Education in Nanotechnologies

Project no. 543861-TEMPUS-1-2013-BG-TEMPUS-JPCR

IMPLEMENTATION REPORT

PROJECT PARTNERS

BULGARIA

Technical University of Sofia

ITALY

Polytecnico di Torino

FRANCE

CIME Nanotech at Grenoble INP

ISRAEL

Bar-Ilan University
Ben Gurion University of the Negev
Hebrew University of Jerusalem
Technion
Tel Aviv University
Weizmann Institute of Science
Samuel Neaman Institute for Advanced Studies in Science and Technology
Elbit Systems

Co-funded by the Tempus Programme of the European Union

This project has been funded with support from the European Commission.
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Introduction

Nanotechnologies cover different scientific areas not only nanoelectronics. In the EduNano project some of the existing courses were updated and new courses were developed to enrich the nanotechnology curriculum: in physics, engineering, biotechnology. The topics and contents were selected according to the current needs of industry and on technological forecasts after a survey with the nano industry in Israel and analysis of currents and forthcoming educational needs.

Each university participating in the project developed courses in its best fields of expertise and is benefiting now from courses developed by other universities in their areas of specialization. For each Nano centre to develop high quality courses for its own students is not cost effective. This pooling of resources enables the building of a repository of high quality fully online courses for the benefit of all participating Nano centres and universities.

The fifth and last EduNano project objective is "To perform a pilot test and to start the implementation of the joint modules/courses delivery." In this report we present the implementation of the courses at each university and the exploitation results.

Background

Through domain/job analysis the necessary knowledge, skills and competences in nanotechnologies were defined in terms of learning outcomes. A survey on the necessary competencies was developed by SNI and evaluated by the partners first, on-line, and then peer-reviewed during the second project meeting. The survey was distributed to 140 Nano-companies and researchers in order to meet the industry employment needs and the needs of the researchers/teachers to help provide students with the most relevant skills and competencies in this field. According to the need analysis and towards the learning outcomes defined, 24 courses for the new skills in nanotechnology training were developed.

To facilitate the mobility of students between institutions in Israel and Europe, to each course credits had to be provided, compatible with European Accreditation Transfer System (ECTS) requirements. To achieve these goals HUJI organized two meetings of institutional representatives including Bologna Process consultant and module coordinators. The first meeting introduced the Bologna process principles by the consultant. By the end of this meeting a general module plan was introduced. In the second meeting lead also by the consultant, each participant introduced his module structure and its logic was discussed. In addition more detailed discussions about grading system, diploma supplement and quality assurance were performed.

Teachers training on Bologna process and ECTS and on e-learning course development

Though the project objectives do not target directly the institutional and national changes, the training seminars on Bologna process were organised and the new courses developed through learning outcomes definition, credits according ECTS and implementation of courses with recognition of credits between Israeli and EU universities is a step towards introduction of the credit system in Israeli institutions.

Bologna Process Training was done by Prof. Aaron Palmon and Dr. Tatiana Gornostaev at the Hebrew University of Jerusalem.

The 1999 Bologna Declaration established a common platform aimed at integrating and standardizing the higher education curriculum and improving students' mobility between institutions. Based on the Bologna Process guidance, and on the experience they have gained

during the implementation of its principles in the Hebrew University, Prof. Aaron Palmon and Dr. Tatiana Gornostaev prepared for the EduNano partners five presentations focused on:

1. Introduction to Bologna Process.
2. Learning Outcomes (definition, logic for change, Bloom's Taxonomy, guidelines, benefits).
3. European Credit Transfer and Accumulation System - ECTS (characteristics, planning, Workload, Bologna cycles).
4. Practical guidelines for syllabi writing.
5. Critical review and common problems in writing EduNano project syllabi.

After the presentations, the partners were asked to prepare syllabi for the courses of the EduNano project.
Syllabi sent to the Bologna Process consultant have been examined, and partners have received feedback and proposals for amendments. This process was carried out on individual consultation meetings.

On sequel summary meeting and followed by further correspondences, the problems, which partners encountered during the process of writing the syllabi, were discussed and possible solutions have been proposed. In this way, partners could also broaden their perspective on syllabi writing, by the experience gained by all partners as a group.

Further consultation meetings were on demand throughout project time by individual partner request.
In summary, Israeli partners participating in the EduNano project were familiarized with the Bologna Process in general by both workshops and individual consultation meetings, and prepared syllabi to the proposed courses.

To achieve the second project objective, Jack Barokas from TAU Computing Division organised two training workshops on the video-recording technique and course development in EduNano Moodle environment.
2014-05-15 Video recording and Moodle workshop
To support the partners in creating the e-learning materials additional three virtual meetings were held with Scopia: on 2014-12-25, 2015-01-20 and 2015-02-23.

The competence matrix

A Competence Matrix served as the starting point for innovating the educational programmes and facilitated the demand-based and competence-oriented process for designing the courses. The core work tasks were identified in the professional context and the courses designed in the learning outcomes approach in order to facilitate transparency.

Course	Knowledge	Skills	Competence
'learning outcomes' means statements of what a learner knows, understands and is able to do on completion of a learning process, which are defined in terms of knowledge,	'knowledge' means the outcome of the assimilation of information through learning. Knowledge is the body of facts, principles, theories and practices that is related to a field of	'skills' means the ability to apply knowledge and use know-how to complete tasks and solve problems.	'competence' means the proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development

skills and competence;	work or study.		
Molecular electronics for the realisation of novel nanoelectronic devices	Basics on quantum mechanics and of the use of molecules, in particular organic ones, for the realization of electronic devices	Ability to apply the theoretic concepts to the design and implementation of novel electronic devices.	Ability to manage the design of molecular devices and to apply the innovative approaches to the study of a not standard solution for the realisation of electronic devices.
Design of Nanoscale MOS ICs	Highly specialised knowledge on CMOS integrated circuit layout, basic technology, IC design and modelling and specific physical effects in short channel transistors.	Ability to design submicron CMOS ICs using CADENCE and solving problems with modelling of submicron devices behaviour.	Demonstrate innovation, autonomy, scholarly to the development of new modelling and design rules at the forefront of work or study contexts including research in nanoelectronics design.
Nanomaterials	Advanced knowledge of a field of materials for nanoelectronics and their use in nanodevices fabrication, involving a critical understanding of theories and principles of their physical and chemical properties.	Advanced skills, demonstrating mastery and innovation in the use of new materials for the fabrication of new submicronic devices.	Manage complex technical and professional activities and projects in using new materials for nanoelectronics.
Introduction to Materials and Nanotechnology (for teachers)	Basic knowledge in the area of material and nanotechnology	Applying this knowledge to critically read and review current research literature in nanotechnology and the ability to identify and discuss ethical issues regarding nanotechnology research and application	The ability to build a presentation of a chosen area in nanotechnology based on synthesis of several research papers, to identify the advantages, disadvantages and the potential of a chosen research, and to evaluate peer presentations of different areas in nanotechnology
Scanning Probe Microscopy and its Applications in	Understand the operation and capabilities of SPM	Ability to critically read nanoscience literature making use	Ability to suggest and implement appropriate use of SPM to solve

Research and Nanotechnology Industry	and how they can be applied to solve research and technical problems.	of SPM, and to make basic analyses of SPM data.	technical problems and as part of nanoscale research
Kinetics of Materials	Knowledge in concepts of driving forces and fluxes. Fundamentals of solid-state diffusion applied to a variety of examples like multi-system, ionic crystals, etc.).	Ability to develop framework of driving forces and fluxes for any experiment involving solid state diffusion	Estimate and predict the results of experiments involving solid state diffusion
Nano-science and nano-technology. Why is “nano” different and how is it useful?	Understanding of the fundamentals of nano-science, its applications for various fields, new developments, including new optoelectronic devices, new materials and new biomedical applications	Ability to design a solution to various technological and scientific problems using nano-fabrication, nano-characterization and nano-devices and methodologies	Design the principle characteristics of nano-particles for biomedical applications, nano-device for near-field optical measurements and nano-based material for surface-chemistry applications.
Macroscopic quantum coherence in engineered nano-systems	Advanced knowledge of the field of quantum coherence, communication and computing. Specifically we will focus on nano-engineered systems for quantum information applications.	Ability to classify the advantages and disadvantages of different engineered quantum nano-systems. Ability to calculate basic properties of different quantized nano-systems and estimate sensitivity to noise and measurement. Ability to critically read and review current literature of nanosystems applied to quantum information processing systems - single photon sources and quantum computing architectures	Solve analytically and numerical simulations of diverse electronic and optical nano-engineered systems for quantum information.
Nanotechnology in service of humanity	General acquaintance with the field of Nanoscience and	Ability to show general knowledge on Nanoscience.	Acquaintance with central terms, methods and research

