors, diffraction, polarisation, reflection, interference, fluorescence, infrared and ultraviolet radiation, gas discharge and lasers. Students' visits are organized as an exciting adventure, which differs from ordinary school lessons. The visit mainly includes own actions with hands-on exhibits, lecturer's explanations about the most difficult topics and some demonstrations shown by the lecturer. The main accent is made on hands-on experiments due to the fact that students, who had performed hands-on experiments, will be emboldened to choose their career in the field of science and technologies. The exposition now is running and is part of Riga Photonics Center. Nearly 200 students from the 8thtill12th grades visited it during academic year 2011/2012 and their generally positive feedback has been analysed.

Study History of Optics: Achievements of Middle Ages

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The goal of our presentation is to attract participants' attention to the III volume of our serial Five Millenium of Optics devoted to Middle Ages. The third volume is devoted to optics formation and development from Vth to XVth centuries. It is the author's sequel of Five Millenium of Optics: Prehistory (2006) and Antiquity (2010). On the background of European and Arabic society's life and scientific knowledge evolution the new ideas relative light nature and mechanism of vision are discussed.

The achievements in optical science are observed through the relation with religious, philosophical and fine arts point of view. The mathematic basis of medieval optics including common aspects of light and color, vision theories, optical materials, technologies and devices are analyzed. The main achievement of middle ages is triumph of intromission model of vision, the discovery and distribution of spectacles, application of camera-obscure and observation devices. The period is characterized by the contribution in optics development the achievements of bright group of outstanding scientists in light rays refraction, optical systems calculation and viewing mechanism investigations. The special attention is given to famous founders of science Perspective Alhasen, Vitello, Pekham and their followers. The book is addressed first of all to the young people: students, teachers, experts in optical specialties and amateur in optics history.

Astronomical phenomena: Events with high impact factor in teaching Optics and Photonics

Dan Curticapean

Offenburg University of Applied Sciences, Germany

Astronomical phenomena fascinate people from the very beginning of mankind up to today. They have a enthusiastic effect, especially on young people. Among the most amazing and well-known phenomena are the sun and moon eclipses. The impact factor of such events is very high, as they are being covered by mass media reports and the Internet, which provides encyclopedic content and discussion in social networks. The principal optics and photonics topics that can be included in such lessons originate from geometrical optics and the basic phenomena of reflection, refraction and total internal reflection. Lenses and lens systems up to astronomical instruments also have a good opportunity to be presented. The scientific content can be focused on geometrical optics but also diffractive and quantum optics can be incorporated successfully. The author will present how live streams of the moon eclipses can be used to captivate the interest of young listeners for optics and photonics. The gathered experience of the last two moon eclipses visible from Germany (on Dec, 21 2010 and Jun, 15 2011) will be considered. In an interactive broadcast we reached visitors from more than 140 countries.

Towards a Research Pole in Photonics in Western Romania

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We present our efforts in establishing a Research Pole in Photonics in the future Arad-Timisoara metropolitan area projected to unite two major cities of Western Romania. Both the research objectives and the related training activities of the various institutions and groups involved are presented, in their evolution during the last decade. The multi-disciplinary consortium consists in principal of two universities: UAVA (*Aurel Vlaicu* University of Arad) and UMF (*Victor Babes* Medicine and Pharmacy University of Timisoara), but also of the Arad County Emergency University Hospital and several innovative SMEs, such as Bioclinica S.A. (the largest array of medical analysis labs in the region) and Inteliform S.R.L. (a competitive SME focused on mechatronics and mechanical engineering). While a brief survey of the individual and joint projects of these institutions is done, their teaching activities are also stressed, mainly at graduate but also at undergraduate level. Some of the main international and local collaborations of the consortium are pointed out, for both R&D, training and education in biomedical imaging, especially with our main partner, the University of Kent, U.K., and with two universities from the New York State, USA. Some of our main OCT (Optical Coherence Tomography) but also other applications are presented, in a multi-disciplinary approach that includes optomechatronics, precision mechanics and optics, dentistry, medicine, and biology.

The Puerto Rico Photonics Institute

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We have founded the Puerto Rico Photonics Institute (PRPI) in the Barceloneta, Puerto Rico campus of the Universidad Metropolitana. PRPI is established to provide opportunities in education, research and training and is unique in Puerto Rico. There are two initial focus areas of research and education: aerospace photonics and remote sensing. In particular, we will conduct studies and research and development in remote and in situ sensing of the upper atmosphere and near-space environment. PRPI has established local collaborations with the Arecibo Observatory, Puerto Rico Science Trust, and the Puerto Rico Industrial Development Corporation. Outside of Puerto Rico, PRPI collaborators include the University of Arizona (OSC), University of Central Florida (CREOL), University of Dayton (UD), Georgia Institute of Technology (GT), Scientific Solutions, Inc. (SSI), Atmospheric and Space Technologies Research Associates (ASTRA), and the MIT Draper Laboratory. These organizations will help PRPI to: 1) establish its curriculum, 2) provide research opportunities for PRPI students, 3) participate in faculty exchange programs, and 4) build research and development programs and collaborations. PRPI will have educational and training programs for both Associate and Masters' degrees. It will provide the opportunity for undergraduates in science and engineering programs at any Puerto Rican university to attain a certification in optics and photonics to enhance their baccalaureate degrees.

Concept of the International Project University "Learning without boarders"

Irina Livshits, Vladimir Vasilyev,

National Research University of Information Technologies, Mechanics and Optics, Saint Petersburg

The proposed concept concerns master students education based on implementing projects. The total educational structure has feedback from students and professors and is based on using theory of automatic operation related to the education process. Students select a project and study all subjects which are necessary to achieve the project goals. We consider this as an active educational style, where student decides him/her self what subjects to take and when, depending on the project type. This gives students a lot of freedom and initiative. They can use different types of education up to their choice: attending lectures, or distant education - it is allowed if they are successful in implementing projects. In this practical and experimental type of education the priority is given to creativity in solving engineering problems and learning subjects through their practical use. We call this type of education "Learning without boarders" - as students will have no boarders: political (they can participate in international projects); without strict

educational frames - they follow their own schedule and took necessary subjects; they are also free to participate in the projects with professors and adults researchers - so they are not limited only to students projects. Some examples of projects are given.

Formulation of didactic interest of the laws of refraction of light

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In this work, an alternative formulation of the laws of refraction of light is presented. The proposed formulation unifies the two classic laws of refraction, and it is shown the correspondence between the new and the classic formulations. This new formulation presents a remarkable didactic interest for the conceptual interpretation and resolution of classic problems related to the phenomenon of refraction of light, such as those proposed to students of geometric optics on their first year of college. As an example, this formulation is applied for the resolution of two reflection problems typically assigned to student of such educational level. Results and comments from the students are presented. Although rigorously formulated in this work, the new formulation can be stated from a didactic viewpoint, using everyday language, as follows: "When a ray is refracted, the only variation that undergoes its direction vector is that the parallel component to the surface separating two media (defined in the plane formed by the incident ray and the normal to the surface at the point of incidence) is multiplied by the relative refractive index between both media".

Joint Special Session ETOP2013 RIAO/OPTILAS2013

Enterpreneurship in Optics & Photonics

Entrepreneurship for Scientists and Engineers

Duncan Moore

Rudolf and Hilda Kingslake Professor of Optical Engineering, Vice Provost for Center for Entrepreneurship, University of Rochester

At the University of Rochester, we understand entrepreneurship to mean the transformation of an idea into an enterprise that creates value—economic, social, cultural, or intellectual. More than a discrete set of business skills or practices, entrepreneurship is a calling that can be pursued in many realms of experience and achievement. Entrepreneurship is a way of thinking, an approach to problems, an attribute of mind, and even a trait of character. It is a science and an art; entrepreneurship is a primary way in which a free society grows and improves not only its economy, but its cultural and social life as well. Professor Moore will discuss the role entrepreneurship plays in engineering education and a new degree program entitled Technical Entrepreneurship in Management.

Research, entrepreneurship and the virtue of limits

Gerd Haeusler

Friedrich-Alexander-University, Erlangen-Nürnberg

The most noble duty of a scientist is to formulate an important problem, as Einstein said. This is not only an imperative, but is also helpful in the struggle for orientation in the daily scientific life. Apparently, finding really important problems is difficult. Fortunately, optics (and other applied sciences) offer roads (not as stoney as basic science) to important problems. The first road is to ask about the limits in our area of research. Exploiting this knowledge opens the second road: the cooperation with appliers of science and technology, who, skillfully interrogated, will reveal a vast quantity of interesting problems. Sometimes these problems satisfy the condition to be important, unsolved and - a solution is possible with good optical skills and understanding the limits. We will illustrate successful examples of following this

procedure in the field of optical metrology and hope the formulation might support young and older scientists on the road to entrepreneurship.

Strategies for an efficacious entrepreneurship in iberoamerican countries: a proposal

Guillermo Baldwin

Pontificia Universidad Católica de Peru

Round table "Entrepreneurship in Optics & Photonics"

Alexandra Xavier, INESC Porto, Portugal (moderator), Eric Rosas, RIAO & CIO, Mexico; Duncan Moore, University of Rochester, USA; Gerd Haeusler, Friedrich-Alexander-University Erlangen-Nürnberg, Germany; Guillermo Baldwin, Pontificia Universidad Católica de Peru, Peru; Eugene Arthurs, SPIE, USA; Barry Shoop, U.S. Military Academy West Point, New York, USA; Francisco Araújo, FiberSensing, Portugal; João José Pinto Ferreira (MIETE, Faculdade de Engenharia da Universidade do Porto, Portugal)

Hands-on sessions

Hands-on Holography

*Pedro Pombo**, Emanuel Santos**

** Physics Department, University of Aveiro*

***Fábrica Ciência Viva Science Center*

Holography is well known as a technique for 3D imaging and large scale projection. Nevertheless, students do not know the principle of this technique and for several applications and products it is confused with other imaging techniques. This interactive demo will involve participants into detailed process for holographic registration and projection. During this hands-on presentation the differences between holography and other 3D techniques will be discussed and analyzed. All equipments and materials will be presented and several holography techniques will be explored. On laser holography different types of holograms will be analyzed, such as reflexion gratings, transmission gratings, pseudo colour reconstruction and realtime interferograms. On computer generated holograms an example of twenty-four projections will be presented. Finally, hand drawn holograms will be constructed by participants taking into account special features like resolution, efficiency and spatial projection. At the end, it is supposed that participants were hands-on involved on all activities and that they were awareness on theory and process for different types of holograms, became clear the difference between holography and other techniques.

"The magic of light!" – An entertaining optics and photonics awareness program

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Illusionism provides a surprising and unforgettable way of explaining photonics to a wide audience. It just jumps over the obstacle of talking about those tiny particles with strange behaviours! Imagine grabbing with your own hand an egg-sized photon with the same incredible properties as in a quantum computer! And what if you could touch the light beam which detects and removes diseased cells like in cutting edge prototypes? Magic allows to promote photonics, exploring advanced subjects in an understandable and palpable fashion that strongly inspires all ages. The author is a well-trained magician also studying Engineering and Mathematics. Thanks to the scientific as well as magical expertise of the performer, a fascinating light magic show has been developed. Another key point to produce a sharp content for the illusions has been the constant support of the top leading scientists from ICFO [1]. The result is a solid program, which was performed at International Symposiums such as NLO50 [2] or at conferences in science museums, such as CosmoCaixa [3] and mNACTEC [4]. Other primordial targets are also students. Promoting the learning of optics and photonics must be done in such a manner there is no time for boredom but only for interaction and amazement. This is exactly what we are able to achieve through magic shows! Thus, the shows have been taken to places as the FME [5] or a theatre full of high-school pupils. This project has already boosted many inspirational vibes from the youngest to the eldest people. Parts of the shows themself will be presented along with the building process of this fusion of dramatic arts and science. How does the show create an intellectual challenge, awaking curiosity? A real taste of what science is!

References:
[1] The Institute of Photonic Sciences. http://www.icfo.eu/
[2] 50 Years of Non Linear Optics International Symposium.http://nlo50.icfo.es/
[3] CosmoCaixa Museum of Science http://www.agendacentrosobrasociallacaixa.es/es
[4] Museum of Science and Technology of Catalonia. http://www.mnactec.cat/
[5] Mathematical Faculty and Statistics – UPC Barcelona-Tech University. http://fme.upc.edu/

The Hands-On Optics Project

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The Hands-On Optics project offers an example of a set of instructional modules that foster active prolonged engagement. Developed by SPIE, OSA, and NOAO through funding from the U.S. National Science Foundation, the modules were originally designed for afterschool settings and museums. However, because they were based on national standards in mathematics, science, and technology, they were easily adapted for use in classrooms. The philosophy and implementation strategies of the six modules will be described as well as lessons learned in training educators. The modules were implementing with the help of optics industry professionals who served as expert volunteers to assist educators. A key element of the modules was that they were developed around an understanding of optics misconceptions and used culminating activities in each module as a form of authentic assessment. Thus student achievement could be measured by evaluating the actual product created by each student in applying key concepts, tools, and applications together at the end of each module. The program used a progression of disciplinary core concepts to build an integrated sequence and cross-cutting ideas and practices to infuse the principles of the modern electro-optical field into the modules. Whenever possible, students were encouraged to experiment and to create, and to pursue inquiry-based approaches. The result was a program that had high appeal to regular as well as gifted students. Our independent assessment of the knowledge gains from using the modules will be described.

Poster Session

Predicting scientific oral presentation scores in a high school photonics program

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The reporting research group operated a hybrid student physics, technology, engineering and mathematics and teacher professional program, Photonics Leaders II program, for the past three years. Overall the program has reached 69 students from 13 counties in North Carolina and 59 teachers from 30 counties spread over a total of five states. Quantitative analysis of oral presentations given by participants at a program event is provided. Scores from multiple raters were averaged and used as a criterion in several regression analyses. Overall it was revealed that student grade point averages, most advanced science course taken, extra quality points earned in their most advanced science course taken, and post-test scores on a pilot research design survey were significant predictors of student oral presentation scores. Rationale for findings, opportunities for future research, and implications for the iterative development of the program are discussed.

Piloting a fiber optics and electronic theory curriculum with high school students

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Previous participants from a multiyear blended learning intervention focusing on science, technology, engineering and mathematics (STEM) content knowledge, technical, college, and career preparatory skills were recruited to pilot a new module designed by the project staff. Participants met for a total of 22 contact hours receiving lectures from staff and two guest speakers from industries relevant to photonics, fiber optics hands-on experimentation, and practice with documenting progress. Activities included constructing a fiber optics communication system, troubleshooting breadboard circuits and diagrammed circuits as well as hypothesis testing to discover various aspects of fiber optic cables. Participants documented their activities, wrote reflections on the content and learning endeavor and gave talks about their research experiences to staff, peers, and relatives during the last session. Overall, it was found that a significant gain in content knowledge occurred between the time of pre- (*Mean*=0.54) and post-testing time points for the fiber optics portion of the curriculum via the use of a paired samples t-test (*Mean*=0.71), t=-2.72, p<.05. Additionally, the electronic theory test results were not a normal distribution and for this reason non-parametric testing was used, specifically a Wilcoxon signed-ranks test. Results indicated a significant increase in content knowledge occurred over time between the pre- *(Mdn*=0.35*)* and post-testing time points (*Mdn*=0.80) z=-2.49, p<,05, r=-0.59 for the electronic theory portion of the curriculum. An equivalent control group was recruited from the remaining participant pool, allowing for comparison between groups. The program design, findings, and lessons learned will be reported in this paper.

Graduate Studies on Optoelectronics in Argentina: An experience

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The number of graduate programs in Optoelectronics in Argentina is scarce. The current Optics and Photonics Education Directory lists only three programs. One of them was launched in 2001 in the Facultad de Ingeniería (College of Engineering), Universidad de Buenos Aires (UBA). This was the first graduate program in the field, leading to a Master Degree in Optoelectronics. This decision arose from the demand of telecommunications industries and several estate- or private-funded research institutions working with us in the fields of lasers, optics, remote sensing, etc. A great bonus was the steady work, during several decades, of research groups in the College on the development of different type of lasers and optical non destructive tests and their engineering applications. As happened in many engineering graduate programs in Argentina at that time, few non full-time students could finish their studies, which called for 800 hours of traditional lecture-recitation classes and the Master Thesis. In recent years Argentine Education authorities downsized the Master programs to 700 hours of blended learning and we redesigned the Graduate Optoelectronic Engineering Program to meet the challenge, dividing it in two successive one-year programs, the first aimed at a professional training for almost immediate insertion in the labor market (called Especialización en Ingeniería Optoelectrónica), and the second aimed at a more academical and research target to comply with the UBA standards for Master degrees. The present work is a presentation of the new program design, which will begin in the current year.

ALOP-Active Learning In Optics and Photonics - A UNESCO's program spreading in Colombia through the National University.

Catalina Ramírez – Freddy Monroy

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The National University of Colombia is committed to the spreading of the UNESCO's ALOP program throughout the country by programming a series of workshops (ALOP-SPN) to be held in each of its eight campuses; four of them are located in big or intermediate cities and the other are located in border zones and are called National Presence Campuses. The border zones where the National Presence Campuses can be found are important for the University because several aspects such as privileged geostrategic positions, wide and representative presence of ethnic, Indigenous and African-Colombian peoples and high degrees of biodiversity in their ecosystems. However, their socioeconomic context shows high rates of unsatisfied basic needs, low educational levels in terms of coverage and quality, and, last but not least, lack of State's presence. The great effort that the UNC is doing is intended to contribute at the national scale to the training of high school teachers in new pedagogic methodologies. Between 2009 and 2013 there have been four ALOP-workshops in Colombia and are organizing one more for 2013. Furthermore, the ALOP Workshop has had large impact in the recently established Masters program on teaching of Sciences, a degree program addressed to middle

and high school teachers, which has a current enrollment of more than 400 teachers from all over the country. We present results of this experience.

Diffraction Operators in Paraxial Approach

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The free space electromagnetic field propagation in the Fourier transform technique is used to show an elaborated pedagogically form for the Fresnel and Fraunhoffer diffraction concepts with the curvature transparency and electromagnetic field transfer operators in the paraxial approach.

Top Lateral Refraction and Reflection of Polarized Light in Lenses. Coplanar Lens System. Applications.

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When linearly polarized light impinging on a lens, it will reflect and refract along the lines curves resulting from the interception of a plane (plane of polarization) with a sphere (lens surface) maintaining the orientation of refraction and reflection within the plane of polarization. This effect is significant only looking at the lens laterally. Therefore, a lens acts as a lateral analyzer when the polarization plane of polarized light incident on the lens is rotated. Following this principle that in the spherical surface of a lens fit n circles of radius r, where n is inversely proportional to r, and each circle is a lens itself. Then if a beam of light is shined in one of these areas, the phenomenon is expressed lateral side and diametrically opposite to where the incident linearly polarized light, the lens acting as a waveguide for the light beam polarized.

Contribution from optical course for the educational guidance of engineering careers students

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The work shows the fundamental elements of an inclusive educational guidance conception of substantive university processes and results achieved at the Instituto Superior Politécnico José Antonio Echeverría of Havana in the contribution from optical course to develop it for the students in first and second year of the engineering programs, by means of lectures on holography and three-dimensional images of motivation and link with different specialties and the development of experimental facilities and methodology for the construction of holograms and anaglyph by students for engineering applications.

On-Light: Optical Social Network

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Social networks are a recent phenomenon of communication, with a high prevalence of young users. The concept of network serves as a motto for this multidisciplinary project, which aims to create a simple communication network, using light as the transmission medium. Mixed team, composed by students from secondary and higher education schools, are partners on the development of an optical transceiver. A LED lamp array and a small solar panel are the optical transmitter and receiver, respectively. Using several transceivers aligned with each other, this configuration creates a ring communication network, enabling the exchange of messages

between users. Through this project, some concepts addressed in physics classes (photoelectric phenomena and the properties of light) are experimentally verified and used to communicate, in a classroom or laboratory environment.

TEACHING OPTICAL DIMENSIONAL METROLOGY OF SURFACES AND INTERNATIONAL STANDARDS

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Dimensional metrology is a demanding subject that requires an in-depth knowledge not only of the characteristics of the object of the measurement and the method and system to be used to perform the measurement but also of the standards to followed and strictly respected. This is especially true for surface metrology. The definition of surface, particularly when using optical methods in the measuring process, is a first problem to be understood. From this definition discussion, in our pedagogical approach, we move to the study of the characteristics of light and light/matter/surface interaction. Surface characterization parameters and the main ISO standards are studied. Particular attention is given within the study of the sensing/measuring processes to the definition of uncertainty of a measurement. ISO' Guide of Expression of Uncertainty of a Measurement, GUM, is studied (as well as the VIM). A review of the main optical surface inspection system is made. We believe on the importance of an active student centred learning and on the resource to hands-on experimental practice and therefore all this teaching approach evolves from practical examples and actual experiments and observations.

Investigating shadows. A pedagogical intervention project with primary school children

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This communication results from a pedagogical intervention project, carried out at a primary school in the district of Braga - Portugal. The intervention took place in a class of the 3rd year, composed of 16 students, and it incorporated the practice of inquiry-based science teaching addressing the theme "Light Experiments", which is part of the "Environmental Studies" curricular area. Various class activities were planned and implemented concerning some of the factors that influence the shadow of an object, in order to find answers to the following three questions: a) will 3rd year students, aged 7/8 years, be able to construct and execute an investigation strategy that involves manipulating and controlling variables? b) what are the main difficulties experienced by students in the designing and execution of such a strategy? c) how will students, in interaction with the teacher and with their peers, gradually design and execute their investigation strategy in order to respond to the problem formulated? The project adopted an action research methodology. A careful record was kept of the events most relevant to the questions under study in each class. This data was used to prepare the class diaries - descriptive and reflective narratives prepared based on recorded audio and field notes made during participant observation in the context of the classroom. A content analysis of the diaries has identified a few elements that provide answers to the research questions raised. In order to plan and implement a research project with children in the 7/8 years old range require a high level of scaffolding to allow students to gradually build a coherent strategy to tackle the research problem. Teacher's role is crucial. The teacher, by questioning and inducing reasoning and discussion, promotes encourages and regulates the cognitive activity of students. Some level of autonomy should be given to the students in large group collaborative work.

Light. An experiment based learning approach with primary school children

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A pedagogical intervention project was carried out at a primary school in the municipality of Vila Verde, Braga in Portugal. In a class of the 3rd grade, composed of 16 students, a practice of inquiry-based science teaching was implemented, addressing the curricular topic "Light Experiments". Various experimental activities were planned within this topic, including: What is light? How does light travel? Does light travel through every material? How is light reflected by a mirror? This project adopted an action research methodology and had as its main objectives: a) to promote a practical and experimental approach to the science component of the Environmental Studies curricular area; b) to describe the scientific meaning construction process inherent to the topics addressed in the classroom with the children, c) to assess the learning steps and children' achievements. Class diaries were prepared, based on field notes and audio recordings taken in the classroom. Through the analysis of the class diary concerning the topic "materials that let light travel through them" we intend to illustrate the process of construction of scientific meanings promoted in the classroom with our approach.

Advanced experiments with an Erbium doped fiber laser

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This communication describes an optical hands-on fiber laser experiment aimed at advanced college courses. Optical amplifiers and laser sources represent very important optical devices in numerous applications ranging from telecommunications to medicine. The study of advanced photonics experiments is particularly relevant at undergraduate and master level. This paper discusses the implementation of an optical fiber laser made with a cavity built with two tunable Bragg gratings. This scheme allows the students to understand the laser working principles as a function of the laser cavity set-up. One or both of the gratings can be finely tuned in wavelength through applied stress; therefore, the degree of spectral mismatch of the two gratings can be adjusted, effectively changing the cavity feedback. The impact of the cavity conditions on the laser threshold, spectrum and efficiency is analyzed. This experiment assumes that in a previous practice, the students should had already characterized the erbium doped fiber in terms of absorption and fluorescent spectra, and the spectral gain as a function of pump power.

Learning Optics using a smart-phone

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Although most students spend huge amount of their time holding a smart-phone, few of them realize that they can learn Optics with it. Smart-phone applications (apps) offer a great variety of optics questions and many of them can be used in the classroom to teach Optics. For example, a simple photometer app may help the students to understand the Malus law to learn polarization. Besides apps, we might wonder about Optics inside a smart-phone. We can deconstruct such a device in order to explain geometrical optics, physical optics, photometry, optical materials, etc. We can learn the ability of the devices for imaging by studying the type of lens used, in order to focus the image in the sensor. Another interesting issue to teach using the smart-phone is diffraction. Measuring the diffraction patterns generated by the periodic structure of the display or the sensor, we can estimate the pixel sizes of both of them. A different subject to analyze is the liquid crystal technology used in the smart-phone displays. In addition we review accessories used to image magnification (as microscopes for instance) for clinical and medical purposes. Some optical demonstrations using the smart-phone will be shown.

Teaching methodologies to promote creativity in the professional skills related to optics knowledge

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We present the methodologies proposed and applied in the context of a teaching-innovation project developed at the University of Granada, Spain. The main objective of the project is the implementation of teaching methodologies that promote the creativity in the learning process and, subsequently, in the acquisition of professional skills. This project involves two subjects related with optics knowledge in undergraduate students. The subjects are "Illumination Engineering" (Bachelor's degree in Civil-Engineering) and "Optical and Optometric Instrumentation" (Bachelor's degree in and Optics and Optometry). For the first subject, the activities of our project were carried out in the theoretical classes. By contrast, in the case of the second subject, such activities were designed for the laboratory sessions. For "Illumination Engineering" we applied the *maieutic* technique. With this method the students were encouraged to establish relationships between the main applications of the subject and concepts that apparently unrelated with the subject framework. By means of several examples, the students became aware of the importance of cross-curricular and lateral thinking. We used the technique based on *protocols of control and change* in "Optical and Optometric Instrumentation". The *modus operandi* was focused on prompting the students to adopt the role of the professionals and to pose questions to themselves concerning the practical content of the subject from that professional role. This mechanism boosted the critical capacity and the independent-learning ability of

the students. In this work, we describe in detail both subject proposals and the results of their application in the 2011-2012 academic course.

Slip-lamp management in Contact Lenses laboratory classes: learning upgrade with monitor visualization of webcam video recordings

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The training in the use of the slit lamp has always been difficult for Optics and Optometry students. Instruments with associated cameras helps a lot in this task, because these allow teachers to observe and control if the students evaluate the eye health appropriately, correcting defects and showing them how to do it with a visual demonstration. However, these devices are more expensive than those that do not have an integrated camera connected to a display unit. With the aim to improve students´ skills in the management of slip lamp, we have adapted USB HD webcams with microphone (Microsoft Lifecam HD-5000) to objectives of the slit lamps available in our contact lenses laboratory room. The webcams are connected to a PC running Linux Ubuntu 11.0, therefore that is a low-cost device. Our experience shows that single method has several advantages. It allows us to take pictures with a good quality of different conditions of the eye health; we can record videos of eye evaluation and make demonstrations of the instrument using. That increases the interactions between students because they could see what their colleagues are doing and take conscious of the mistakes, helping and correcting each others. It is a useful tool in the practical exam too. We think that method supports the training in optometry practice and increase the student´s confidence without a huge outlay.

MATLAB GUI (Graphical User Interface) for the design of GRIN components for optical systems as an educational tool

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New technologies and the available computing tools are becoming more important every day in the teaching evolution. The use of Graphical User Interface (GUI) in MATLAB enables the implementation of practical teaching methodologies to make easier the comprehension of a given subject. In this work, we report on the application of GUI in order to provide the students with a simple tool for a better understanding on how to design GRIN elements for optical systems. Another GUIs advantage is that they can be converted to an executable file, so any student could use the interface in their own computer without having a MATLAB license. We create a graphical interface to show the performance of an optical device for controlling beam size and for deflecting light for coupling purposes, by a simple geometrical optics study, in a tapered GRIN lens illuminated by a parallel beam of tilted rays. We also present a graphical interface to obtain the maximum coupling efficiency between fundamental modes of two single-mode fibers by a scaling operation carried out by a GRIN fiber lens. With this interface the students can vary the input parameters of the monomode fibers in order to get the more suitable GRIN fiber lens to maximize the coupling efficiency between fibers.

Development of Matlab GUI Educational Software to Assist a Laboratory of Physical Optics

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Physical optics is one of the subjects in the Grade of Optics and Optometry in Spanish universities. The students who come to this degree often have difficulties to understand subjects that are related to physics. For this reason, the aim of this work is to develop optics simulation software that provides a virtual laboratory for studying the effects of different aspects of physical optics phenomena. This software can let optical undergraduates simulate many optical systems for a better understanding of the practical competences associated with the theoretical concepts studied in class. This interactive environment unifies the information that brings the manual of the practices, provides the visualization of the physical phenomena and allows users to vary the values of the parameters that come into play to check its effect. So, this virtual tool is the perfect complement to learning more about the practices developed in the

laboratory. This software will be developed through the choices which have the Matlab to generate Graphical User Interfaces or GUIs. A set of knobs, buttons and handles will be included in the GUI's in order to control the parameters of the different physics phenomena. Graphics can also be inserted in the GUIs to show the behavior of such phenomena. Specifically, by using this software, the student is able to analyze the behaviour of the transmittance and reflectance of the TE and TM modes, the polarized light through of the Malus'Law, degree of polarization or study of the behaviour of the retarder waveplates.

NEMO Educational Kit on Micro-Optics at the Secondary School

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NEMO was the "Network of Excellence in Micro-Optics" constructed under the European "Sixth Framework Programme". It aimed at providing Europe with a complete Micro-Optics food-chain, by setting up centres for optical modelling and design; measurement and instrumentation; mastering, prototyping and replication; integration and packaging and reliability and standardization. More than 300 researchers from 30 groups in 12 countries participated in the project. One of the objectives of NEMO was to spread excellence and disseminate knowledge on micro-optics and micro-photonics. To convince pupils, already from secondary school level on, about the crucial role of light and micro-optics and the opportunities this combination holds, several partners of NEMO had collaborate to create this Educational Kit. In Spain the partner involved in this aim was the "Microoptics and GRIN Optics Group" at the University of Santiago of Compostela (USC). The educational kits provided to the Secondary School were composed by two plastic card with the following micro-optical element: different kinds of diffractive optical elements or DOES and refractive optical elements or ROEs namely arrays of micro-lenses. The kit also included a Cd-Rom with a handbook for performing the experiments as well as a laser pointer source. This kit was distributed free of charge in the countries with partners in NEMO. In particular in Spain was offered to around 200 Secondary School Centers and only 80 answers accepted to evaluate the kit.