	Nanotechnology, several of its central research fields and general applications and importance to humanity in general and industry in particular.	Ability to generally present the field and explain its characteristics, its general research directions and its contribution to humanity and industry.	directions towards the ability to communicate with people in the field of Nanoscience and Nanotechnology for the purpose of collaboration.
Biotechnologies	Understand the basic concepts and applications based on biological molecules engineering from the nano- to microscale.	Apply the advanced technical approaches used in biotechnology (bioactive surface preparation, nano-particles functionalizing, biosensors use,…)	Ability to use the biotechnology methodology to resolve engineering issues in devices and systems.
Spintronics	Understand the basics of magnetic materials and building blocks of a magnetic/spintronic devices	Ability of using technical approaches (fabrication, characterization) for a spintronic device	Ability to use different proprieties of magnetic nanostructures to engineer devices with new applications.
Advanced topics in Electro-Optics and Photonics	From fundamental principles of quantum solid state physics to selected advanced photonic devices. Focusing on photonic devices that are based on nano-scale structures	Ability to apply the theoretical solid state quantum mechanical theory to the devices design and expanding the student's capabilities in understanding the structures of new photonic devices.	Applying innovative approaches and solutions for the realisation of electro-optics devices.
Journey through time and space towards the future drugs	Basic knowledge in nanotechnology: history, definition and vision and the impact of nanotechnology in array of fields. Introduction to nanomedicine: the needs and the expectations and their assimilation in drug design	Ability to understand and discuss nanotechnology and target drug delivery research and application.	Ability to understand research in nanotechnology and nanomedicine and accomplishing a solid background that will enable wider study in those areas

The new courses

Syllabi of the 24 courses were designed and credits for each course were determined. The courses were developed with three different foci. First are full-semester academic courses, which will allow different universities access to the same class. These courses had to be approved by each academic program individually, and they cover introductory topics, such as physics of nano-systems, basic biology for physics students, basic photonics for non-engineering students, etc.

The second class of courses are full academic courses focusing on technology. These courses are similar to courses already existing in most universities, but they complemented and enhanced by documented demos, which will allow improved learning for students. These courses should be extremely valuable to people from the industry.

The third type of courses are of a small scope, covering a particular topic. They are used as introductory courses for graduate student training, or for people from the industry. Those courses will be most valuable in enhancing the training of users in new technologies.

To achieve the third project objective, the TAU Computing Division organised two training workshops on the video-recording technique and course development in EduNano Moodle environment. The contents for the defined learning outcomes were designed and the video-recording of lectures and practical work in the Nano laboratories of partner institutions was done.
The project Web site is: http://edunano.eu/.
The EduNano platform address is: http://edunano-lms.tau.ac.il/
The access as a guest:
username: demouser
password: user1-Demo

Exploitation/Implementation of e-learning courses

The new courses are structured according to the three cycle system and using the ECTS: 6 courses for BSc degree, 11 – for MSc, 10 – for PhD students, 5 – could be used by industry, 5 – for high school teacher training and 2 – for high school students. The total of courses is 24 and most of them are suitable for MSc and PhD level, or BSc and high school teachers etc. The list of courses per partner institutions, the level in the three cycle system and the number of students who have already attended it given in brackets is the following:

BIU: ‘Nanoscience and nanotechnology. Why is ‘nano’ different and how is it useful?’ (10) - MSc, PhD
’Kinetics of Materials’ (15) - MSc, PhD

BGU:‘Nanotechnology journey through time and space towards the future drugs’ (18) – high school students, Basics
‘Advanced topics in electro-optics and photonics’ (19) – MSc PhD, suitable for industry

WEIZMANN: a course for chemistry high school teachers to disseminate nanotechnology in their chemistry lessons: ‘Into materials and nanotechnology’ (90),
and an advanced course in the field of nanotechnology focusing on the ‘SPM technique and its applications in research and in nanotechnology industry (8)’; MSc, PhD, suitable for industry

HUJI: ‘Microscopic quantum coherence in engineered nano-systems’ (47) – MSc and PhD
‘Nanotechnology in service of humanity’ (108) – BSc and general public including humanity students and social sciences and general public.

TECH: ‘Quantum mechanics for the nano-programme' (4) MSc, PhD
‘Fundamentals of nano-biotechnology’ (31) – MSc, PhD

TAU: ‘Atomistic Simulation of Materials’ (11) for MSc students
‘Introduction to Surface Science’ (34) for BSc students
‘Micro-Nano Technologies’ (89) for MSc students
Hi-Tec Entrepreneurship – additional extra course (to once indicated in the submission) ongoing and recorded during current semester
Fabrication of Microelectromechanical System (MEMS) Devices – repository of recorded procedures in the clean room – for prfessionals from industry, MSc and PhD students
The Micro Nano Electronics course authors from TAU, POLITO and EPFL conducted many online video conference meetings to coordinate the joint course and its live webcast so students could attend on real time

Elbit developed a course for industry training 'Advanced Materials and Nanotechnologies for Electrochemical Energy Storage Systems' – training professionals.

POLITO: 'Bio-nanoelectronic devices for biosensing (29), 'Molecular electronics for the realization of novel nanoelectronic devices’(17) , the Nano/microelectronic interfaces being part of this course and ‘CAD for Microsystems’ (80) for PhD students and for MSc students, specialised technological courses

TUS: 'Nanomaterials for electronics' (9) – MSc and PhD students
'Design of nanoscale MOS ICs' (20) - BSc, MSc, suitable for industry

CIME: 'Biotechnologies' (37)– Engineering schools MSc and PhD,
‘Spintronics’ (42) PhD and MSc, suitable for industry

Elbit developed a course for industry training 'Advanced Materials and Nanotechnologies for Electrochemical Energy Storage Systems' – training professionals.

All courses were peer reviewed during the project meetings and on-line and the necessary improvements were done. At TUS, first a pilot test with a small groupd of students was done and after improvement of HTML courses and with better support if students, the field trial with regular students was done.
In EduNano project we applied the assessment of learning outcomes through the knowledge tests and/or completing assignments/projects for design of circuits or devices.
All courses were designed for corresponding credits and are part of the regular curriculum the university delivering it or formally recognised by the other universities which students enrolled in the course, e.g. students from Weizmann, BIU, Polito were enrolled for a course delivered by TAU. All Israeli students who performed the practical training in Grenoble and Torino have followed the corresponding to the practical training on-line course and after successfully passing the tests could perform the mobility. The courses were mutually recognised by the Israeli and European HEI.

Exploitation/Implementation of the training mobility of students and high school teachers

From July 7th to July 12th 2016, 25 Israeli students from the six partner universities performed a mobility for intensive practical training in the clean rooms in Grenoble. In December 2016 eight Israeli high school teachers attended the sessions on electrical characterization, photovoltaics, scan probe microscopy, nanobiotechnology and clean room processes.
23 Israeli students attended the practical training at Polito in two sessions, 18/07/2016 – 22/07/2016 and 25/07/2016 – 29/07/2016.

The students were evaluated on their performance during the practical assignments and on the final test. They were certified with corresponding to the training credits.
The detailed reports on the practical training in France and Italy are presented in the in the next two sections. Examples of the certificates are also presented in the next sections.