Optics in the Physics Degree at the USC: The use of the Moodle platform

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The unification of the new European studies under the Bologna process creates a new adaptation within the field of Physics. An adjustment to the programs is required to migrate to the new European Credit Transfer (ECTS). According to the art. 12.2 of the R.D. 1393/2007, the Physics Degree at the University of Santiago de Compostela, Spain, has 240 ECTS distributed in 4 years with 60 ECTS each. In particular, the subject of Optics is imparted in the third year of the degree and it is divided in two courses, Optics I and Optics II, both belonging to the Module "Fundamentals of Physics". Both courses are mandatory and are composed by 6 ECTS, distributed in 30 hours of theory, 15 hours of seminars and 15 hours of particular tutorials. Besides, the work developed by the students is supposed to be 75 hours of dedication for learning the theoretical lectures contents and 15 hours for the development of exercises and other homework. The reduction of the number of hours devoted to the theoretical lesson respect to the older syllabus has made necessary the use of virtual platform for helping the teacher and the student to be more connected and to share the academic material needed for the good developing of the course. This work is devoted to the analysis of this kind of virtual tools, in particular, to the Moodle platform, in the course Optics I, analyzing the satisfaction degree of the student with it.

Master on "Photonics and Laser Technologies": on-line teaching experience

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The Galician Universitary System (SUG) in the framework of the European studies under the Bologna process presents a huge number of Masters. This work presents the teaching framework of the Master in Sciences on “Photonics and Laser Technologies”, coordinated by the University of Vigo (UVigo) that involves the three Universities of Galicia: UVigo, University of Santiago de Compostela (USC) and University of Coruña (UdC). The aim of this work is to show how the teaching of this Master is carried on using an online platform in order to use the whole expertise of the three Universities and overcome the geographic dispersion of the teachers and the students. The used platform (Adobe(c) Connect (TM)), permits the students to attend the lessons from their own University without expend time and money in traveling. Besides, each teacher can gives class in his University, allowing the combination of this activity with other professional obligations. Thanks to this tool, the Master has had student that have followed the lessons from other countries The platform has been used for lectures, seminar class, examinations, conferences and the coordination of the teachers and the students of the Master.

Incorporating active-learning techniques into the photonics-related teaching in the Erasmus Mundus Master in “Color in Informatics and Media Technology”

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Sometimes teaching based on traditional lectures can lead to a passive attitude on the part of students. Therefore, it is necessary to incorporate innovative methods to make the course interesting for students while encouraging their participation in the learning process. One way to motivate student involvement in the teaching-learning process is by incorporating active methodologies. In this work, we present a teaching methodology using active-learning techniques in the course “Devices and Instrumentation” of the Erasmus Mundus Master in “Color in Informatics and Media Technology” (CIMET). A part of the course "Devices and Instrumentation" of this Master is dedicated to the study of image sensors and methods to evaluate their image quality. The teaching methodology that we present consists of incorporating practical activities during the traditional lectures. In these activities, among others, students evaluate the image quality of digital cameras by the Modulation Transfer Function (MTF). The instructor presents a random or bar pattern on his laptop screen. Next, students photograph this pattern using their cameras and save the photograph in their laptops. Finally, students calculate the MTF of their cameras from this pattern image. One of the most innovative aspects of this teaching method is that students apply the concepts and methods studied in class to real devices. For this, students use their own digital cameras, webcams, or mobile-phone cameras in class. These activities allow students a better understanding of the theoretical subject given in class and encourage the active participation of students.

Measuring the image quality of digital-camera sensors by a ping-pong ball

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In this work, we present a low-cost experimental setup to evaluate the image quality of digital-camera sensors, which can be implemented in undergraduate and postgraduate teaching. The method consists of evaluating the Modulation Transfer Function (MTF) of digital-camera sensors by speckle patterns using a ping-pong ball as a diffuser and a handmade black cardboard with a slit. The experimental setup is composed of the digital camera under study, a laser diode, a polarizer sheet, the slit and the ping-pong ball with two handmade circular apertures which act as an input and exit ports. Speckle is an interference phenomenon produced when coherent radiation is scattered from a rough surface. The laser radiation is aimed at the input port of the ping-pong ball, generating a speckle pattern at the output port. The slit situated in front of the output port determines the content in spatial frequency of the speckle pattern photographed by the digital camera, and the polarizer sheet provides a linearly polarized laser-speckle pattern. The image-sensor MTF can be calculated from the Power Spectral Density (PSD), which is proportional to the squared magnitude of the Fourier transform of the speckle pattern. First, the MTF of a digital-camera sensor was calculated using a ping-pong ball and a handmade black cardboard slit, and then the MTF was calculated using an integrating sphere and a high-quality steel slit. Finally, the results achieved with both experimental setups were compared, showing a similar MTF in both cases.

A proposal on teaching methodology: cooperative learning by peer tutoring based on the case method

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The European Higher Education Area (EHEA) proposes substantial changes in the teaching-learning model, moving from a model based mainly on the activity of teachers to a model in which the true protagonist is the student. This new framework requires that students develop new abilities and acquire specific skills. This also implies that the teacher should incorporate new methodologies in class. In this work, we present a proposal on teaching methodology based on cooperative learning and peer tutoring by case study. A noteworthy aspect of the case-study method is that it presents situations that can occur in real life. Therefore, students can acquire certain skills that will be useful in their future professional practice. An innovative aspect in the teaching methodology that we propose is that work groups would consist of students from different levels in the same major. In our case, the teaching of four subjects would be involved: one subject of the 4th year, one subject of the 3rd year, and two subjects of the 2nd year of the Degree in Optics and Optometry of the University of Granada, Spain. Each work group would consist of a professor and a student of the 4th year, a professor and a student of the 3rd year, and two professors and two students of the 2nd year. Each work group would have a tutoring process from each professor for the corresponding student, and a peer tutoring from the student of the 4th year for the students of the 2nd and 3rd year.

Naked-eye Astronomy: Optics of the starry night skies

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The world at night offers a wealth of stimuli and opportunities as a resource for Optics education, at all age levels and from any (formal, non formal or informal) perspective. The starry sky and the urban nightscape provide a unique combination of pointlike sources with extremely different emission spectra and brightness levels on a generally darker, locally homogeneous background. This fact, combined with the particular characteristics of the human visual system under mesopic and scotopic conditions, provides a perfect setting for experiencing first-hand different optical phenomena of increasing levels of complexity: from the eye's point spread function to the luminance contrast threshold for source detection, from basic diffraction patterns to the intricate irradiance fluctuations due to atmospheric turbulence. Looking at the nightscape is also a perfect occasion to raise awareness on the increasing levels of light pollution associated to the misuse of public and private artificial light at nigh, to promote a sustainable use of lighting, and to take part in worldwide citizen science campaigns. Last but not least, night sky observing activities can be planned and developed following a very flexible schedule, allowing individual students to carry them out from home and sharing the results in the classroom as well as organizing social events and night star parties with the active implication of families and groups of the local community. This contribution describes these possibilities and introduces some of the free resources available to put them in practice.

Optics in engineering education: stimulating the interest of first-year students

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The work here presented deals with stimulating the interest for Optics in first-year students of an Engineering School, which are not specifically following Optical Engineering studies. Optic-based technologies are nowadays wide spread, and growing, in almost all the engineering fields (from non destructive testing or alignments to power laser applications, fiber optic communications, memory devices, etc.). In general, the first year curriculum doesn't allow a detailed review of the main light properties, least its technical applications. We present in this paper our experience in showing some basic optic concepts and related technologies to the students of our school. Based on the fact that they have a very basic training in this branch of physics, we have designed a series of experimental demonstrations with the dual purpose of making them understand the basic principles of these technologies, and to know the potential of applications to engineering they offer. We assembled these experiments in the laboratory and invited students to pass to get to know them, giving them an explanation in which we focused on the possible range of application of each technique. The response was very good, not only by the number of students who attended the invitation but also by the interest demonstrated by their questions and opinions.

A teaching resource using the GUIDE environment: simplified model of the eye for secondary school students

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Nowadays, new technologies have great influence on our lives and how we have access to the information. The new generations have never known a world without them and they make use of these new technologies in practically all facets of their day-to-day. Education systems have also evolved rapidly and make use of learning strategies based on interactive tools frequently. In this workwe have created a graphical user interface with GUIDE, a development environment of MATLAB, to show, in a simple way, how the eye works. This interactive program is addressed to the first courses of secondary students and designed to introduce them to the basic concepts of the normal refractive condition of the eye and the most common visual defects, as myopia and hyperopia. The graphic interface makes use of the simplified model of the eye, where the optic system of the visual organ is represented by a converging lens (cornea and crystalline) and a screen (retina). Emmetropic, myopic and hyperopic eye operation is shown graphically to the students, as well as how these focusing error scan be solved with a diverging and converging lens, respectively. This teaching tool is going to be tested this course in the ColegioHogar de Santa Margarita (A Coruña) to evaluate its influence in the better understanding of the students in this matter and try to catch their attention to the world of Optics and its importance.

The USC-OSA Student Chapter: goals and benefits for the Optics community

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The USC-OSA Student Chapter has been constituted in March 2013. It is located at the University of Santiago de Compostela (USC) in Spain and sponsored by The Optical Society of America (OSA). It is formed by graduate and undergraduate students with the common interest in Optics and Photonics research and a professor of the USC is also involved as a faculty advisor. We decide to start this group with the aim to involve kids, precollege and undergraduate students in the world of Optics and Photonics. The activities that the USC-OSA Student Chapter members intend to realize are mainly educational tasks for the spreading of knowledge in Photonics by means of basic experiments, demonstrations and lectures by leading researches and teachers. Most of the needed resources to accomplish these activities are provided by the OSA, such as educational posters and a portable kit for demonstrating Optics to students. The first programmed activity will consist in different journeys at the Santiago de Compostela University Hospital Complex (CHUS), where hospitalized children can approach to Optics through some simple experiments and games. Another activity will take place in November during the Science Week, which includes a program of lectures targeted to undergraduate students and an exposition of several demonstrations. A teaching program is also being organized in collaboration with Galician secondary schools in order to show students the importance and uses of Optics and Photonics and to arouse their interest in this field as well as encouraging them to develop their scientific thinking.

Using ray matrices to derive analytical expressions of optical aberrations

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Ray matrix formalism is a useful theory applied in many areas related to paraxial geometrical optics, where 2×2 ABCD matrices are used. This formulation allows complex, multi-element, optical systems to be analyzed and simplified using easy calculations, either analytically or numerically. For teaching purposes, the matrix theory is easy to understand and well-valued by students.From practical pint of view, paraxial approximation is not fulfilled so "perfect" images are not obtained. In that sense aberration theory is required and it is a subject therefore included in Optics courses. Usually, aberration concept is defined in terms of the distortion of the "ideal" spherical wavefront passing through the optical system. The aberration function is well defined and mostly all primary aberrations such spherical aberration, coma, astigmatism, field of curvature, etc are expressed using the aberration function. However this aberration function theory can be quite annoying for students since the polynomial expressions are complex, and analytical expressions are

difficult to derive. In this work we show an easy way to teach aberrations in terms of ray matrices. We derive expressions to account for the spherical aberration in terms of 3×3 ray matrices, where additional elements are included to account for the errors in the rays height and angle caused by the aberration. This 3x3 ray matrix technique is a usual method applied to analyze misaligned laser resonators. Thus, it permits to illustrate students in Optics with additional examples. Comparison with common geometrical paraxial equations is included.

Course for Undergraduate Students: Analysis of the Retinal Image Quality of a Human Eye Model

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In teaching of Vision Physics or Physiological Optics, the knowledge and analysis of the aberration that the human eye presents are of great interest, since this information allows a proper evaluation of the quality of the retinal image. The objective of the present work is that students evaluate the optical quality of the human visual system for emmetropic and ammetropic eye, both with and without the optical compensation. For this purpose, an optical system corresponding to the Navarro-Escudero eye model, which allows calculating and evaluating the aberration of this eye model in different ammetropic conditions, was developed employing the OSLO LT software. Specifically, obtain the third and fifth order aberration coefficients, the impact diagram, wavefront analysis, calculation of the Point Spread Function and the Modulation Transfer Function for ammetropic individuals, with myopia or hyperopia, both with or without the optical compensation. A course such as this will is expected to be of interest for student of Optics and Optometry Sciences, last courses of Physics or medical sciences related with human vision.

Motivational activities based on previous knowledge of students

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Academic results depend strongly on the individual circumstances of students: background, motivation and aptitude. We think that academic activities carry on to increase motivation must be tuned to the special situation of the students. Main goal of this work is analyze the students in the first year of the Degree in Optics and Optometry in the University of Granada and the suitability of an activity designed for that students. Initial data were obtained from a survey inquiring about the reasons to choose this degree, their knowledge of it, and previous academic backgrounds. Results show that: 1) the group is quite heterogeneous, since students have very different background. 2) Reasons to choose the Degree in Optics and Optometry are also very different, and in many cases were selected as a second option. 3) Knowledge and motivations about the Degree are in general quite low. Trying to increase the motivation of the students we designed an academic activity in which we mix different topics studied in the Degree. Results show that students that have been involved in this activity are the most motivated and most satisfied with their election of the degree.

"Pick it up with light!"- An Advanced Summer Program for Secondary School Students

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Photonics is an upcoming field that offers immense possibilities to revolutionarize the technology. Optics which forms the basis of this field needs to be introduced among the young students to invoke their interest and eventually mold them into future scientists and technocrats in photonics. However, inadequacies in science education at school level have been a major concern among educationists. In order to address this situation, ICFO-The Institute of Photonics Sciences, has been very active in developing various programs for primary and secondary school students [1,2]. Recent efforts have been directed towards bringing the state-of-the-art research tools in a simple yet interesting manner to the students who do not have a strong mathematical background. Here, we present an advanced program named, "Pick it up with light!". This idea, derived from the author's experience in developing and guiding such programs, has been realized as a two-week summer workshop designed for Spanish, highly motivated, secondary school students. This event is sponsored by CatalunyaCaixa, a Spanish bank that promotes science among motivated and entrepreneurial high school students. The program constitutes many events including the construction of an optical tweezer. It is designed in such a

way that the students were involved in all the steps that led to the construction of the optical tweezers, acquiring the fundamental concepts of optics and the basic experimental skills required to build optical setups. This event with active involvement of the students and instructors is very well appreciated. The students had a great time while doing the activity and hence the learning process was easier and also invoked their curiosity, an essential tool in molding future scientists. We believe such programs will motivate student to pursue their future career in the field of opticsand photonics. The planning, organization and outcomes of the program will be presented.

References
1. S. Chaitanya Kumar, M. Mathew, G. Volpe, O. Takayama, and A. Valencia., "El Día de la Luz — II (The Day of Light -II) — Optics Demonstration for High School Students," in *Education and Training in Optics and Photonics*, OSA Technical Digest Series (CD) (Optical Society of America, 2009), paper ESA4.
2. O. Takayama, A. Niederberger, P. Ghenuche, M. Mathew, and G. Volpe, "*El día de la luz* (the day of light)-two hours optics demonstration for secondary school students," in *Education and Training in Optics and Photonics*, OSA Technical Digest Series (Optical Society of America, 2007), paper ESD6.

The design of partially coherent sources

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When modeling partially coherent sources, one has to face the problem of devising sources endowed with sensible correlations functions. The basic correlation function between two points, specified by coordinates x and y, is the so-called cross-spectral density $W(x,y) = \langle V^*(x)V(y) \rangle$, where V represents the optical field at a fixed temporal frequency and the angular brackets mean an ensemble average [1]. A fundamental point is that W cannot be chosen at will because it must satisfy the mathematical condition of being a non-negative definite kernel. This means that, for an arbitrary (well behaving) function f(x) a certain quadratic quantity, implying f and W, has to be non-negative. This is difficult to ascertain except for certain types of model sources. Up to recent times, in fact, researches on spatial coherence properties of light have been essentially limited to fields produced by few model sources. Lately, rules ensuring non-negativeness of W have been discussed [2] and led to explore different types of partially coherent fields. Here, we will discuss this rule and present a number of examples. It will be seen that partially coherent fields with peculiar correlation properties can be envisaged. The results obtained in the scalar treatment can be extended to the vectorial case, where a matrix formulation is required. An even richer variety of cases will be seen to appear.

[1] L. Mandel and E. Wolf, *Optical Coherence and Quantum Optics*, Cambridge University Press, 1995.
[2] F. Gori and M. Santarsiero, Opt. Lett. **32**, 3531-3533, 2007.

Single-photon interference experiment for High Schools

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We follow the *reductio ad absurdum* reasoning described in the book “Sneaking a Look at God's Cards” by Giancarlo Ghirardi to demonstrate the wave-particle duality of light in a Mach-Zehnder interferometric setup analog to the conventional Young double-slit experiment. We aim at showing the double nature of light by measuring the existence of interference fringes down to the single-photon level. The setup includes a strongly attenuated laser, polarizing beam splitters, half-waveplates, polarizers and single-photon detectors. Logical steps: 1) Demonstrate that the detectors can measure single photons; 2) Demonstrate that the polarizing beam splitters divide the light according to polarization even in the single photon regime and that 45°-polarized single photons are never measured at the two outputs of a beam splitter simultaneously: photons behave like indivisible particles and follow a defined path inside the interferometer; 3) Inject 45°-polarized single photons into the interferometer and measure the output intensity through a 45°-polarizer: according to step 2), the expected number of photons should be the sum of those following the two paths in the Mach-Zehnder. What we instead observe is a modulation in the number of detected photons as a function of the mirror position; 4) Measure the inteference fringes at single-photon level by scanning the detector and accumulate the counts. The setup was initially installed at the University, but more recently we realized a portable version of the apparatus to bring the experiment directly in the High Schools. The didactic activity was performed with more than twenty different groups of students.

Scientific evaluation of an intra-curricular educational kit to foster inquiry-based learning (IBL)

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Society becomes increasingly dependent on photonics technologies; however there is an alarming lack of technological awareness among secondary school students. They associate photonics with experiments and components in the class room that seem to bear little relevance to their daily life. The Rocard Report [Csermely, P. et al. 2007] highlights the need for fostering students' scientific skills and technological awareness and identifies inquiry based learning (IBL) as a means to achieve this. Students need to actively *do science* rather than be silent spectators. The 'Photonics Explorer' kit was developed as an EU funded project to equip teachers, free-of-charge, with educational material designed to excite, engage and educate European secondary school students using guided inquiry based learning techniques. Students put together their own experiments using up-to-date versatile components, critically interpret results and relate the conclusions to relevant applications in their daily life. They work hands-on with the material, thus developing and honing their scientific and analytical skills that are otherwise latent in a typical class room situation. A qualitative and quantitative study of the impact of the kit in the classroom was undertaken with 50 kits tested in 7 EU countries with over 1500 students in the local language. This paper reports on the results of the EU wide field tests that show the positive impact of the kit in raising the self-efficacy, scientific skills and interest in science among students and the effectiveness of the kit in implementing IBL strategies in classrooms across EU.

Building an Optomechatronics Group in a young university in Western Romania

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We present our experience regarding the establishing of an interdisciplinary group with Optics as one of its main topic at the *Aurel Vlaicu* University of Arad (UAVA) – linked with the improvement through research of our educational activities. A brief history of UAVA is provided, as well as the academic and industrial background of Western Romania in general and of the town of Arad in particular. The 3OM Group (in Opto-Mechatronics, Optical Metrology and Optical Materials) is described in its evolution from optomechanics to photonics, the latter with a focus on OCT (Optical Coherence Tomography) – with the national and the international collaborations established, the latter including the Applied Optics Group of the University of Kent, UK, and The Institute of Optics of the University of Rochester, NY, USA. While the research directions of the 3OM Group are presented, they are linked with the educational components implemented in the various subjects we teach, for both undergraduate and graduate students, both in Mechanical and in Electrical Engineering. The main effort is to integrate education and research, to move teaching beyond the classical aspects to put the stress on hands-on-experiments, as well as on research-based activities – even with undergraduates. The main goals of this approach are to obtain an early orientation towards innovation and discovery, with a taste for novelties and with a clear focus on international standards. While this account is only one of many, it offers our experience in passing through the difficulties of developing both research and education in Optics in a young university in an emergent economy in Eastern Europe. .

Expansion of Student Activities in Africa: from South to North

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Optics and photonics research in Africa has gradually grown in the past ten years with a very active optical community involved in state-of-the-art research. Despite relatively low resources in Africa, optics research in the continent is competitive with many international benchmarks and has had a significant impact within the African continent. In the past five years, a group of dynamic students have developed the student chapter network from Tunisia to South Africa. The first student chapters of the optical society of

America (OSA) and the international society for optics and photonics (SPIE) were established in South Africa (CSIR and University of Stellenbosch), followed by a chapter in north Africa in Tunisia (engineering school of communications of Tunis). In this paper, we will present the major activities of the student chapters of Tunisia and South Africa, and how they are promoting optics and photonics in Africa. The activities of the chapters, driven by both graduate (PhD and MSc) and undergraduate students, include the promotion of science in general and optics in particular, with the aim of attracting more and more students into the field, thus enlarging the optics community in Africa. The activities are divided into three categories: education, seminars, and outreach. The chapters work on maintaining a strong leadership, motivation, and access to resources, so that they can reach large numbers of pre-college students through educational activities. Organizing regular seminars with pioneers in the field of optics and photonics gives the PhD and MSc students the opportunity to share their results and discuss them. Local and international outreach activities of the chapters have brought hands-on demonstration materials involving optics and photonics to thousands of students in secondary schools, including rural and underpriviledged schools and communities, conveying the impact and fascination of modern optical technology. Visits of active researchers to school classes greatly improve the interest of the students in their science lessons by putting their knowledge into perspective with current research objectives and visions of the future. The visits can also trigger an early motivation in the students to consider a career in science and improve the acceptance of science and technology as a major factor in the growth and development of the continent.

Active Learning in Optics and Photonics. Hands-on in waveoptics

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Nothingthatwesee in ourdailylivescan not avoid diffraction. This commonphenomenonis the basis of the wavetheory of light, however it is still difficult to explain simply to the students. With the advent of lasers and dazzlinges sort of new tecnologies, it is now very easy to make a good diffraction pattern, to draw its contours and even to measure at the time its characteristics. The purpose of this lecture is to show how to achieve this task by using an equipment became accessible to many of us. We then show how, thanks to computers, itis possible to explore close configurations.

Numerical Simulation of Optically Trapped Particles

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An optically trapped Brownian particle is a sensitive probe of molecular and nanoscopic forces.An understanding of its motion, which is caused by the interplay of random and deterministiccomponents, can help gain physical insight into the behavior of stochastic phenomena. However, modeling of realistic stochastic processes typically requires advanced mathematical tools. Here, we discuss a simple finitedifference algorithm to compute the motion of an optically trapped particle. We then apply it to interpretnanoscale force and torque measurements,and more complex phenomena, such as Kramers transitions, stochastic resonant damping, andstochastic resonance.Some randomness is present in most phenomena, ranging from biomolecules and nanodevices to financial markets and human organizations. However, it is not easy to gain an intuitive understanding of such stochastic phenomena, because their modeling requires advanced mathematical tools, such as sigma algebras, the Itô formula and martingales. Here, we discuss a simple finite difference algorithm that can be used to gain understanding of such complex physical phenomena. In particular, we simulate the motion of an optically trapped particle that is typically used as a model system in statistical physics and has a wide range of applications in physics and biophysics, for example, to measure nanoscopic forces and torques. First, we will explain how to simulate a random walk and how to treat the white noise term within a finite difference framework. We will then describe how to simulate the free diffusion of a Brownian particle and study its transition from the ballistic to the diffusiveregime due to the presence of inertial effects at short time scales, and examine the effect of anoptical trap on the motion of the particle. We also outline how to use simulations of opticallytrapped Brownian particles to gain understanding of nanoscale force and torque measurements, and of more complex phenomena, such as Kramers transitions, stochastic resonant damping, andstochastic resonance.

Application of Computerized Models in the University Course of Optics

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The report informs of experience in using computerized models created by students in the process of mastering a course in optics. The author provides description of: authentic programs for a computerized modeling of complicated optical systems and their calculation by a matrix method, computerized simulators (training facilities) for a laboratory practical work in optics. The report illustrates the following modeling programs:

1) calculations for optical systems by matrix method (it affords to form a centered lens systems from a set of refraction spherical surfaces and calculate them by this method);
2) determination of radiation wave length and curvature lens radius with the help of Newton interference rings (imitation of an actual interference stand);

The programs realize the principle of optical constructors. The data obtained from a computer experiment are the results of calculation made on the basis of pre-set parameters. A considerable didactic effect, non-attainable in work with actual experimental stands, makes it possible for students to observe a sequential reply of the system. These programs afford the admission control as well. A virtual experiment may be carried out by students in case of their knowledge of the test that controls the level of comprehension of experimental purposes, physical essence of studied phenomenon, and methods of an actual experiment.

Virtual-Reality-Based Educational Laboratories in Fiber Optic Engineering

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Researchers and educators have observed great potential in virtual reality (VR) technology as an educational tool due to its ability to engage and spark interest in students thus providing them with a deeper form of knowledge about a subject. The focus of this project is to develop an interactive VR educational module, *Laser Diode Characteristics and Coupling to Fibers*, to integrate into a fiber optics laboratory course. The developed module features a virtual laboratory populated with realistic models of optical devices in which students can set up and perform an optical experiment dealing with laser diode characteristics and fiber coupling. The module contains three increasingly more complex levels for students to navigate through, with a short built-in quiz after each level to measure the student's understanding of the subject. Seventeen undergraduate students learned fiber coupling concepts using the designed computer simulation in a non-immersive desktop VE condition. The analysis of students' responses on the updated pre- and post test show statistically significant improvement of the scores for the post-test as compared to the pre-test. In addition, the students' survey responses suggest that they found the module very useful and engaging. The conducted study clearly demonstrated the feasibility of the proposed instructional technology for engineering education, where both the model of instruction and the enabling technology are equally important, in providing a better learning environment to improve students' conceptual understanding as compared to other instructional approaches.

Development of an Optics Based Approach to Record the Acoustic Fingerprints of Molecules

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The process of generating sound waves using optical pulses is popularly known as Photo-acoustic phenomena. We have developed a novel approach to record the acoustic finger prints of some the complex organic and inorganic molecules which mainly belong to the group of atmospheric pollutants, human biomarker and High energy material. The optics and sound are the important courses taught in the undergraduate degree levels. Using the basic mechanism of generated acoustic modes such as longitudinal, radial and azimuthal in a closed cylindrical cavity help us to design a suitable resonance acoustic system. If this cavity is filled with selected vapors or gaseous molecules which have some selected absorption optical bands in UV-VIS-IR region then one can generate photoacoustic signal due to non radiative relaxation process. This signal can be record using a suitable microphones housed in the cavity. The FFT of the resultant signal provides the acoustic finger prints of the given molecules. We have used 532 nm wavelength of 7ns pulse width, 10Hz repetition rate obtained form Q-switched Nd:YAG laser to record the PA spectrum of NO_2, Br_2, I_2 etc.. The PA theory has been used to simulate the normal; distribution of the cavity eighen modes between 10Hz -45 kHz range.

Laser Light Scattering for Investigation of Particle Size Dependency of Quality and Flavour of Coffee Samples Grown in Ethiopia.

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This paper reports the investigation of extinction coefficient, scattering coefficient, reduced scattering coefficient and particle size of the five samples of coffee grown in different parts of Ethiopia. Five different samples of roasted grounded Arabica coffee consisted *Washed Lekempti2*, *Unwashed Harar4*,*Washed Sidamo2*, *Washed Yirgacheffee2* and *Washed Limu2.* Collimated beam from 35 mW He- Ne laser operating at wavelength 632.8 nm passed through chopper frequency controller and sample solutions viz., Coffee with and without caffeine . The concentrations of five samples were gradually increased from 2.22% to 11.11% The transmitted intensity was detected with a photodiode connected to the lock-in amplifier. The total extinction coefficient was found to vary from 3.635×10^{-3} per mm for washed Lekempti coffee to 8.582×10^{-3} per mm for washed Yirgacheffee-2 sample. The scattering coefficient for Yirgacheffee-2 coffee was 5.71610^{-2} per mm and was least for washed Lekempti coffee. A multi-angular distance measurement of fluence rate or emittance was carried for all five samples. For each measurement the angle was varied from 27^{o} to 72^{0} in steps of 9^{0} from the line of transmission. The particle size was found to vary from 0.9000 μm for washed Yirgacheffee-2 sample to 1.085μm for unwashed Harar -4 samples. The results for all used coffee samples confirm that the diffusing medium, coffee, has a high and dominant scattering property in the forward direction with negligible absorption property for the given wavelength 632.8 nm of incident light. The particle size results of different coffee samples showed that finest particle size may be related to good quality and flavour with highest scattering coefficient. This is in conformity with the information supplied by Supreme Small Holders Coffee PLC using traditional cup-test method. Accordingly washed Yirgacheffee-2 is the first in quality with succession of others.

Optics Education aand Training in Pakistan

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Recent advances in information technology, biotechnology and other emerging disciplines have significant dependence on optics. Since it is an enabling technology, optics is taught at various levels after high school in Pakistan. At undergraduate level both geometrical and wave optics is taught along with electromagnetic theory and other basic physics thus laying out a solid foundation for further study. In the post-graduate M.sc we have two required courses in our department at the Quaid-i-Azam University, one of which is optics, covering basic topics of both physical and geometrical optics and its applications, more advanced topics are covered in the course of Laser Physics. At the M.Phil. level we have two semester course on quantum optics, and also an additional course on Atomic and molecular spectroscopy. The preparation in these courses on optics allows all trained students to get jobs in Laser laboratories in the country. In addition, we have a big fiber optics manufacturing facility, where polarization maintaining and other fibers for communication purposes are manufactured. This talk will give an overview of optics education in Pakistan and employment and further training opportunities.