Training at CIME Nanotech, Grenoble INP, France

Introduction

CIME Nanotech as a partner involved in the EduNano project contributed by providing two video recorded lectures in the field of Spintronics and Nanobiotechnologies. In addition, CIME Nanotech offered four one week lab sessions organized in July 2016 and December 2016**.**

Spintronics

Since the discovery of giant magnetoresistance, research activity in spintronics is evolving extremely fast and many applications have been developed such as magnetic sensors, read heads, magnetic memories, magnetic logic devices, microwave components. A major trend of spintronic devices is the continuously decreasing size of the active part combined with an increasing operation frequency (nanosecond and below). The course covered spintronics from basic knowledge to working principles of several applications, describing fabrication and characterization technics. Knowing how the magnetic behaviour is affected by device scaling and how to control magnetization is the key-issue for developing new applications or optimizing those already existing.
The lecture has been set up by Professor Liliana Buda-Prejbeanu with the help of two course lecturers, Mair Chshiev and Ursula Ebels. In order to follow this course, students need some prerequisites, namely basics in solid state physics, quantum mechanics, electromagnetism and magnetism.
At the end of the courses, students should be able to:

- Understand the basics of magnetic materials and building blocks of a magnetic device
- Know the basic properties of magnetic nanostructures
- Use the LLG equation to understand the control of magnetization
- rigorously analyse the scientific literature
- Know the basic principles of various applications (sensors, memories, oscillators)

Nanobiotechnologies

Nanobiotechnology is a new and vast domain, which is intrinsically multidisciplinary: first because at this scale, combined chemical and physical properties provide new functions; second because living cells and organisms are sensitive to molecules and molecule assemblies from the nano- to the microscale. The possibility to engineer objects with such resolution gives the opportunity to strongly influence biological phenomena, for the best and the worse. It is therefore essential to provide a good overview of the possibilities and the difficulties of these technologies, using examples of ongoing research activities. In this way, the student will develop his/her imagination and be ready to seize new opportunities from his own work.
The lecture has been set up by the Professor Franz Bruckert with the help of several course lecturers, Marianne Weidenhaupt, Didier Delabouglise, Catherine Picart, Didier Gasparutto, Charlotte Vendrely, Dominique Bourgeois, Valerie Stambouli. The course prerequisites are a basic knowledge of biological macromolecules (DNA, RNA, proteins) and of genes (gene structure, promoter, transcription, translation, splicing). Moreover, a knowledge of prokaryote

and eukaryote cell culture and of the control of gene expression (transcription factors, histones) is a plus.
Upon a successful completion of this course students should be able to:

- Understand the basics of protein engineering
- Use fluorescent molecules
- Know the basic properties of nanoparticles and how to functionalize, characterize and handle them
- Know how to prepare bioactive surfaces and to characterize them
- Know the basic principles of most biosensors
- Critically read the scientific literature about possible applications of nanoparticles and bioactive surfaces in biology and medicine

Laboratory practices organized at CIME Nanotech, Grenoble, France

First session

CIME Nanotech in Grenoble hosted students from the partner Israeli universities in the framework of Edunano project. From July 7th to July 12th, 25 students and a faculty member from Technion, the Weizmann Institute, Tel Aviv University, Bar Ilan University, the Hebrew University of Jerusalem and Ben Gurion University attended practical works on our facilities. Two main themes were proposed within this program:

- MOS transistor manufacturing, with practices on clean room processes, processing technology simulation and MOS transistor electrical characterization (2 groups of 8 students).
- Nano-biotechnology labs, with practices on DNA extraction from a bacteria, DNA labeling by fluorescence, DNA hybridization on an oligonucleotide and AFM manipulation, which can also be used on biological materials (1 group of 10 students).

Ten faculty members from the University Grenoble Alpes and the Grenoble Institute of Technology were involved in these classes. Students really appreciated their professionalism and expressed their individual feeling, such as that of Tony Y. from Baryan University: “We get to know amazing people who guided us along the workshop and taught us about the facilities and the manufacturing processes ... Although I already have an experience of working in a clean room, this experience was really extraordinary due the really high quality process and the endless options of fabrication and research”.

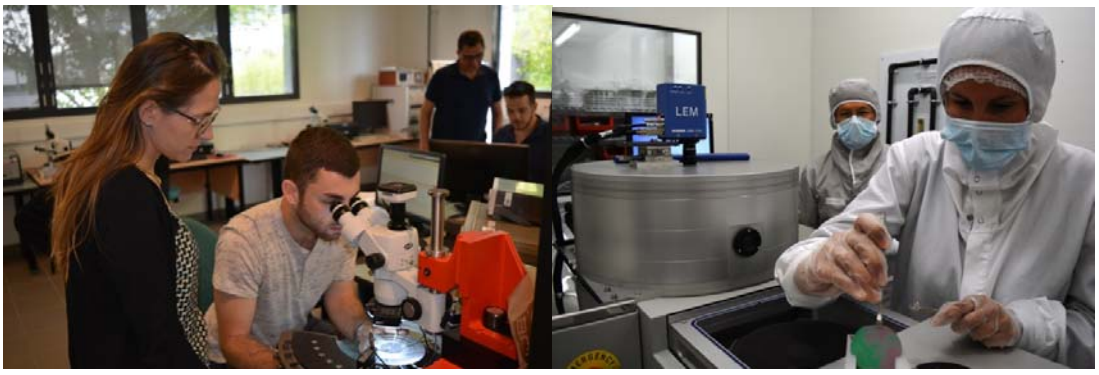


Fig 1. Israeli students on the electrical characterization platform and in the clean room.

At the end of this session, our faculty members unanimously declared themselves very satisfied with the interactions they had with the students. It must be said though that our Israeli colleagues were careful to send only their best elements to Grenoble; this could be felt through the issues that they raised and through their great interest for state-of-the-art equipment at CIME Nanotech.

Every student passed these classes with a high grade and left with an attendance certificate that will enable him/her to validate 1.5 ECTS credits in his/her home university.

Fig 2. Israeli students receive their certificate.

Second session

CIME Nanotech hosted a second session dedicated to high school teachers from December 12th to 14th. Eight Israeli high school teachers attended this session (1 group). They followed practicals on electrical characterization, photovoltaics, scan probe microscopy, nanobiotechnology (PCR) and clean room processes.

Fig 3. Israeli teachers practicing photolithography in the clean room under the supervision of Prof. Marceline Bonvalot

In addition to the labworks in our facilities, they met the founders of the Nano@school program. This program, offered to high-schoolers from the area of Grenoble for several years, intends to connect nanotechnology with high school science. This was a unique opportunity for Israeli teachers to discuss nanotechnology teaching issues with their French counterparts**.**

Fig 4. Learning scan probe microscopy with an haptic interface and electrical circuit characterization

Student list and affiliations

EduNano					
Univ.	**First name**	**Name**	**Lab**	**Contact**	
Technion	Heidi	Leonard	Bio	Simcha	4 Bio
Technion	Sofi	Arshevski	Bio	Simcha	
Technion	Boris	Simakhov	Bio	Simcha	
Technion	Reef	Enoch	Bio	Simcha	
Weizmann	Eran	Mishuk	MOS	Sidney	2 MOS
Weizmann	Olga	Kranis	MOS	Sidney	
TAU	Yonatan	Vaknin	MOS	Jack	6 MOS
TAU	Assaf	Peled	MOS	Jack	
TAU	Ronen	Dagan	MOS	Jack	
TAU	Giorgia	Fiaschi	MOS	Jack	
TAU	Richa	Pandey	MOS	Jack	
TAU	Tali	Dotan	MOS	Jack	
Bar Ilan	Tony	Yamin	MOS	Yael	5 MOS
Bar Ilan	Erez	Zion	MOS	Yael	
Bar Ilan	Efrat	Roth	Bio	Yael	1 Bio
Bar Ilan	Anat	Yitzhak	MOS	Yael	
Bar Ilan	Tali	Sharabani	MOS	Yael	
Bar Ilan	Yael	Goldfinger	MOS	Yael	
HUJ	Hadas	Han	Bio	Tirza	5 Bio
HUJ	Dvir	Dror	Bio	Tirza	
HUJ	Itamar	Peled	Bio	Tirza	
HUJ	Shani	Koshrovski	Bio	Tirza	
HUJ	Tal	Stern	Bio	Tirza	
BGU	Nir	Yarza	MOS	Tziona	3 MOS
BGU	Hadas	Lupa	MOS	Tziona	
BGU	Ofir	Shmolovich	MOS	Tziona	

Teacher's feedback

- The hospitality was wonderful! ☺
- Hands-on with advanced instrumentation that they only read about
- Excellent teachers in CIME
- Experienced different pedagogy approached (very open inquiry)
- Received ideas how to support students' inquiry
- Their preparation was sufficient (based on Ron's course).

Training at Politecnico di Torino, Italy

The Hands-On course of EduNano Project held at Politecnico di Torino, Italy, was done in two sessions:

- 18/07/2016 – 22/07/2016
- 25/07/2016 – 29/07/2016

To the course, a total of **23 students** participated, specifically:

WEEK 1: 9 Students

Avichai Marcovici	BGU
Yossi Keydar	BGU
Netanel Barhanin	BGU
Daniel Itshak	BIU
Hadas Navenzal	BIU
Edith Beilis	TAU
Kian Kadan	TAU
Celine Maud Bounioux	TAU
Dima Kalaev	TECH

WEEK 2: 14 Students

Shir Shahal	BIU
Chen Tzur	BIU
Haim Sazan	BIU
Nava Shmoel	HUJI
Avner Neubauer	HUJI
Nir Sukenik	HUJI
Amir Ziv	HUJI
Samuel Goldstein	HUJI
Hen Alpern	HUJI
Ayelet Yashar	HUJI
Lilach Saltoun	HUJI
Michal Golan	TAU
Srdjan Pusara	TECH
Matej Kurtulik	TECH

And the assessments for the 2 courses were done on the last days of the two weeks, Friday 22nd and Friday 29th of July, 2016.