Diversiform and Practice-connected Class-teaching in Fourier Optics for Undergraduate Students

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Class-teaching is also a compulsory method in university education. However, in the class that seat dozens of students, there are always the phenomenons that some of the students do not learning actively, but just sit passively. It is worth to research how to increase the charm of class-teaching, thus transform our classes into exciting venues for learning. Some measures were taken and practiced in our teaching of Fourier Optics for undergraduates in the field of Applied Physics at Beijing University of Technology. Diversiform and practice-connected class-teaching are developed, including emphasized participation class-teaching (e.g. simulation and demonstration of diffraction phenomena hosted by students themselves), special seminars focusing on frontier of the field (e.g. Holography Display), and company-based class-teaching (e.g. visiting Manufacture of Optical Disks). Since knowing and ability of the students maybe mostly depends on engagement in practice, diversiform class-teaching play an important role during the education for our students. This has produced an obvious result that our diversiform classes have transformed learner-centered and exciting learning venue. A favorable cycle from learning, participation, and practice to innovation has formed for the learners.

Understanding the Fourier transform

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Fourier transform is a reserved teaching topic for science and engineering students in almost all polytechnics and universities. Fourier Optics is one example of its penetration into optics and phonics. Among the large audience, some of them feel it is too difficult. This article is written for them in a casual and friendly way, with the humble aim of giving them more confidence in reading formal textbooks.

Training on the thin anti-reflection within the curriculum of the optical optometry professional license: Optique Optométrie

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Thin films and their applications in the field of eyewear is an important module in the curriculum of the professional license: Optics Optometrie assured by the Faculty of Science Semlalia of Marrakech.Students receive theoretical training on thin films in general and antireflection layers in particular. The various deposition techniques and characterization are reviewed. In the production side of antireflection layers, students are greeted in the in the Laboratory of Physics and Thin Films where the work in this area focuses on the use of TiO2 thin films as antireflection layers. Indeed, thin films of TiO2 are of particular interest in this area and in particular because: Their good adhesion to glass; Their mechanical hardness (scratch resistant layers); A high refractive index (antireflection layers); A good transparency in the visible and near infrared.
This article reviews the main optical properties of thin films deposited at the Laboratory by RF sputtering. The work done directly by the students of the License is a very interesting opening module for our students.

Modulation of Optical Pulse Shape Using Electrical Signals

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Using a suitable pulsed electric signal a continuous wave laser pointer (diode laser) can be converted into pulsed laser. Frequency and pulse width of the optical signal can be varied by varying the frequency and pulse width of the electric signal. Apart from the normal pulse shape of electric signal such as square wave, triangular and sinusoidal wave, one can obtain various other non conventional pulse shapes by summing these signals and varying their phase. These non conventional shaped electric signals can be easily transformed into optical pulse if their amplitude is above the threshold level which is needed for lasing. This experiment can be easily assembled into undergraduate or post graduate laboratory for the demonstration of conversion of continuous wave laser into pulsed laser and for getting various shaped optical pulses using a cheap and easily available laser pointer.

Sculpting of Optical Fiber: Classroom Experiment

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An innovative laboratory experiment has been demonstrated with cheap and easily available plastic optical fiber. Fiber tip modification is a widely researched topic. Fiber tip can be modified to get the ball lens, side angle firing, high power density, and diffuser. Applications of this mainly lie in the medical and sensor field. Lot of other innovative modifications of fiber tip have been already demonstrated for various applications. To get an idea of this mainstream research topic, we demonstrated a simple classroom experiment with plastic fiber which is cheap and easily available. This paper reports the tip modification of plastic fiber to get ball lens, side angle firing, diffuser and beam splitter. This can be a laboratory experiment for undergraduate or post graduate students of photonics.

Workshop onTeaching with the Galileoscope

Stephen M. Pompea

National Optical Astronomy Observatory

Stephen Pompea proposes to conduct a workshop on teaching with the Galileoscope for ETOP participants. At minimum, each participant will build a Galileoscope in the workshop. Ideally each participant would receive additional Galileoscopes and tripods in order to be able to run their own program for students.

New Frontiers in Color Management by using modern Spectrometers

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Offenburg University of Applied Sciences

Nowadays digital media have a fast paced development process, and a crucial responsibility of media engineers and designers is the proper color management. Print, screen and mobile applications must independently display the same colors. The authors will present their experience in the field of color management. All above mentioned aspects in print, screen and mobile devices will be considered. The color measure system is based on a modern spectrometer, and an older color measure system is also considered. The paper will present how the students learn to find technical solutions in classical color management and how can they recognize the specific upcoming difficulties in this area.

Teaching Optics with the centennial universal lantern

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A projection apparatus was bought in 1909 by the Physics Cabinet of the Polytechnic Academy (predecessor to the University of Porto's Faculty of Science) in order to present various physics experiments, mostly in the realm of Optics, to a large student audience. A stout and impressive mahogany and brass piece, with a voltaic arc lighting system, it was manufactured by the firm E. Leybold's Nachfolger, based in Chemnitz (Germany), already with a worldwide reputation as a supplier of teaching instruments and equipments to superior schools and universities. It was sold along with an extensive set of accessories, allowing for demonstrations in geometrical optics, spectrum analysis, interferometry, diffraction, polarization and double refraction. Two extra attachments, one for projecting microscopic objects, and the other for the projection of gypsum preparations in polarized light, added to the versatility of this lantern, appropriately dubbed of universal use. Both apparatus and accessories are presently to be found in the collection of the Museum of Science of our University. On studying them, we have come to the conclusion that many classical experiments in Optics may be displayed, without great effort and in an attractive manner. The adaptation to present day usage takes no more than the replacement of the lantern's voltaic arc by a suitable and safer light source. It so happens that a hundred-year old projection apparatus, fitted with a set of purposely designed add-ons, becomes so effective as its modern counterpart.

Development of an undergraduate optics laboratory based on the analysis of digital images

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The aim of this work is to present a simple methodology based on the use of digital images and computer processing techniques for enhanced undergraduate laboratory teaching aids. In the field of optics, the experiments may present both qualitative and quantitative nature. The former case comprises demonstrations of the physical concepts involved, and the latter offers the students the possibility of obtaining numerical values, in such case, further attention is required in the development of the experimental set up in order to ensure consistent results. In order to obtain high quality teaching material, images must meet certain requirements and thus a number of points involving lighting, scales or camera settings among others, should be taken into account during the process of image acquisition. In this communication detailed analysis of these aspects and their influence on the success of the implementation of different experiments is presented. The experiments which we have considered cover the usual topics at undergraduate level, which comprise both geometrical optics (thin lenses, mirrors, prisms…) and physical optics (diffraction, interference, spectral analysis, among others) and different levels of complexity. The use of different software tools such as Matlab®, VideoPoint® or PixelProfile have been also evaluated, depending on the topic studied, and the depth of the data analysis required in each case.

A Laboratory Module on Radiometry, Photometry and Colorimetry for an Undergraduate Optics Laboratory Course

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Abstract: The bachelor's degree in Physics at Loyola University Chicago requires both an upper-division course in Optics as well as a companion Optics Laboratory course. Recently, the laboratory course has undergone dramatic changes. Traditional weekly laboratories have been replaced with three laboratory modules, where students focus on a single topic over several weeks after which the students submit a laboratory report in the style of a journal article following American Institute of Physics style manual. With this method, students are able to gain a deeper understanding of the specific topic areas of radiometry, photometry and colorimetry, lens design and aberrations, and polarization and interference while using industry-standard equipment and simulation software. In particular, this work will provide the details of the laboratory module on radiometry, photometry and colorimetry where students use a photoradiometer and integrating sphere to characterize the optical properties of a LCD monitor, light bulb and a light emitting diode calculating properties such as luminous flux, luminous intensity, luminance, CIE color coordinates, NTSC ratio, color temperature and luminous efficacy.

Pre-design and implementation of spectrometers in Peru

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In our university we have developed a workshop about the implementation of Czerny-Turner spectrometers for students and teachers of universities from Peru. This work describes the stages of the implementation of a spectrometer, such as: the pre-optical design, the location of the optical elements, optical alignment, the focusing of the light spectrum on a linear CCD, and recording the electrical signal linear CCD using an oscilloscope. The pre-optical design has been developed using the OSLO program, and of accord to the following optical characteristics: the spectral range of detection is visible and near-infrared, the optical resolution is less than 1 nm, and the f-number is 4.

Lighting the way: Photonics Leaders II (PL2) optics and photonics teacher professional development

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A sample group of nineteen teachers completed the second phase of the Photonics Leaders II Optics and Photonics professional development program. Participants took a basic Physics content knowledge test that was designed by a Professor of Physics. The test was completed before participating in the program and at the end of the program to gather data for statistical inquiry. Statistical studies on pre-test and post-test data indicated significant gains in physics content knowledge over time, and that instructors teaching at the middle school level or only teaching one subject area scored significantly lower during the pretest. Additionally, reports from previous participants are summarized to disseminate the percentage of teachers who have incorporated at least one workshop activity and the kind of activity performed into their school curriculum. The teacher professional development program model, findings, and limitations will be reported in this paper.

Student Reactions to Problem-Based Learning in Photonics Technician Education

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Problem-based learning (PBL) is an instructional approach in which students learn problem-solving and teamwork skills by collaboratively solving complex real-world problems. Research shows that PBL improves student knowledge and retention, motivation, problem-solving skills, and the ability to skillfully apply knowledge in new and novel situations. One of the challenges faced by students accustomed to traditional didactic methods, however, is acclimating to the PBL process in which problem parameters are often ill-defined and ambiguous, often leading to frustration and disengagement with the learning process. To address this problem, the New England Board of Higher Education (NEBHE), funded by the National Science Foundation Advanced Technological Education (NSF-ATE) program, has created and field tested a comprehensive series of industry-based multimedia PBL "Challenges" designed to scaffold the development of students' problem solving and critical thinking skills. In this paper, we present the results of a pilot study conducted to examine students' reactions to the PBL Challenges in photonics technician education. During the Fall 2012 semester, students (n=12) in two associate degree level photonics courses engaged in PBL using the PBL Challenges. Qualitative and quantitative methods were used to assess student motivation, self-efficacy, critical thinking, and metacognitive self-regulation using selected scales from the Motivated Strategies for Learning Questionnaire (MSLQ). Results showed positive gains in all variables. Follow-up focus group interviews yielded positive themes supporting the effectiveness of PBL in developing the knowledge, skills and attitudes of photonics technicians.

Light & Optics Conceptual EvaluationFindings from First Year Optometry Students

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The Light and Optics Conceptual Evaluation (LOCE) was developed to examine conceptual understanding of basic geometric and physical optics for the Active Learning in Optics and Photonics program administered by UNESCO. This 50 item test (46 multiple choice, 4 ray-tracing, short answer) was administered to entering students in the Optometry professional degree (OD) program. We wanted to determine how much of the physics/optics concepts from undergraduate physics courses (a pre-requisite for entry to the OD program) were retained. In addition, the test was administered after the first year students had taken a required course in geometric and visual optics as part of their first semester courses. The LOCE was completed by two consecutive classes to the program in 2010 (n=89) and 2011 (n=84). The tests were administered the first week of the term and the test was given without any prior notice. In addition, the test was administered to the class of 2010 students after they had completed the course in geometric and visual optics. The means of the test were 22.1 (SD=4.5; range: 12-35) and 21.3(SD=5.1; range: 11-35) for the two entering classes. There was no statistical significance between the two classes (t-test, p>0.05). Similarly there was no difference between the scores in terms of gender. The post-course test (administered during the first week of the second term) showed a statistically significant improvement (mean score went from 22.1 to 31.1, a 35% improvement). It should be noted that both groups of students performed worse in questions related to physical optics as well as lens imaging, while scoring best in questions related to refraction and reflection. These data should be taken into consideration when designing optics curricula for optometry (and other allied health programs such as opticianary or ophthalmology).

Misconceptions about optics: an effect of misleading explanations?

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During our activities of physics dissemination with High School students especially concerning optics, we are used to distribute a questionnaire about colors and image formation by mirrors and lenses. The answers to some questions clearly show misconceptions and naïve ideas about colors, ray tracing, image formation in reflection and refraction. These misconceptions are widespread and do not depend on the gender, the level, and the age of the students: they seem to depend on some wrong ideas and explanatory models that are not changed by the curricular studies at school. In fact, the same errors are present in groups of students before and after optics courses at High School. On the other hand we have also found some misleading explanations of the phenomena both in textbooks and websites. Most of the time, errors are found in the explanatory drawings accompanying the text, which are based on some hybrid description of the optical processes: sometimes the description of the path of the ray light is confused with the image reconstruction by the lenses. We think that to partially avoid some errors it is important to use a teaching path centered on the actual path of the rays and not on what eyes see (the vision). In our oral we present the results of data collected from more than 200 students and some considerations about figures and explanations found in textbooks.

Active learning in optics & photonics: sustaining its benefits

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The training workshops on Active Learning in Optics and Photonics (ALOP) have been introduced to physics teachers in about 15 countries since UNESCO launched the project in 2003. So far, follow-up workshops in Colombia, Morocco, Philippines and Tunisia have been organized. The follow-up activities have come in forms consistent with the situation and capability of the host country. At the ALOP follow-up workshop, the ALOP Ateneo de Manila 2011, held in the Philippines on 17-21 October 2011, innovations in the workshop format were introduced. This follow-up activity was organized to enhance the capacities of Filipino physics teachers in optics and photonics. The workshop program was designed to build on the university's commitment to effective science education and its strong capability in designing, building and fabricating laboratory materials and equipment. The participants of the ALOP Ateneo workshop were completely involved in the preparation of materials for the hands-on activities in Geometrical Optics, Lenses and Optics of the Eye, Interference and Diffraction, Atmospheric Optics and Optical Data Transmission. All materials used in the workshop were acquired locally and almost all of the workshop facilitators were local experts. Workshop participants responded to an evaluation questionnaire particularly designed for use in the workshop. Further details of the innovations introduced in the workshop are discussed. Moreover, other formats of local ALOP follow-up activities being explored are presented.

Learning about light and optics in on-line general education classes using at-home experimentation

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General education courses are a critical part of improving a non-science major's understanding of science in general and of physics in particular. To keep pace with changing modes of instruction, on-line classes are also becoming a standard method of instruction. We offer several on-line courses: such as Physics for Computer Graphics and Animation and Light and Color. The courses are designed to teach students about basic concepts of light, color and optics. For Physics for Computer Graphics and Animation, software is used to demonstrate additive and subtractive light mixing as well as the function of lenses and mirrors. The software can provide students with the ability to control surface coloration, reflectivity and shape features that cannot be readily changed in laboratory. Both Physics for Computer Graphics and Animation and Light and Color include a significant amount of investigation into light, color and optics when taught "face to face." However, in the context of an on-line class, the question is how we might provide a meaningful and equivalent (or better) experience for on-line students? Our solution has been to develop kits the students rent or purchase that allow them to become "at home" investigators. The activities are designed so that the students must be engaged with the material and build upon their observations and conclusions. In the course, the students must participate in collaborative group discussions about their results. We present details of these courses, show student projects and discuss assessment of student understanding of light, color and optics after performing at home investigations.

An internet-based, post-graduate course in Spectacle Lens Design.

M Jalie

University of Ulster

The complexity of spectacle lenses has increased enormously over the last three decades. The advent of aspheric lenses for the normal power range and the, now commonplace, progressive lenses for the correction of presbyopia, are just two examples of 21st Century technology. Freeform surfaces are now employed to personalize lenses to wearer's needs and these may be both progressive and atoroidal in nature. At the same time, optometry has taken a sideways step from optics and physics into a more general primary health care profession with an ever-increasing amount of biological and medical content added to an already brimming curriculum, hence the need for persons without optometry training to undertake the study of spectacle lenses. Some years ago a post-graduate course was designed for opticians who had a good grasp of mathematics and the ability to pay close attention to detail in the lengthy trigonometric ray-tracing techniques employed in lens design calculations. The year-long course, is undertaken by distance learning, and has been undertaken via the internet by students from many countries around the world. Final assessment is by means of examination held by the Association of British Dispensing Opticians and takes the form of two three-hour papers, Paper One consisting of the determination of the aberrations of a spectacle lens by accurate trigonometric ray tracing and the second, a general paper on the optics of ophthalmic lenses. It leads to the professional qualification, ABDO (Hons) SLD.

HoloNet: a network for training holography

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Holography is an optics technique based on wave physics and lasers with several applications at our day life. The production of holograms involves experimental work based on hands-on activities and creativity. All these elements can contribute to the promotion of experimental teaching of optics and training on holography. The hologram itself acting as a final result from a long process of research and study can enable the engagement of high school students on physics and promote the stimulus on optics learning. Taking these assumptions into account a network of schools working on holography was built involving thirty schools from all country. Holography systems were developed and several hands-on activities were constructed. During last sixteen years students are working on laser optics and holography producing different kinds of holograms. This study presents all holography labs implemented at schools and it will analyzed the holography systems and materials developed for students. Training strategy will be discussed and holograms obtained by students will be presented. Results obtained show us that holography can be implemented as a strategy for promoting the learning of optics and it is a particular way to involve students on experimental work and lab research. Results obtained during this study will be presented in detail and analyzed with focus on students performance. Educational results, teachers training, prizes and other positive outcomes will be discussed and compared.

Interdisciplinary Education in Optics and Photonics based on Microcontrollers

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Not only is the number of new devices constantly increasing, but so is their application complexity and power. Most of their applications are in optics, photonics, acoustic and mobile devices. Working speed and functionality is achieved in most of media devices by strategic use of digital signal processors and microcontrollers of the new generation. Considering all these premises of media development dynamics, the authors present how to integrate microcontrollers and Digital Signal Processors in the curricula of Media Technology lectures by using adequate content. This also includes interdisciplinary content that consists of using the acquired knowledge in media software. These entries offer a deeper understanding of photonics, acoustics and media engineering.

Laws of Reflection and Snell's Law revisited by Video Modeling

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Video modelling is being used, nowadays, as a tool for teaching and learning several topics in Physics [1-3]. Most of these topics are related to kinematics. In this work we show how video modelling can be used for demonstrations and experimental teaching in optics, namely the laws of reflection and the well-known Snell's Law of light. Videos were recorded with a photo camera at 30 frames/s, and analysed with the open source software Tracker. Data collected from several frames can be treated with the Data Tool module, and graphs are built to obtain relations between incident, reflected and refraction angles, as well as to determine the refractive index of Perspex. These videos can be freely distributed in the web and explored with students within the classroom, or as a homework assignment to improve student's understanding on specific contents. They present a large didactic potential for teaching basic optics in high school with an interactive methodology.

[1] Brown, D. (2008). Video Modeling: Combining Dynamic Model Simulations with Traditional Video Analysis, *American Association of Physics Teachers (AAPT) Summer Meeting*, Edmonton (available at http://www.cabrillo.edu/~dbrown/tracker/, retrieved 21/09/2012).
[2] Brown, D., Cox, A.J. (2009). Innovative Uses of Video Analysis, *The Physics Teacher*, 47, 145-150.
[3] Rodrigues, M, Carvalho, P.S. (2013). Teaching Physics with Angry Birds*:* Exploringthe kinematics and dynamics of the game, *Physics Education*, *in the press*.

A correlation of thin lens approximation to thick lens design by using context based method in optics education.

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The effect of Coddington factors on aberration functions has been analysed using thin lens approximation with optical glass parameters. The dependence of spherical aberration on Coddington shape factor for the various optical glasses in real lens design was discussed using exact ray tracing for the optics education and training purposes. Thin lens approximation and thick lens design are generally taught with only lecturing method. But, thick lens design is closely related to the real life. Hence, it is more appropriate to teach thin lens approximation and thick lens design with real-life context based approach. Context based teaching can be effective in solving the problems in which the subject is excessively difficult and irrelevant. Also it provides extensive evidence for optics education that students are generally unable to correctly apply the concepts of lens design to optical instruments currently used. Therefore, the outline of real-life context based thick lens design lessons were proposed and explained in detail considering thin lens approximation.

Advantages and disadvantages of using computers in education and research

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Use of computers in education and research has completely changed the way things were made before. For example a lecture to the students or the presentation of a paper to a Congress are completely different with respect to those of only a few decades ago, when blackboard, transparencies or photographic slides were used. There are many positive aspects of using computers, for example making a talk very attractive. However there are also negative aspects. In this paper an analysis is presented of advantages and disadvantages and of consequences of using computers.

m-Learning and holography: compatible techniques?

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Since the last decades, cell phones have become increasingly popular and are nowadays ubiquitous. New generations of cell phones are now equipped with text messaging, internet, and camera features. They are now making their way into the classroom [1]. This is creating a new teaching and learning technique, the so called m-Learning (or mobile-Learning). Because of the many benefits that cell phones offer, teachers could easily use them as a teaching and learning tool. However, an additional work from the teachers for introducing their students into the m-Learning in the classroom needs to be defined and developed. As an example, optical techniques, based upon interference and diffraction phenomena, such as holography, appears to be convenient topics for m-Learning. They can be afforded with simple examples and experiments from the cell phones performances and classroom accessibility. We will present some results carried out at the Faculty of Physical Sciences in UCM to obtain very simple holographic recordings via cell phones. The activities were carried out inside the course on Statistical Optics, offered to students in the fourth course of the licentiate degree in Physical Sciences. Some open conclusions and proposals will be presented.

1.- Z. Ben Lakhdar, Z.Dhaouadi, H.Ghalila, S.Lahmar and Y. Majdi, "Using mobile camera for a better exploitation and understanding of interference and diffraction experiments", Proc. The Education and Training in Optics and Photonics (ETOP) (Ed. A. Shore), Proc. SPIE (2009).

Phase derivative estimation in digital holographic interferometry

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Estimation of phase derivatives from a fringe pattern is a challenging problem with immense practical significance, since they provide information about the physical quantities such as strain, curvature and twist distribution of a deformed object. In the talk, we discuss the problem in the context of digital holographic interferometry, and present some novel techniques for phase derivative estimation. These techniques exhibit great application potential in areas such as non-destructive testing, experimental mechanics and material characterization.

Photonics and Scientoonics: We Can Create A New Light

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Science education and research is facing now-a-days a tough challenge around the world. Many times, the way it is being taught, it looks very technical, less interesting and sometimes even boring. Educationists around the world including in USA, are worried as students are opting for more lucrative career options in business, commerce and information technology. This trend is not a healthy one as no country can progress without the development in science. Now-a-days most of the scientific researches have become interdisciplinary and many experts from different background have to work together. To communicate to such different experts from various disciplines, is a real challenge. It is well said that a picture is worth thousand words. *Cartoons* are the combination of caricature and satire. *Caricature* means distorted drawing and *satire* means a humorous comment. If the subject of the cartoon is science then they are called science cartoons. Scientoons are a new class of science cartoons, based on science. They not only make you smile and laugh but also provide information about new researches, subjects and concepts in a simple, understandable and interesting way. Scientoonics is new branch of science, which deals with effective science communication using a novel class of science cartoons called scientoons. Scientoons have been recognized/ appreciated all over the world by several international organizations including WHO, UNESCO, UNEP, Royal Swedish Academy, International Union of Pure and Applied Chemistry, American Chemical Society, Junior Chamber International (USA), DECHEMA, Germany and also by NCSTC (DST, Govt. of India), CSIR, Indian Science Congress Association and many more. European Science Festival 2008 held from July 18-22, 2008 at Barcelona, Spain, organized a full session on Scientoonics (www.esof2008.org) The word 'photonics' is derived from the Greek word "photos" meaning light; it appeared in the late 1960s to describe a research field whose goal was to use light to perform functions that traditionally fell within the typical domain of electronics, such as telecommunications, information processing, etc. Why do we need Photonics is very simple as Uninhibited light travels thousands of times faster than electrons in computer chips. Optical computers will compute thousands of times faster than any electronic computer can ever achieve due to the physical limitation differences between light and electricity. Applications of photonics are ubiquitous. Included are all areas from everyday life to the most advanced science, e.g. light detection, telecommunications, information, lighting, meteorology, spectroscopy, holography, (surgery, vision correction, endoscopy, health monitoring), military technology, laser material processing, visual art, biophotonics, agriculture and robotics. This Scientoon based audiovisual technique is more useful when a scientific program is undertaken to make people understand and learn and thus create interest in that area for mass awareness, higher education and research. This paper is an attempt to show that how complex subjects of science like photonics and optics can be presented and effectively explained using scientoons so that the science communication/education/research in these areas can be made more informative, effective, interesting and useful. This in turn will help new students to know, understand and work in the area of Photonics, a very promising area where a lot can be done.

Evolution of the Centre for Optical and Laser Engineering in Singapore

Anand Asund

Director, COLE, Nanyang Technological University Singapore

The Centre for Optical and Laser Engineering in Singapore evolved from various angles. Researchers in the School of Mechanical and Aerospace Engineering had been working in this field for some time most notably in Optical Metrology, Instrumentation and Laser Processing. There was also a strong presence of Photonics in the School of Electrical and Electronic Engineering who were primarily concentrating on devices such as diodes and fiber optics for telecom applications. Since Photonics was more in fashion, there was lot of interest in this area. However, Singapore has a strong Precision Manufacturing Industry and hence is strong in areas of Design, Manufacturing and Metrology. This was attractive to Optical Engineering companies such as Coherent, Edmund Optics and QiOptiq to have their manufacturing base here. Furthermore semi-conductor fabs industry was strong and with new companies such as Ultratech setting up their facilities here, the need for optical engineers became apparent. The Photonics graduates were not entirely suited for this industry. It took some time to convince administrators that Photonics and Optical Engineering while having commonalities are distinct and separate and that the Mechanical Engineering curriculum is better suited to train Optical Engineers. Hence the set-up of COLE which primarily teaches and researches in areas such as Optical Design, Optical Metrology and Instrumentation and Laser

Processing and Precision Optical Manufacturing. In this talk, some of the background on COLE and its mission and objectives will be highlighted.

DEVELOPING THE CRITICAL THINKING, CREATIVITY AND INNOVATION SKILLS OF UNDERGRADUATE STUDENTS

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A desirable goal of engineering education is to teach students how to be creative and innovative. However, the speed of technological innovation and the continual expansion of disciplinary knowledge leave little time in the curriculum for students to formally study innovation. At West Point we have developed a novel upper-division undergraduate course that develops the critical thinking, creativity and innovation of undergraduate science and engineering students. This course is structured as a deliberate interactive engagement between students and faculty that employs the Socratic method to develop an understanding of disruptive and innovative technologies and a historical context of how social, cultural, and religious factors impact the acceptance or rejection of technological innovation. The course begins by developing the background understanding of what disruptive technology is and a historical context about successes and failures of social, cultural, and religious acceptance of technological innovation. To develop this framework, students read *The Innovator's Dilemma* by Clayton M. Christensen, *The Structure of Scientific Revolutions* by Thomas S. Kuhn, *The Discoverers* by Daniel J. Boorstin, and *The Two Cultures* by C.P. Snow. For each class meeting, students survey current scientific and technical literature and come prepared to discuss current events related to technological innovation. Each student researches potential disruptive technologies and prepares a compelling argument of why the specific technologies are disruptive so they can defend their choice and rationale. During course meetings students discuss the readings and specific technologies found during their independent research. As part of this research, each student has the opportunity to interview forward thinking technology leaders in their respective fields of interest. In this presentation we will describe the course and highlight the results from teaching this course over the past five years.

CApability Matrix for Photonics Up-Skilling – CAMPUS

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This paper describes work aimed at delineating industrially-relevant photonics up-skilling capabilities available within higher education (HE) institutions in Wales, UK. The primary outcome of aim of the project was an easily accessible summary of those resources. In order to capture such data in a user-friendly form use was made of a CApability Matrix for Photonics Up-Skilling - CAMPUS'. CAMPUS was part of a wider project which was focussed on enhancing opportunities in Science, Technology, Engineering and Mathematics (STEM). The HE-STEM project was funded by the Higher Education Funding Councils of England and Wales – HEFCE and HEFCW respectively. CAMPUS was delivered by the Photonics Academy of Wales@Bangor (PAWB) and developed with assistance of the Welsh Opto-electronics Forum – the de facto photonics industry trade association in Wales In the presentation the methodology adopted in developing CAMPUS will be described and exemplar content discussed. In order to fully represent the capabilities of the HE institutions data was collected on resources for Training, Research, Expertise and Equipment (TREE). Multiple platforms have been used to communicate the outcomes of the CAMPUS project. On completion of the project, two public dissemination events were held in two locations in Wales. Those events attracted representation from industry, government and academia. The Welsh Government 'Expertise Wales' website also hosts the outputs from CAMPUS. Printed copies of CAMPUS were made available via these events and can be sourced from the present author. An indication will be given of continuing activities directed at sustaining the momentum created by CAMPUS.

Hands-On Physics Displays for Undergraduates

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Initiated by Frank Oppenheimer in 1969, the Exploratorium in San Francisco has been the model for hands-on science museums throughout the world. The key idea has been to bring people with all levels of scientific background in contact with interesting and attractive exhibits that require the active participation of the visitor. Unfortunately, many science museums are now forced to cater primarily to very young audiences, often 8 years old or less, with predictable constraints on the intellectual depth of their exhibits. To

counter this trend, the author has constructed several hands-on displays for the University of Michigan Physics Department that demonstrate: (1) magnetic levitation of pyrolytic graphite, (2) the varied magnetic induction effects in aluminum, copper and air, (3) chaotic motion of a double pendulum, (4) conservation of energy and momentum in a steel ball magnetic accelerator, (5) the diffraction pattern of red and green laser pointer beams created by CDs and DVDs, (6) a magnetic analog of the refraction of light at a dielectric boundary and (7) optical rotation of light in an aqueous fructose solution. Each of these exhibits can be constructed for something like $1000 or less and are robust enough to withstand unsupervised public use. The dynamic behavior of these exhibits will be shown in accompanying video sequences.

Hands-on optics for active and cooperative learning

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Many approaches can be employed for making knowledge of Optics and its learning more attractive and efficient. Hands-on Optics activities permit students to be able to carry out experimental work and thus construct their knowledge bearing in consideration the way in which people learn Science. In them, an understanding of many natural and technical processes is carried out via direct observation and experience. Usually, they will promote active participation and engagement and can be found at interactive centers, but an important strength is also being made in order to introduce them into formal learning environments. In this invited talk, an updated view of Hands-on Optics resources (books, journals, events, projects, associations, mass media, companies, museums...) is presented together with several strategies for using this kind of experiments inside/outside the classroom.