Course content

The general description of the course is split in two main topics:

1. Use of tools for molecular level simulation
2. Fabrication of NanoGaps for molecular electronics and biosensors

1. Use of tools for molecular level simulation

The training started with the introduction and review of the electrical conduction in molecular transistors. Inspiration of the approach is related to the paper "A. Zahir, A. Pulimeno, D. Demarchi, M. R. Roch, G. Masera, M. Graziano, and G. Piccinini, "EE-BESD: molecular FET modeling for efficient and effective nanocomputing design," *J Comput Electron*, Jan. 2016".

Then this review, joint with the acquired knowledge from the online course "Molecular Electronics for the Realisation of Novel Nanoelectronic Devices", was exploited in the realization of few Lab works.

The Hands-On was devoted to the use of CAD tools for the molecular level simulations. The tools used were:

1. **MotorDuck**, a set of Octave scripts to evaluate the conduction in a molecular transistor as a function of technological and molecular parameters, starting from results obtained in molecular level simulators built using **Atomistix ToolKit (ATK) - Virtual Nanolab (VNL)**
2. **VHDL-AMS,** for molecular based circuit modeling, using the EE-BESD model, embedded in the VHDL-AMS simulator
3. **Gaussian,** (as in "LAB1: Gaussian" and "LAB2: Electronic Structure of Molecules with Gaussian"). Gaussian is the most common computational chemistry tool. Starting from the fundamental laws of quantum mechanics, Gaussian predicts the energies, molecular structures, vibrational frequencies and molecular properties of molecules and reactions in a wide variety of chemical environments. Some simple molecules will be defined and simulated. It will be used for Molecular QCA simulations.
4. **Mosquito**, a MatLab based tool developed at VLSI group of Politecnico di Torino for performance evaluation of molecular circuits
5. **Atomistix ToolKit (ATK) - Virtual Nanolab (VNL)** (as in "LAB3: I-V simulation of molecular devices with VNL"). This tool gives the possibility of using Molecular Dynamics computational tools, for an "ab-initio" approach to solve problems at the nano-Angstrom scale. The first part focuses on the Gaussian-Gaussian Viewer software for molecular optimization, the second on the Atomistix ToolKit (ATK) - Virtual Nanolab (VNL) software for the study of the charge molecular transport.

2. *Fabrication of NanoGaps for molecular electronics and biosensors*

This section focused on the concepts presented in the course "Bio-Nanoelectronic Devices for BioSensing".
During the Lab, in which the students did not do personally the work, but followed a demonstration, the custom system NanoCube, realized by the researchers of Politecnico di Torino. The system is described in the paper "P. Motto, M. Crepaldi, G. Piccinini, and D. Demarchi, "NanoCube: A Low-Cost, Modular, and High-Performance Embedded System for Adaptive Fabrication and Characterization of Nanogaps," *IEEE Trans. Nanotechnology*, vol. 13, pp. 322–334, Mar. 2014".
The specific activities were:

1. Fabrication of nanogaps/nanoelectrodes
2. Functionalization with organic molecules, but also with the deposition of ZnO nanowires inside the gaps
3. Characterization of the produced nanodevices

Detailed Programs

Week 1: 18/07/2016 – 22/07/2016

Monday 18/07/2016	Teacher	Topic
9:00-10:30	Piccinini	Introduction/Review to Transport at the Nanoscale
Coffee Break		
10:45-12:15	Piccinini	Description and Analysis of a Model for Current evaluation in Molecular Devices - I

Lunch Break		
14:00-15:30	Piccinini	Description and Analysis of a Model for Current evaluation in Molecular Devices - II
Coffee Break		
15:45-17:15	Graziano	Introduction to Molecular Electronics Labs

Tuesday 19/07/2016	Teacher	Topic
9:00-10:30	Graziano	EE-BESD Lab - I
Coffee Break		
10:45-12:15	Graziano	EE-BESD Lab - II
Lunch Break		
14:00-15:30	Graziano	Motor Duck Lab - I
Coffee Break		
15:45-17:15	Graziano	Motor Duck Lab - II

Wednesday 20/07/2016	Teacher	Topic
9:00-10:30	Richter	Practical molecular electronics
Coffee Break		
10:45-12:15	Richter	Introduction to biomolecular electronics
Lunch Break		
14:00-14:30	Demarchi	Introduction to the use of Nanogaps, Nanowires and Dielectrophoresis for Integrated Sensors
14:30-17:00	Miccoli	Demonstration Lab on Intergration of ZnO Nanowires on Nanogap Devices for UV Sensing

Thursday 21/07/2016	Teacher	Topic
9:00-10:30	Miccoli	Introduction and Demonstration of Atomic Force Microscopy and its Electrical Characterizations
Coffee Break		
10:45-12:30	Demarchi/Miccoli/ Sanginario	Visit to the Chivasso MiNES Laboratory
Lunch Break		
14:00-17:00	Demarchi/Miccoli	Introduction to Micro4Nano Devices

Friday 22/07/2016	Teacher	Topic
9:00-10:30	Miccoli/Sanginario	Lab for Metalization of M4N Chips
Coffee Break		

10:45-12:15	Miccoli/Sanginario	Characterization of Metalized M4N Chips and Sensing Measurements
Lunch Break		
14:00-15:30	All	Course Assessment
Coffee Break		
15:45-17:15	All	Closing Remarks

Week 2: 25/07/2016 – 29/07/2016

Monday 25/07/2016	Teacher	Topic
9:00-10:30	Piccinini	Introduction/Review to Transport at the Nanoscale
Coffee Break		
10:45-12:15	Piccinini	Description and Analysis of a Model for Current evaluation in Molecular Devices - I
Lunch Break		
14:00-15:30	Piccinini	Description and Analysis of a Model for Current evaluation in Molecular Devices - II
Coffee Break		
15:45-17:15	Graziano	Introduction to Molecular Electronics Labs

Tuesday 26/07/2016	Teacher	Topic
9:00-10:30	Graziano	EE-BESD Lab - I
Coffee Break		
10:45-12:15	Graziano	EE-BESD Lab - II
Lunch Break		
14:00-15:30	Graziano	Motor Duck Lab - I
Coffee Break		
15:45-17:15	Graziano	Motor Duck Lab - II

Wednesday 27/07/2016	Teacher	Topic
9:00-10:30	Graziano	Molecular Field-Coupling Nanocomputing
Coffee Break		
10:45-12:15	Graziano	Lab on Mosquito Tool
Lunch Break		

14:00-14:30	Demarchi	Introduction to the use of Nanogaps, Nanowires and Dielectrophoresis for Integrated Sensors
14:30-17:00	Miccoli	Demonstration Lab on Intergration of ZnO Nanowires on Nanogap Devices for UV Sensing

Thursday 28/07/2016	Teacher	Topic
9:00-10:30	Miccoli	Introduction and Demonstration of Atomic Force Microscopy and its Electrical Characterizations
Coffee Break		
10:45-12:30	Demarchi/Miccoli/ Sanginario	Visit to the Chivasso MiNES Laboratory
Lunch Break		
14:00-17:00	Demarchi/Miccoli	Introduction to Micro4Nano Devices

Friday 29/07/2016	Teacher	Topic
9:00-10:30	Miccoli/Sanginario	Lab for Metalization of M4N Chips
Coffee Break		
10:45-12:15	Miccoli/Sanginario	Characterization of Metalized M4N Chips and Sensog Measurements
Lunch Break		
14:00-15:30	All	Course Assessment
Coffee Break		
15:45-17:15	All	Closing Remarks

Student Assessment and Certificate of Achievment

The assessment was based on 3 questions:
1) Briefly describe how a logic gate based on Molecular Transistor works and how it can be implemented.
2) Briefly describe the concept of Micro4Nano and its advantages for its use in Molecular Electronics and/or (Bio)NanoSensors.

3) Briefly describe the methodologies for the production of nanogaps and their use in Molecular Electronics and/or (Bio)NanoSensors.

All the students passed the test.

Figure 1: Certificate of Achievement.

To each student has been given a Certificate of Achievement as the one in Figure 1.

Student Feedbacks

At the end of the course was requested to the student to fill a questionnaire and the received responses are reported in Table 1.

Table 1: Student Feedbacks

	Bad	Poor	Good	Very Good	Excellent
Overall Organization of the Course	-	-	-	10	13
Quality of Teachers	-	-	1	2	20
Quality of Lab Experience	-	2	4	7	10
Fitting with Expectations	-	-	2	6	15

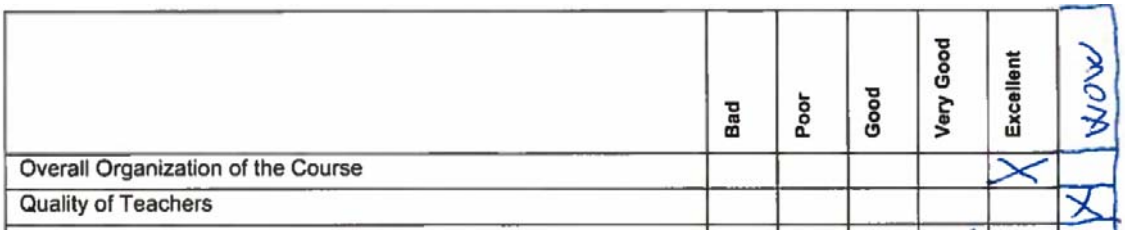
The results were very good, with a stimulus to improve the quality of the Lab Experience. This matter was discussed directly with the students. The grade “Poor” was given by students of the second week, in which there were more students and so the Lab was more crowded. For this reason, the experience was less effective.
For future editions this aspect has to be taken seriously in consideration.

Students gave feedbacks to their Universities too, and all of them were very positive. Here we report 2 of them that are representative and summarize the general feedback received.

Feedback 1 : «I was a participant in "Practical training in Politecnico di Torino". The course was well organized; the material and the syllabus of the course were well built. We learned different kinds of uses for biological molecules as electronic transporters and how these are used in the real world. Moreover, we have learned about the actual synthesis of these molecules.
We started off with the theoretical knowledge and then entered the labs. The practice part in the labs was interesting and gave us an understanding of the real problems. We learned about the stages in creating nano-devices from the

basic physical and mathematical concepts to the synthesis and construction of the electrical circuit components, and all to the end point device. We visited different institutions and campuses associated with the university. I felt it had contributed a lot to my knowledge and experience.
All of the professors and the teaching staff were nice and attentive and made an effort to answer all of our questions. The teaching staff seemed to understand that the students came from different disciplines and different background.
I felt the course gave me imponent knowledge that I would not have learned otherwise. Also this was a great opportunity to see different ways of working and to get new ideas. I was happy to make new connections with professors and young researchers from abroad.»

Feedback 2 : «I enjoyed the lectures very much. The topics were highly innovative and as an electrical engineer who has former experience in the field of bio chemical sensors, fabrication and system on chip electronics, the topics we encountered were exactly the 'next step' I had expected to see in those fields.
The lecturers were extremely vivid and made the students want to listen.
All of the lectures, from chemistry to logic gates, were a treat for me.
I am now a researcher in the field of nano photonics and going back to my roots was very nice for me. It also gave me future research ideas that combine nano optics and nano electronics.
Our Host Prof. Danilo was extremely pleasant. He and his student Beatrice took great care of us and spent a lot of time with us. They helped our group to interact with each other and I think we all owe them gratitude.
During the trip I got a chance to talk to prof. Danilo about future events that include Israeli universities and I hope I will have the chance to participate in courses and conferences, and maybe even a combined research with Politechnico di Torino.
I also got to interact with Danilo's student named Beatrice, which is working on a project that can be applicable to nano optics.
I was privileged enough to meet great students from Bar Ilan named Haim Sazan and Shir Shahal. They were true partners in every field. Tempus project help me meet fellow researchers from BIU, other universities and even Politechnico.
I think that Tempus project and especially the combined course with Politechnico di Torino, is a great tool to combine minds and research methods. It is far more powerful that any conference because the student has more time to interact with other researchers and exchange ideas in every topic there is. As a researcher, my research has a profound influence on every other field in my life and even 'everyday' talks with other researchers influence my work.»



	Bad	Poor	Good	Very Good	Excellent	WOW
Overall Organization of the Course					X	
Quality of Teachers						X

It is also our pleasure to report that a student added one more column in the evaluation, grading the “Quality of Teachers” as WOW. This seems to be a very good result in the implementation of the course.

Exploitation/Implementation of the new courses in all participating universities

The implementation of the new courses delivered in the new learning environment started in January 2016 and the courses were delivered correspondingly to the academic programme at each university.
A questionnaire to evaluate students ‘attitudes towards the new courses was developed and students asked to answer it after passing the course.

Questionnaire for online course:

1. Name of course
2. Is this your first formal online educational experience? (y/n)
3. Did you complete 100% of course requirements? (y/n)
4. If answer to (1) was no, did you view more than 50% of the course? (y/n)
5. Did this course offer subject matter not available in your university? (y/n)
6. Are you taking this course for credit? (y/n)
8. Please rate the following on scale of 1 – 5
   Course material content (bad = 1, excellent = 5)
   Level of difficulty (very easy = 1, very difficult = 5)
   Quality of video clips (sound, editing, video quality – bad = 1, excellent = 5)
   Usefulness of homework assignments (1 = not useful 5 = very helpful)
   Ease of use of the Moodle interface (1= cumbersome, 5 = very smooth and intuitive)

9. Did you encounter difficulties (technical or other) during the course - if so what, and were they adequately resolved?
10. Please write a few words about your impression of this mode of learning relative to frontal (face-to-face) learning: advantages and disadvantages.
11. Did you have interactions with the other students? (y/n) if yes describe their nature.
11. Please comment on what you most liked about this course.
12. Please indicate areas or items which could be improved.
14. Please write why you chose to take the on-line course?

Would you be interested in participating in other online courses in the future? (y/n)

The reports of all universities are presented in the next sections.

Weizmann Institute of Science for the final report

The Weizmann Institute participated in Pilot test in four ways:

1) Pilot of Course “Scanning Probe Microscopy Applications in Research an Industry” offered by the Weizmann. Here, some impressions of that course will be given. (8 students took the course). In addition to 7 students who took the course in Weizmann – these used the on-line materials to repeat a lesson.

2) Pilot of the Course "Introduction to Materials and Nanotechnology for High School Teachers" offered by the Weizmann to high school chemistry teachers in Israel. (More than 40 students started, 24 completed all course assignments, 16 filled the on-line questionnaire).

3) Pilot of Course “Surface Science” from Tel Aviv University was promoted heavily at the Weizmann so that 16 students took the course for credit. Here issues of the local organization and administration will be reported.

1) Scanning Probe Microscopy Pilot

This course was prepared using a dedicated software package (Camtasia by TechSmith) which allowed preparing video and slide presentation directly on the PC. The lectures included embedded quizzes/homework (typically multiple choice, true-false, or short answer) which were wrapped in the SCORM zipped file which was then uploaded to the Moodle site. The software provider (Techsmith) sends on a daily basis spreadsheets giving both specific question – by – question scoring results for each student as well as the overall statistics. Students were allowed to re-submit answers and for each set of delivered answers the amount of time spent viewing the lecture was recorded. This provided an easy and direct way for me to see where students may have had problems, but on the other hand, the students do not get direct feedback such as personally corrected homework showing the logic that goes behind the correct answer and what they misunderstood.

This course was simultaneously given F2F at my institute, so some of the students used the online lectures for review of material they heard or as preparation for lectures (lectures were made available to students starting one week before lecture given in class, and kept available on the system until the end of the semester).

A relatively small number of students participated in this pilot (8 overall, not all completed the entire course). One of the students was from industry and found it difficult to keep up the pace of the course due to work obligations so will finish

somewhat later. Another student is enrolled at the Weizmann but due to personal matters could not attend the lectures so made sole use of the online course. Due to the small number of students, it was possible to give individual attention to students needing this by email.

The initial preparation of the lectures was very time–intensive as each presentation had to be specially prepared to suit the video format, and after recording, significant time was required to edit the clip. Overall, 3-4 hours were spent preparing, recording, editing, and producing the clips for each 1 hour of actual lecture time.

Since the clips were not simply films of a frontal lecture, they could be designed to accommodate attention spans. In general, shorter clips ranging from 8 to 40 minutes were prepared. Clips longer than 10-12 minutes were broken up by quizzes, or a simple break with musical interlude.

Overall, the student feedback on the clips was favorable. As lecturer I would note one drawback that since students view the lectures at different times and submit quizzes at different times, it is hard to get overall impression on how a particular subject is comprehended.