Hands-On Session: Student Activity: Verification on Malus's Law of Polarization at low cost.

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Polarization is the property of electromagnetic waves that describes the orientation of their field oscillation. Students face hard problem to visualise the important of the polarization in daily life. In common practise, students are taught with the help of sketch diagram. In this project, we describe both quantitative and qualitative ways of experimenting polarization using very low cost and easily available material: polarized sunglasses, PVC tubes, light-dependat resistors, LED, etc. With this set, the experiment of the Malus's Law verification of light polarization can be done without the need of expensive optical detector for quantitative measurement. Students will develop their own simple optical sensor if the set is developed as a project. This set of experiment integrates the concept of basic electricity. Therefore, students acquires the practical knowledge of electricity and optics in the easy way.

Learning to teach Optics through experiments and demonstrations

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We have applied an active methodology to pre-service teacher training courses and to active teacher workshops on Optics. As a practical resource, a set of demonstrations has been used to learn how to perform classroom demonstrations. The set includes experiments about polarization and birefringence, optical information transmission, diffraction, fluorescence or scattering. It had been prepared for Science popularization activities and has been employed in several settings with a variety of audiences. In the teacher training sessions, simple but clarifying experiments have been performed by all the participants. Moreover, in these workshops, devices or basic set-ups, like the ones included in our demonstration set, have been built. The practical approach has allowed the enthusiastic sharing of teaching and learning experiences among the workshops participants. We believe that such an active orientation in teacher training courses promotes the active and collaborative teaching and learning of Optics in different levels of Education.

Multicolour LEDs in Educational Demonstrations of Physics and Optometry

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Availability of light emitting diodes LED in wide spectral region makes demonstrations and practical exercises simple and attractive. Sufficient offer in LED colour selections, its good colour purity, relative negligible inertia especially comparing to eye photoreceptors characteristic time, easy organizable intensity control on TTL voltage level and sufficient low cost electronics basis in market allow implement new educational ideas in teaching optics and optometry. In stimuli for experiments of trichromatic colour maching three – red, green and blue high intensity LEDs are placed either in focus of collimating lens system of projector or attached to ends of diffuse scattering PMMA bars. The first way realizes light sources of large intensity range, the second gives the possibility to integrate the Lambertian type light source with color varying background as computer display. Both solutions provide stimulus with homogenous color and luminance distribution. Besides colour maching the set-up allows to realize simple for students studies of eye relative color sensitivity using heterochromatic flicker photometry technique, or using specially selected red-yellow-green LEDs to build visual stimuli for experiments of isolation of eye cone photoreceptor system [principles described in 1,2]. Report demonstrates *in vivo* and on tablet computer screen the applications of LED based practical exercises.

1. J. Pokorny, V. Smith, and M. Lutze, "Heterochromatic modulation photometry." *J. Opt. Soc. Amer.***A6**, 1618–1623 (1989).
2. J. Kremers, T. Usui, H.P.N. Scholl, and L.T. Sharpe, "Cone Signal Contributions to Electrograms in Dichromats and Trichromats." *Invest, Ophth. Vis. Scie.* **40**, 920-930(1999).

Laser Spectroscopy Education and Development in Biophotonics Research at Nairobi

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We highlight for the purpose of sharing experience, progress in research and capacity building in laser physics and spectroscopy at University of Nairobi since 2002. We have built capacity in optical physics and photonics at undergraduate, and laser physics and spectroscopy at graduate levels. A major research line has been established in method development and instrumentation in laser spectroscopy and multispectral imaging for problems in geothermics, medicine and environment. We have set-ups in tunable diode laser absorption spectroscopy (TDLAS) for trace atmospheric greenhouse gas monitoring; and for gas in scattering media absorption spectroscopy (GASMAS) studies; laser induced breakdown spectroscopy (LIBS); laser Raman spectromicroscopy; and LED-based multispectral microscopy for medial imaging applications. Although these analytical tools have high accuracy and versatility, their utility is limited by the complexity of the samples and of data analysis and interpretation. We here explain how we combine these tools with multivariate chemometrics and machine learning techniques to help reduce the data complexity and increase the information gained. Our work is especially strong in medical elementology and spectral diagnosis of disease, which involves spectroanalytical and hyperspectral imaging (*in vivo* and *ex vivo*) of pathogens and trace elements and their speciation in body tissues and fluids associated with *malaria and cancer.*
The goal is to elucidate their role in biopathological activity, and their profiles, distribution and evolution with disease progression (dynamic analysis); and to monitor their response to therapeutic intervention, at sub-cellular scales. We consider this capacity mature for forging international research collaboration; and plan to introduce courses such as Non-Linear Optics, Nanophotonics, Biophotonics, Applied Biophysics and Quantum Optics and to establish a Laser Center for Atomic and Molecular Physics for more specialized research and for hosting an MSc course in Applied Photonics.

Visualization of light beams in liquid crystal layers for demonstration of basic optical phenomena.

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We propose to use a liquid crystal cell as a new teaching tool for a study of basic optical phenomena like refraction and reflection of light. Such possibility is based on previously obtained experimental results [1,2] concerning propagation of light beams in the plane of a liquid crystal layer. In particular, the electrically controlled refraction and reflection of light at crossing the boundary separating regions of different orientations was registered. The scattering of light induced by thermal fluctuations of a director was used to visualize light beams. It opens new way for demonstration of optical phenomena for teaching at schools and universities.

[1] A.G. Maksimochkin, S.V. Pasechnik, V.A. Tsvetkov et al, Optics Comm. 270 (2007) 273–279.
[2] A.G. Maksimochkin a, S.V. Pasechnik a,b, G.I. Maksimochkin, V.G. Chigrinov, Optics Comm. 283 (2010) 3136–3141.

Optical demonstrations with spatial light modulators

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Liquid crystal on silicon displays, otherwise known as spatial light modulators (SLMs), are now ubiquitous tools in many research laboratories. In general they are phase-only devices, pixelated, and have found numerous applications in the spatial and spectral control of light fields, both for classical and quantum studies. In this paper I will outline how SLMs may be used in the teaching laboratory as a learning tool. I will start by showing how to augment teaching of Fourier optics with practical demonstrations using SLMs, and then move on to show how optical experiments with SLMs may be used to unlock some interesting physics often taught theoretically but seldom experimentally. In particular I will illustrate how to measure microscopic forces with SLMs incorporated into optical traps, how to visualize the outcome of quantum entanglement experiments with classical light and SLMs, and finally how to build a student-friendly laser that incorporates an SLM. In the process I will highlight some of the present outreach activities by the National Laser Centre in South Africa.

Variable retarders by modified twisted nematic liquid crystal keychain for education purpose.

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An objective of this research is to construct a prototype of an alternative polarizing device using a twisted nematic liquid crystal (TN-LC) keychain as variable retarders for education purposes. In the first part of this study, an unknown TN-LC keychain is investigated in terms of fundamental characteristics. In the second part, the performance of the liquid crystal keychain is studied as variable retarders. This experimental setup consists of a 650 nm laser diode as a light source, the TN-LC sandwiched between a polarizer and a polarimeter which is used to investigate the polarization state of an output. From the investigation, the retardance introduced by the liquid crystal can be fully controlled by an applied ac voltage. The TN-LC keychain is applied by voltages between 1.65 to 1.70 volt at frequency 100 Hz and voltages between 3.60 to 3.90 volt at the same frequency so as to create quarter and half wave retardance, respectively. In the final part, the modified liquid crystal keychain as an alternatively low cost device is implemented in a simple experiment for studying purpose in the topic of polarization.

Learning in the cloud: A new challenge for a global teaching system in optics and photonics

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Nowadays, it is assumed of many applications, companies and parts of the society to be always available online. However, according to [Times, Oct, 31 2011], 73% of the world population do not use the internet and thus aren't “online” at all. The most common reasons for not being “online” are expensive personal computer equipment and high costs for data connections, especially in undeveloped areas that comprise most of the world’s population (e.g. parts of Africa, Asia, Central and South America). However it seems that these countries are leap-frogging the “PC and landline” age and moving directly to the “mobile” age. Decreasing prices for smart phones with internet connectivity and PC-like operating systems make it more affordable for these parts of the world population to join the “always-online” community. Storing learning content in a way accessible to everyone, including mobile and smart phones, seems therefore to be beneficial. This way, learning content can be accessed by personal computers as well as by mobile and smart phones and thus be accessible for a big range of devices and users. A new trend in the Internet technologies is to go to “the cloud”. This paper discusses the changes, challenges and risks of storing learning content in the “cloud”. The experiences were gathered during the evaluation of the necessary changes in order to make our solutions and systems “cloud-ready”.

Web based interactive educational software introducing semiconductor laser dynamics: Sound of Lasers (SOL)

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In this work, educational software for intuitive understanding of the basic dynamic processes of semiconductor lasers is presented. The proposed tool is addressed to the students of optical communication courses, encouraging self consolidation of the subjects learned in lectures. The semiconductor laser model is based on the well known rate equations for the carrier density, photon density and optical phase. The direct modulation of the laser is considered with input parameters which can be selected by the user. Different options for the waveform, amplitude and frequency of the injected current are available, together with the bias point. Simulation results are plotted for carrier density, output power and instantaneous frequency versus time. Instantaneous frequency variations of the laser output are numerically shifted to the audible frequency range and sent to the computer loudspeakers. This results in an intuitive description of the "chirp" phenomenon due to amplitude-phase coupling, typical of directly modulated semiconductor lasers. In this way, the student can actually listen to the time resolved spectral content of the laser output. By changing the laser parameters and/or the modulation parameters, consequent variation of the laser output can be appreciated in intuitive manner. The proposed educational tool has been previously implemented by the same authors with locally executable software. In the present manuscript, we extend our previous work to a web based platform, offering improved distribution and allowing its use to the wide audience of the web.

Design, development, testing and validation of a Photonics Virtual Laboratory for the study of LEDs

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This work presents the design, development, testing and validation of a Photonic Virtual Laboratory, highlighting the study of LEDs. The study was conducted from a conceptual, experimental and didacticstandpoint, using e-learning and m-learningplatforms. Specifically, teaching tools that help ensure that our students perform significant learninghave been developed. It has been brought together the scientific aspect, such as the study of LEDs, with techniques of generation and transfer of knowledge through the selection, hierarchization and structuring of information using concept maps. For the validation of the didactic materials developed, it has been used procedures with various assessment tools for the collection and processing of data, applied in the context of an experimental design. Additionally, it was performed a statistical analysis to determine the validity of the materials developed. The assessment has been designed to validate the contributions of the new materials developed over the traditional method of teaching, and to quantify the learning achieved by students, in order to draw conclusions that serve as a reference for its application in the teaching and learning processes, and comprehensively validate the work carried out.

Graphical User Interfaces for Teaching and Research in Optical Communications

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This paper highlights the use of graphical user interfaces (GUIs) developed with the guide tool from Matlab® for university level optical communications courses and research activities. Graphical user interfaces programmed with Matlab® would not only improve the learning experience, making models easier to understand, but also could be tweaked and improved by students themselves. As Matlab is already taught in many universities, this would ease the process. An example of a model for a stationary EDFA is given to demonstrate the ease of use and understanding of the role of all the different parameters of the model, so students can get a real interactive experience. Another considered potential application is in research. With GUIs, researchers can make real-time parameter optimization, quick assessments and calculations, or simply showcase their work to broader audiences who may not be so familiar with the topic. A practical example of a research application is given for a parameter optimization of a model for non-linear phenomena in uncompensated long-haul transmission links is given. Besides all the emphasis given to practical applications and potential situations for its use, the paper also covers the basic notions of the critical steps in making a successful Matlab® GUI. Ease of use, visual appearance and computation time are the key features of a successfully implemented GUI.

Diversity of devices along with diversity of data formats as a new challenge in global teaching and learning system

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The popularity of mobile communication devices is increasing day by day among students, especially for e-learning activities. “Always-ready-to-use” feature of mobile devices is a key motivation for students to use it even in a short break for a short time. This leads to new requirements regarding learning content presentation, user interfaces, and system architecture for heterogeneous devices. To support diverse devices is not enough to establish global teaching and learning system, it is equally important to support various formats of data along with different sort of devices having different capabilities in terms of processing power, display size, supported data formats, operating system, access method of data etc. Not only the existing data formats but also upcoming data formats, such as due to research results in the area of optics and photonics, virtual reality etc should be considered. This paper discusses the importance, risk and challenges of supporting heterogeneous devices to provide heterogeneous data as a learning content to make global teaching and learning system literally come true at anytime and anywhere. We proposed and implemented a sustainable architecture to support device and data format independent learning system.

Workshop on: Active Learning in Optics: Two Examples

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Optics is an enabling technology that has far ranging importance in fields such as nanoscience. However, it is not of great interest to the vast majority of students. A solution to this problem is the training of teachers in active learning methodologies. We will organize a workshop to present an example of an active learning process in Optics developed for training of teachers in developing countries (a UNESCO project) and will focus on 2 modules:

1 - Interference & diffraction is considered by students as being very hard to understand and is taught in most developing countries as purely theoretical with almost no experiments. Simple experiments to enhance the conceptual understanding of these wave phenomena will be presented.

2 - Lenses and optics of the eye are of interest to all students. In this module, we will deal with image formation by eye, myopia, hyperopia, astigmatism and accommodation.

The objectives of the workshop will be: To provide an experience of the use of the active learning method in optics including the use of experiment, mind’s on & hands-on exercises, group & class discussions; To share information about teaching of optics in high school & universities.

Integrating Undergraduate Research into the Electro-Optics Program

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Bringing research into an undergraduate curriculum is a proven and powerful practice with many educational benefits to students and the professional rewards to faculty mentors. In recent years, undergraduate research has gained national prominence as an effective problem-based learning strategy. Developing and sustaining a vibrant undergraduate research program of high quality and productivity is an outstanding example of the problem-based learning. To foster student understanding of the content learned in the classroom and nurture enduring problem-solving and critical-thinking abilities, we have created a collaborative learning environment by building research into the Electro-Optics curriculum for the first- and second-year students. The teaching methodology is described and examples of the research projects are given. Such a research-integrated curriculum effectively enhances student learning and critical thinking skills, and strengthens the research culture for the first- and second-year students.

Interdisciplinary High-School Curriculum in Electro-Optics as a Tool to Enhance Students' Interest in Optics and Electronics

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An interdisciplinary curriculum in electro-optics was recently developed and implemented in a leading high school. This unique three-year program integrates optics and electronics and is designed to enhance students' interest in these areas. The program begins in 10th grade with the fundamentals of geometric optics and basic concepts in electricity (e.g. Ohm's law and Kirchhoff's laws) and electronics (e.g. sinusoidal signals and operational amplifiers). In 11th grade, the students study wave optics, the dual nature of light, atomic structure, light-matter interactions, and fundamentals of modulation (AM/FM). During the final year of study (12th grade), the program focuses on light sources (LED and laser), radiation detectors (photodiodes and solar cells), and electro-optical systems such as optical communication systems and imaging systems. The study described in the paper characterized the changes during the course of the school year in the attitudes towards the program and towards future pursuit of optics and electronics of fourteen 12th grade students. Questionnaires and semi-structured interviews were used to collect data. Research findings reveal a considerable improvement in students' attitudes towards interdisciplinary studying of optics and electronics. Students found the integration of the two areas to be interesting and believed that it leads to a deeper understanding of the disciplinary contents. The research also indicates that in addition to an increase in the students' interest in the program, their desire to continue with more advanced studies in these fields increased as well.