Some examples of comments:

1) Difficulties encountered:

“I had difficulty obtaining the password for online course which was quickly resolved”

“The online course wasn’t always available”

“Problems loggin in addressed quckly and well by staff”

“There is no explanation about the questions”

Advantages and disadvantages relative to F2F

“Faster delivery, increased reach, eco-friendly”

“i found the online course very useful. The main advantage was to go over specific part multiple times”

“Gives better possility to follow and repeat the subjects”

“Allows me to work where and when most convenient for me”

“Very useful to have lectures available when and where I want”

“Very much like frontal lecture only I could stop and repeat a part I did not understand”

“ I can do it at any time and it also provides more information on the subject. But there is no discussion.

To question – did you discuss material with other students – approximately 50% said no, some of others said they discussed some assignments and the final project.

To question: What did you like most about this course?

“Personalized training experience”

“Applications of SPM in different fields and industries”

“:Lecturer and topics”

2) "Introduction to Materials and Nanotechnology for High School Teachers" Pilot

This course was prepared using a dedicated software package (Camtasia by TechSmith) which allowed preparing video and slide presentation directly on the PC. The lectures included embedded quizzes/homework (typically multiple choice, true-false, or short answer) which were wrapped in the SCORM zipped file which was then uploaded to the Moodle site. The software provider (Techsmith) sends on a daily basis spreadsheets giving both specific question – by – question scoring results for each student as well as the overall statistics. Students were allowed to re-submit answers and for each set of delivered answers the amount of time spent viewing the lecture was recorded. This provided an easy and direct way for me to see where students may have had problems, but on the other hand, the students do not get direct feedback such as personally corrected homework showing the logic that goes behind the correct answer and what they misunderstood. Students also sent me emails when they had technical problems or questions about the lesson content and assignments. Technical problems were sent directly to Jack and were solved very quickly.

Questions about the content were answered directly and were also shared in the Facebook group to assist other students who may face the same difficulty.

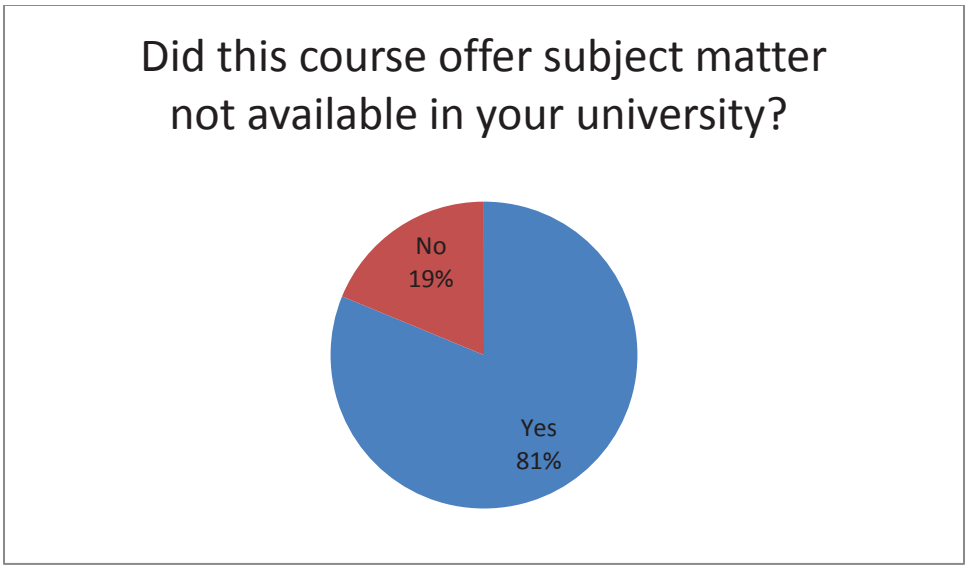
In order to encourage interaction between the students we provided three platforms: a. In the introduction lesson we opened a forum discussion in the course moodle; b. We opened a Facebook group and invited all the students to the group; c) We used "Padlet" application as a platform for joint knowledge organization (e.g., https://padlet.com/ron_blonder/Size_scale).

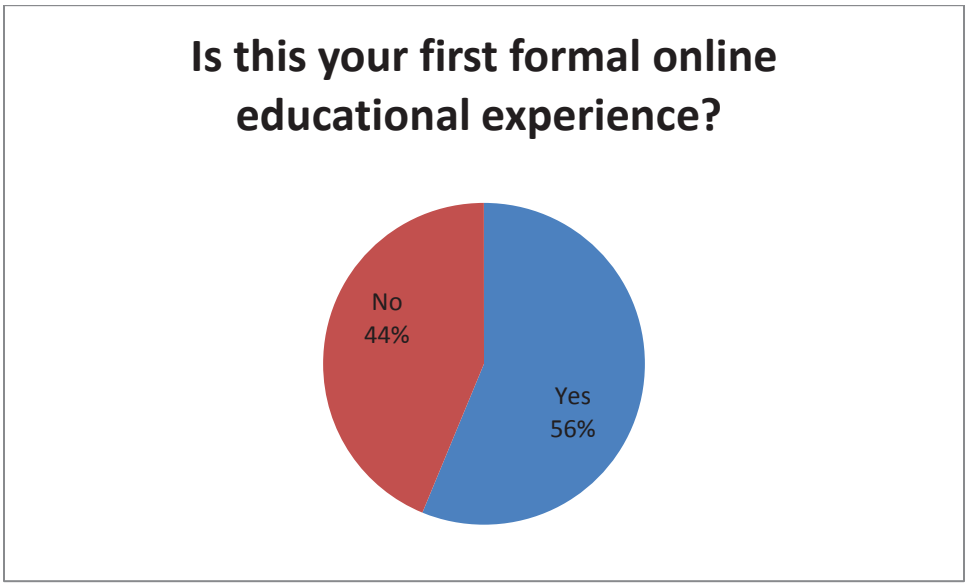
This course included a 6-hours meeting in Weizmann Institute. In this meeting the students described how they study the course at home. They conducted a laboratory experiment and heard a lecture on super-hydrophobic self-assembly monolayers. They also took the sample for characterization in the SEM.

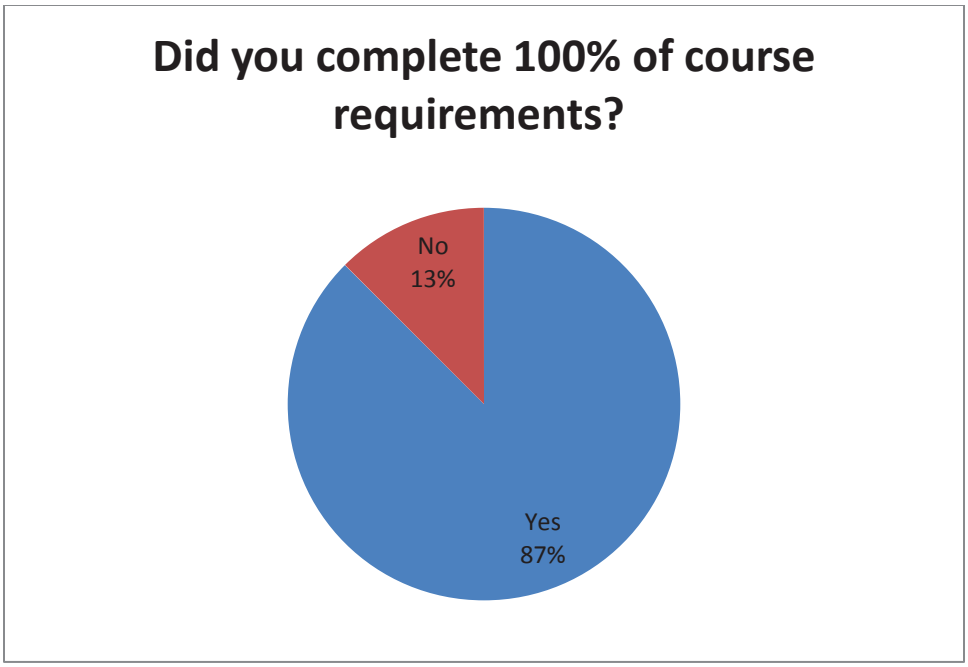
More than 40 students (all chemistry teachers) started the course. 24 teachers completed all the assignments and received a credit (from the Ministry of Education). 13 filled the feedback form at the end of the course. Since the number of students who took the course was relatively low I could give personal attention to each participant.

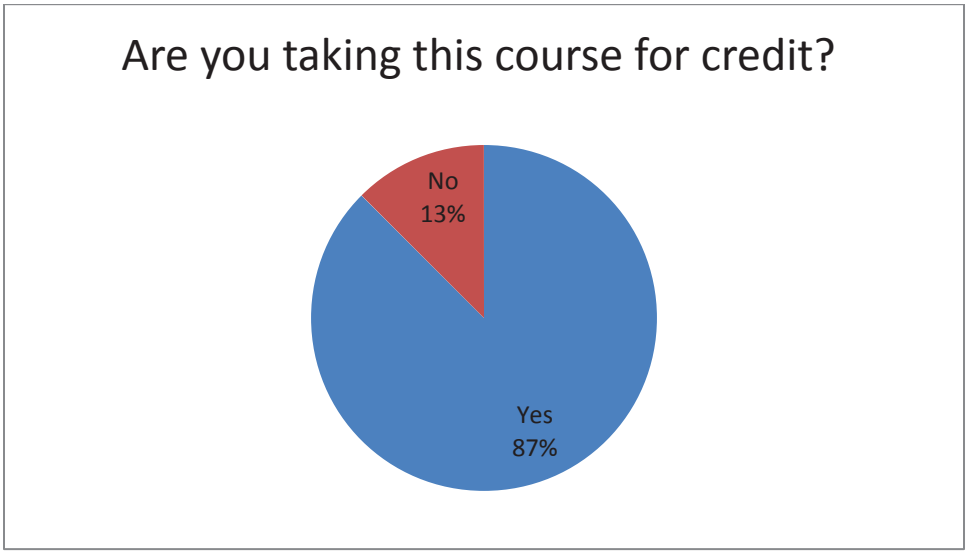
Students (teachers) geographic distribution

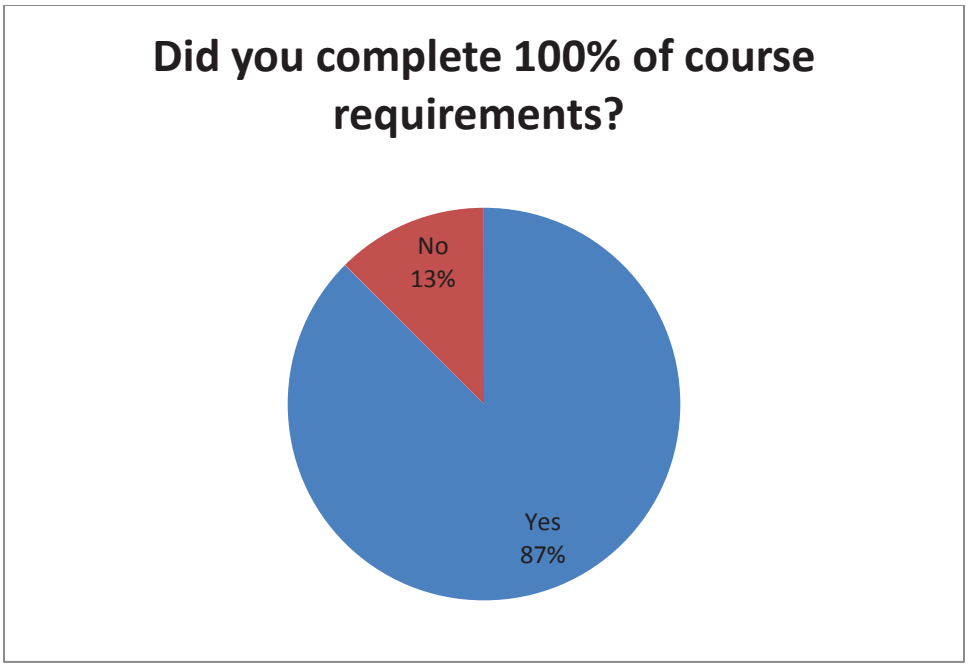

Tyre
קרית שמונה
נהריה
עכו
טבריה
Irbid
מעלה אדומים
ישראל
באר שבע
מצפה רמון
Ma'an
יוטבתה
אילת
40
65
35
47
55

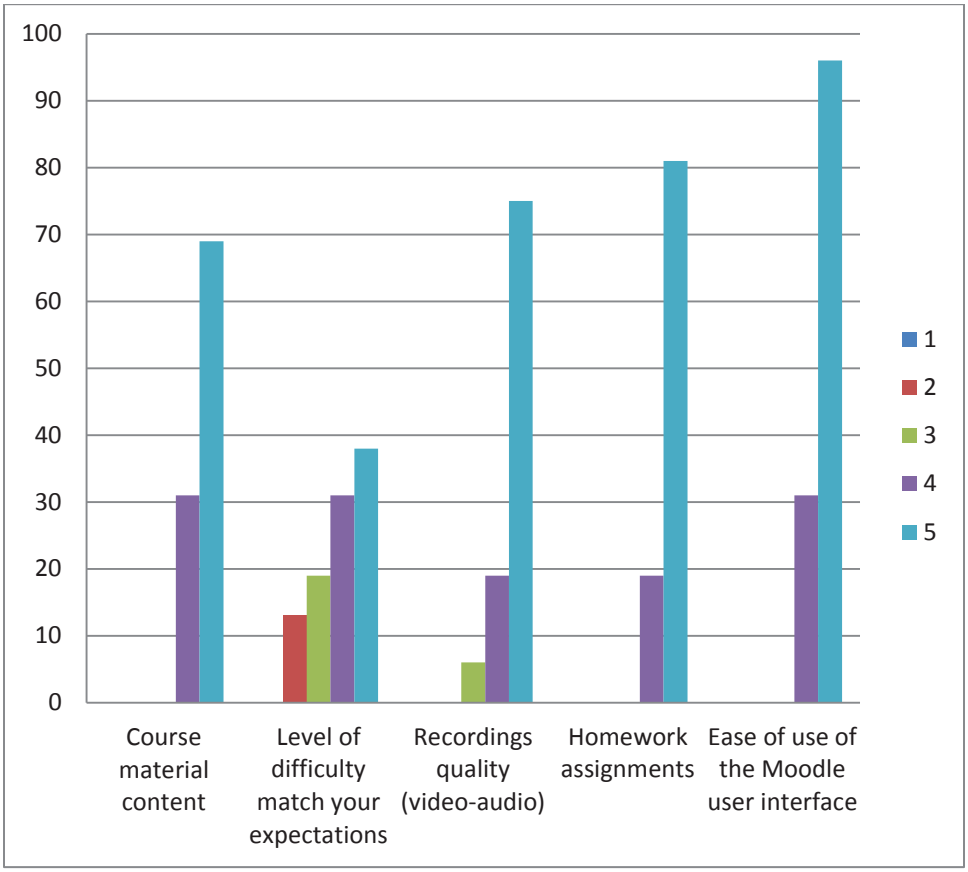

Did this course offer subject matter not available in your university?
No 19%
Yes 81%