Advanced Optics in an Interdisciplinary Graduate Programme

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The Okinawa Institute of Science and Technology Graduate University, established in November 2011, provides a 5-year interdisciplinary PhD programme, through English, within Japan. International and Japanese students entering the programme undertake coursework and laboratory rotations across a range of topics, including neuroscience, molecular science, physics, chemistry, marine science and mathematics, regardless of their previous education. To facilitate interdisciplinarity, the university has no departments, ensuring seamless interactions between researchers from all disciplines. As part of the programme a course in Advanced Optics has been developed to provide graduate students with the practical and theoretical skills to enable them to use optics tools in any research environment. The theoretical aspect of the course introduces students to experimental procedures for complex beam generation (e.g. Laguerre-Gaussian beams), optical trapping, beam analysis and photon optics and is supported through a practical programme covering introductory interference/diffraction experiments, to more applied fibre optics. It is hoped that, through early exposure to optics handling and measurement techniques, students will be able to develop and utilize optics tools regardless of research field. In addition to the formal course in Advanced Optics, a selection of life sciences students also undertake 15 week laboratory rotations in the Light-Matter Interactions research laboratory, where they work side-by-side with physicists in developing optics tools with bio-applications. While currently in the first year of operation, conclusive results about the success of such an interdisciplinary PhD training are speculative. However, initial observations indicate a rich cross-fertilization of ideas stemming from the diverse backgrounds of all participants.

Photonics and Holography through Delight and Enthusiasm Itinerary of Discovery

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In recent years Sciences and Technologies have developed at a fast pace. But while more and more people have access and use the resulting instruments (planes, car, fast trains, TV, telephone, internet etc …) young people have been less and less attracted by sciences wether « hard » or « light » (or « Human » or « Inhuman »). In Europe, recent analysis show that they are more and more attracted by “money” and « management ». They feel that « sciences » are difficult, unattractive and good only for « autistic geniuses », They are more and more attracted by « money » and « management ». To try to react against this evolution, we tried to develop an interactive educational project. We feel that successful innovations within the educational system need to identify and confront challenges that arise from mega-trends on a global scale We design a multidisciplinary program involving teachers of physics, chemistry, art, natural sciences, languages, etc. We try to do this in framework of international cooperation, with european level as a first step forward. We try to emphasize that everything we know about matter has been obtained by using waves. And that everything we know about waves (lights or sounds or others) has been obtained by using materials. We try to make people understand that our culture is mixture of two things:

- Physics (nature in greek: what can be experienced through our senses, or via instruments in contact with our senses)
- Meta-Physics which includes all other things (this is not traditional meaning of « metaphysics ».

Physical world is divided in two domains « materials » and « waves » Modern physics claims that there is an equivalence between « materials » and « waves » To make this more easy to understand, we believe we have to present it in many different ways and aspects. It should be made not only attractive or interesting but even « fascinating ». Relations between objects, 3D images, verbal descriptions and mathematical descriptions can be made more obvious by showing that they are diferent views (under different angles) of the same problems. Holography is thus made a central media to develop an educational tool for the 21st century citizens. We have developed hardware and software tools teach photonics, via holography from nursery school to university level. We present results of experiments in France and Germany and analyse perspectives

Optics and Communication Technology Major of Physics Undergraduate Degree at King Mongkut's Institute of Technology Ladkrabang

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Physics undergraduate degree major in optics and communication technology has been offered at King Mongkut's Institute of Technology Ladkrabang (KMITL), Bangkok, Thailand since June 2009. The goal of the program is to graduate students, who would work in optics industry or continue to do optics research in graduate program both in physics and engineering degree. In 2013, the first group of student just has graduated from the program. There are nine required three credit hour courses plus a number selection in optics and communication base technology courses, which deal with fundamental optics, optical techniques, communication theory, and applications of optics in great details. Two three- hour laboratory courses, which are consists of experiment set emphasis on geometrical and physical optics, the generation and property of laser, Fourier optics, fiber optics, spectroscopy, etc. have been integrated in the required courses for more understanding in lecture courses and increasing in research technical skills. For improving self thinking of the students, as the other majors, nine credit hour research project courses have been including in the curriculum. Having real life research problems and more research opportunities, the students also have been allowed to conduct their research projects with private companies, industries, or research institutes. Moreover, the program has encouraged the students in the major to participate in international conference as well. In order to make more participation opportunity for our students, recently, the program, on behalf of physics department with supporting by NECTEC, SPIE and OSA, has organized its first optical science and engineering conference name "The international conference on Photonic solutions 2013 (ICPS 2013).

DEFI Photonique: a French national training project for optics and photonics industry

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The French government supports a structuring project for French Photonics. This project named *DEFI Photonique* is carried by the CNOP (National Optics-Photonics Committee) for a period of 5 years (2013-2017). It contains a very important aspect dedicated to training for industry, particularly SMEs. The project aims at elaborating a training offer based on the experience of PYLA, the Bordeaux training facility for Optics and Photonics, and create a national network through all the French Photonics clusters.

Getting Light to Work – photonics upskilling for industry

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This paper will provide an overview of an innovative approach to delivering photonics up-skilling for industry. The strong emphasis of the approach is on hands-on creativity whereby participants in the up-skilling process demonstrate novel applications of principles of photonics. The approach has been pioneered within the Photonics Academy of Wales@Bangor (PAWB) and has benefited from support within two projects: UPSKILL -User-driven Photonics Skills Improvement via Life-long Learning (UPSKILL) and OPUS: Optics and Photonics Up-Skilling for industry. UPSKILL was completed in July 2012 whilst OPUS is in progress and will continue until June 2015. UPSKILL was part of a wider project concerned with on enhancing opportunities in Science, Technology, Engineering and Mathematics (STEM). The HE-STEM project was funded by the Higher Education Funding Councils of England and Wales – HEFCE and HEFCW respectively. OPUS is funded under a Work-Based Learning programme support by the European Social Fund and the Welsh Government. The paper will provide exemplars of activity undertaken within both UPSKILL and OPUS and will specifically demonstrate means for enthusing participants to develop novel applications of photonics. Such creativity is underpinned by

participants gaining familiarity with the fundamentals of photonics. The PAWB approach has been used successfully with a wide range of participants from primary school students through to post-doctoral workers and experienced industrial engineers.

MSc degree in Color Technology for the Automotive Sector

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Nowadays the measurement and management of color quality of the gonio-apparent materials is complex, but highly demanded in many industrial sectors, as automotive, cosmetics, plastics, printing inks, architectural coatings, etc. It needs control of a complex instrumentation and visual assessment of texture and color differences in order to get, for instance, a visual harmony in car bodies; and a profound knowledge of physics and chemistry of (metallic, interference, or diffractive) special-effect pigments for their optical formulation in order to obtain attractive visual effects in coatings, plastics, etc, combining among them and with solid pigments. From the University of Alicante, for the academic year 2013-14, we are organizing the first MSc degree in Color Technology for the Automotive Sector, with a design of contents embracing CIE colorimetry and visual perception, included the AUDI2000 color difference formula, instrumentation and color management software (as ColorCare by BASF Coatings, etc), fundamentals of coatings and plastics in the automotive sector, and, optical formulation of pigments. The MSc syllabus, with 60 ECTS, is designed to be taught in only two semesters: from September to February with on classroom theoretical and practical activities, and, from March to June at virtual level, with internships of training (maximum 300 hours) in some companies. So, the MSc Thesis would be the performance report during the internship in companies or research institutions. Some multinational companies, both as car makers and coatings and plastics providers, from European and non-European countries (USA, Latin America, Asia, etc), have already shown their support and interest in welcoming students for specific training, even some job offers when the first MSc edition finishes.

ANSI Laser Standards, Education (Z136.5), Research & Development (Z136.8)

Ken Barat

CLSO

Several factors affect laser use in educational settings. First is the lower cost of lasers, in particular diodes have made lasers more accessible for laser classroom use (think of the hand held laser in red, green and blue). Second in the research and development, no technology has made the impact of the laser. Third the importance of introducing students to this technology. To the point no discipline is laser free. To address laser safety in the academic setting two American National Standard Institute Standards have been developed. The most recent Z136.8 Safe Use of Lasers in Research, Development and Testing Setting, published in 2012. Formerly Z136.5 Laser Safety in Education -2009 version was published. Z136.5 provides guidance for educators starting in public school and ranging into the college level. This includes classroom demonstrations and science fair demonstrations. Z136.8 is geared for the University and Commercial research level. Z136.5 relies on the use of pre-approved safety lessons plans and appreciation of student maturity or lack of, Z136.8 relies heavily on cooperation between the user and the laser safety officer. The presentation will cover the contents of each and the different approaches taken.

Optical inspection methods and their applications in the manufactured industrial sector: Knowledge transfer to Panamanian industry

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A means of facilitating the transfer of Optical inspection methods knowledge and skills from academic institutions and their research partners into Panama optics and optical research groups is described. The process involves the creation of an Integrated Knowledge Group Research (IKGR), a partnership led by Polytechnic University of Panama with the support of the SENACYT and Optics and Optometry Department, Polytechnic University of Catalonia. This paper describes the development of the Project for knowledge transfer “Implementation of a method of optical inspection of low cost for improving the surface quality of rolled material of metallic and nonmetallic industrial use”, this project will develop a method for measuring the surface quality using texture analysis speckle pattern formed on the surface to be characterized. The project is designed to address the shortage of key skills in the field of precision

engineering for optical applications. The main issues encountered during the development of the knowledge transfer teaching and learning are discussed, and the outcomes from the first four months of knowledge transfer activities are described. In overall summary, the results demonstrate how the Integrated Knowledge Group Research and new approach to knowledge transfer has been effective in addressing the engineering skills gap in precision optics for manufactured industrial sector.

Using Concept Building in Optics to Improve Student Research Skills

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One of our goals is to have students become independent researchers. However, to become independent requires confidence and competence. But it also requires developing abilities of inquiry, physical understanding and experimental skills. Unfortunately, the easy route of simply giving students "recipe" laboratories fails to develop student confidence or competence, and certainly does not help develop inquiry. In an effort to remedy this situation, we have been developing a curriculum that assists students in becoming more independent. In this presentation, I will discuss the approach we use in intermediate optics to build competence, confidence, skills, and instill inquiry. I will describe our assessments of the modifications we have performed. I will describe our effort to improve research skills, we attempted to replace our non-traditional, mechanics based laboratories in introductory physics with optics laboratories. Through this work we have identified four critical issues that assist in developing independent researchers: 1) The importance of introductory laboratory in setting student laboratory expectations, 2) The need to instill inquiry in the classroom as well as in the laboratory, 3) The need for laboratory to be anything but training and mere exposure if the students are to have a chance at research success. 4) The need for students to develop communication skills that help them synthesize what they are doing.

An Introductory Approach to The Concept of Spatial Coherence

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The concept of spatial coherente is usually difficult to understand in its first approach. We suggest here a description that involves only elementary trigonometric identities and provides a simple idea on how a Young Fringes system with eventually high visibility can be obtained even if the source is constituted by incoherent sources. The visibility in the fringes with a compound source is found as the coincidence of several shifted fringes systems coming each from every single point. These are added on an intensity basis. This approach leads in a natural way to the same result for the visibility as the Van Cittert-Zernike Theorem for any arbitrary source distribution. The description is accompanied by a simple experiment consisting in the observation of a natural everyday scene through a card with two very small and very close pinholes. After the observer gets familiar by watching the fringes using a pointlike source, he perceives the fringes also around intensity discontinuities in almost any everyday scene, a somewhat surpising result that confirms the concept obtained in the calculations.

A course on Foundations of Optical System Analysis and Design (FOSAD)

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Ready availability of powerful software has brought about a metamorphosis of the field of optical system analysis and design, one of the core areas of optical engineering. Practicing scientists or technologists are no longer constrained by their limited computational ability; rather they can give vent to their imagination and carry out experiments with intensive numerical procedures in pursuance of practical problems in analysis and synthesis of complex optical and photonic systems. Indeed, someone with good understanding of the principles of image formation and image quality assessment procedures, photometry, radiometry, basics of aberration theory and characteristics of different types of lens systems, optical and photonic components, sources and detectors can do wonders with many of the software. Unfortunately, many scientific and/or technical people or their managers seem to have a short sighted perception that procuring powerful optics design software is sufficient for tackling practical problems of analysis and synthesis of optical systems with rudimentary knowledge of optics. This notion has gained ground, because even a novice often comes out with makeshift solutions for routine or known problems by using the software. However, in the assessment process, the question of optimality of the solution is seldom taken into consideration. On the other hand, there is a burgeoning requirement for novel optical and photonic systems catering to needs of diverse fields from defense, aerospace, astronomy and health sciences, to name a few. Emulating routine systems is often inadequate to tackle such problems. With this backdrop in view, a set of ten lecture units dealing with foundations of optical system analysis and design has been developed. In a regular optical engineering course, this is covered in two semesters with accompanying tutorials. For special purposes, the whole course can be squeezed into twenty lecture hours, with two lecture hours assigned for each of the ten units. This course has so far been delivered in Poland, Japan and India, and it is being modified by feedbacks from participants. This talk dwells upon the details of this course.

Calculation of reflected and transmitted powers of a metamaterial waveguide structure using MAPLE software

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In this communication, We Consider a waveguide structure consisting of a pair of Metamaterial and dielectric slabs inserted in vacuum. A plane polarized wave is obliquely incident the proposed structure. Metamaterials or sometimes called left-handed materials (LHMs)) are materials whose real parts of permittivity ε and permeability μ are both negative and consequently have negative index of refraction. The transmission of the electromagnetic waves through the structure is analyzed theoretically and numerically with the emphasis on the dissipation factor. Maxwell's equations are used to determine the electric and magnetic fields of the incident waves in each region. Then, Snell's law is applied and the boundary conditions of the fields are imposed at each layer interface to obtain a number of equations with unknown parameters. The MAPLE software is used to solve these equations for the unknown parameters to calculate the reflection and transmission coefficients. These coefficients are used to determine the reflected, transmitted and loss powers of the structure. In the numerical results the mentioned powers are computed and illustrated as a function of frequency, angle of incidence and slab thickness when the dissipation factor changes.

Joint Special Session ETOP2013 RIAO/OPTILAS2013

Women & Optics

With presentations from: Prof. Maria L. Calvo, Prof. Maria J. Yzuel, Prof Donna Strickland, Prof. Cristina Solano, Susana Silva and Raquel Queirós, and Prof. Anna Consortini.

Round table discussion with the participation of: Prof. Angela Guzman, Prof. Maria S. Millan, Prof. Souad Lahmar, and Prof Patricia Forbes.

Women in Science: Physics and Optics

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The number of women is less than the number of men in degrees like physics and engineering. In this paper we present the percentages of female students at the Spanish Universities. The percentage of women decreases for faculty members. We also give some figures for female students in physics degree. The value of mentoring programs is analyzed. The learning societies in physics and in optics have established committees and programs for helping the women in their scientific career. We describe them in general and we focus on the SPIE Women in Optics program.

SPOF, Sociedade Portuguesa para a Investigação e Desenvolvimento em Óptica e Fotónica, 2013.