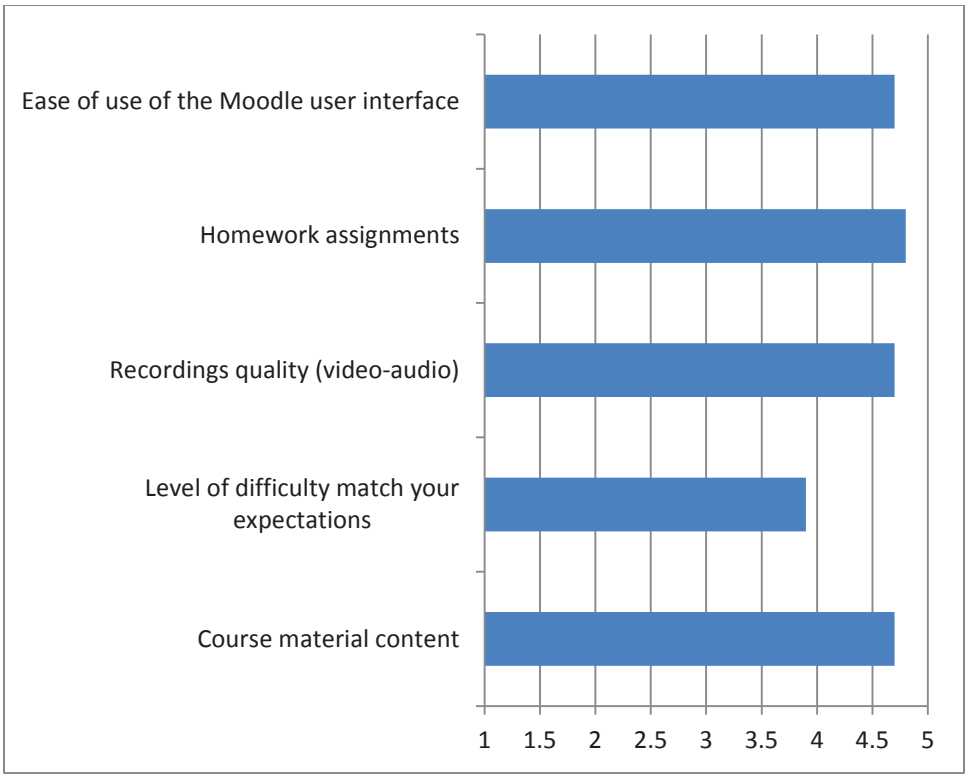

Is this your first formal online educational experience?
No 44%
Yes 56%

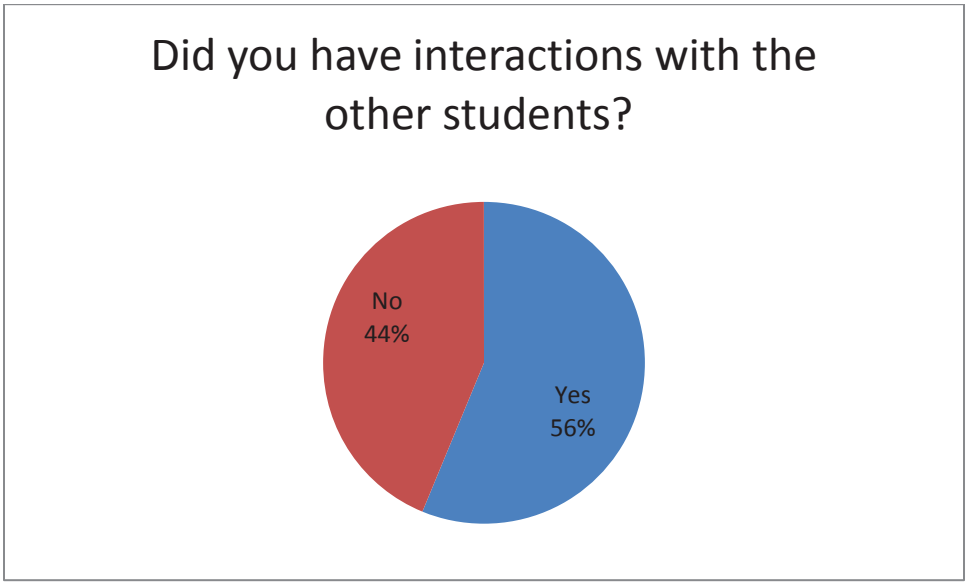

Did you complete 100% of course requirements?
No
13%
Yes
87%


Are you taking this course for credit?
No
13%
Yes
87%


Did you complete 100% of course requirements?
No
13%
Yes
87%


100
90
80
70
60
50
40
30
20
10
0
Course material content
Level of difficulty match your expectations
Recordings quality (video-audio)
Homework assignments
Ease of use of the Moodle user interface
1
2
3
4
5





3) We can report on the Surface Science course from the viewpoint of administration from distant institution:

Obtaining approval of the course was not simple. Initially, the head of studies in Chemistry allowed only one online course to be offered, on the condition that I accept full administrative responsibility for the course. 16 students from the

Weizmann took the course. In a later discussion with the dean of the graduation school, they indicated that they are, in principle, supportive of providing online courses, and currently allow one online course per year (e.g., from Coursera) to count toward credit for each student. There were some issues at the start with our institute's firewall which prevented students from accessing the course material except from any institute connection. This took a couple of weeks to resolve because our responsible technical staff was reluctant to deal directly with the TAU staff. Eventually, this matter was solved and the technical issues went smoothly, including the final student presentations which were done using shared screen on Skype. Student appraisals were quite favorable for the course. Assignment of final grades was by one mid-term extensive homework assignment and the final presented project. The grades assigned were high relative to the norms at our institute so that I had to adjust them downwards to keep in line with our graduate school policies.

4) The course "Introduction to materials and nanotechnology" is given again this year. It started on March 5. 45 teachers registered to the course. 25 teachers are actively participating in the course assignments. The course is ended in the end of May.

Summary of Technion courses developed as part of the Edunano project

Two courses were developed towards the EduNano project. These courses are part of a required curriculum for the Nanoscience and Nanotechnology Multidisciplinary Program at the Technion - Israel Institute of Technology. The courses differ in their approach. The course Quantum Mechanics (QM), given by Prof. Uri Peskin, follows the format of class lectures and was developed for graduate students who do not come from a physics or chemistry background and are introduced to the field for the first time. The course on the Fundamentals of NanoBiotechnology (NB), given by Prof. Avi Schroeder, is a modular course that introduces different topics in the field. Most students who attended the courses had previous online learning experience. Most students found the Moodle interface easy to use. Currently, the two courses are given once a year during the Fall semester. We would like both courses to be available twice a year, if sufficient funds are found to accommodate the TAs.

QM received very positive feedback by all four students who attended the course. The material was reported to be covered thoroughly and the lectures of good quality. While similar courses are available on the undergraduate level at the Technion, this is the only one open for graduate studies. Since the material is considered difficult, the ability to review lectures and proceed at one's own pace was useful. The main criticism was the need to hold frontal recitation hours (which were also recorded). It is noteworthy that the online forum was open for discussions on a weekly basis, but none of the students chose to use it. Most students benefitted from collaborative work on the homework assignments. It brought together students from different disciplines whom otherwise would not have met. At the time of the report, the course website experienced a total of 311 entries by 14 users.

At the time the students attended the NB course, it was still incomplete and in the process of being recorded. The lack of organization led to mediocre feedback, but the course website has been updated since. Nonetheless, the course material was found interesting and its approach novel. 18 students were registered to the course this year, and 13 last year. Eleven students responded to the questionnaire so far this year. As with QM, the students benefitted from working together and at their own pace.

The specific comments to the questionnaire are summarized below for each of the courses.

1. Quantum Mechanics

2. Is this your first formal online educational experience?

50% answered positively.

3. Did you complete 100% of course requirements?

75% answered positively. It is noteworthy that one of the students has attended a similar course during his undergraduate studies.

4. If answer to previous question was no, did you view more than 50% of the course?

100% answered positively.

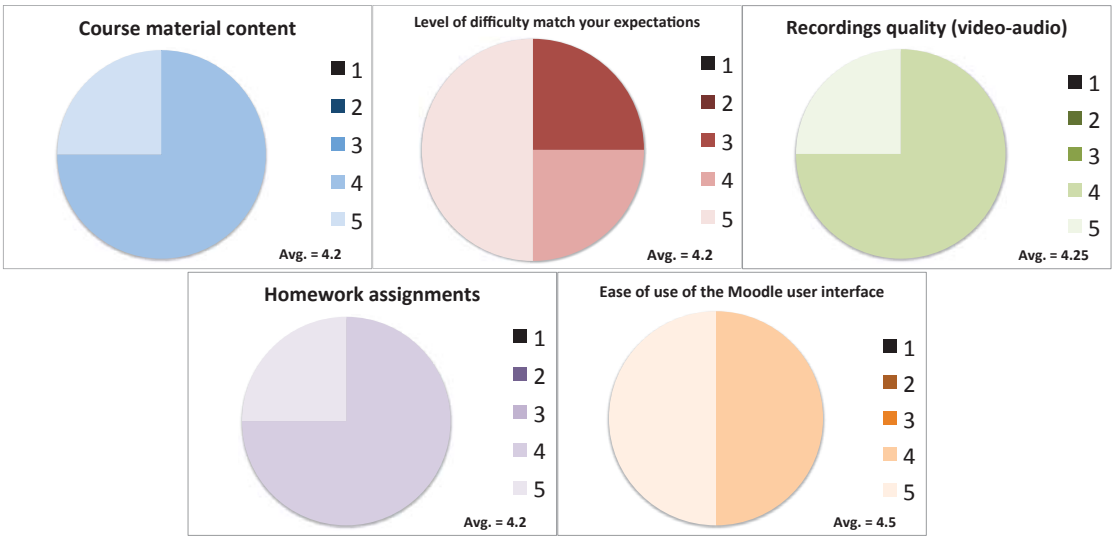
5. Did this course offer subject matter not available in your university?

25% answered positively, as undergraduate level courses intended for physics and chemistry majors offer similar material at the Technion.

6. Are you taking this course for credit?

75% answered positively.

7. Please rate the following on scale of 1 – 5. (poor = 1, excellent = 5)



8. Did you encounter difficulties (technical or other) during the course - if so what, and were they adequately resolved?

100% answered negatively.

9. Please write a few words about your impression of this mode of learning relative to frontal (face-to-face) learning: advantages and disadvantages.

"It is much more flexible to have the whole course recorded" and "it is nice because it makes it possible to dig deeper in the material". However, "I would have preffered the tutorial to be frontal." Indeed, "frontal ta meetings are mandatory".

10. Did you have interactions with the other students?

75% answered positively.

11. If you answered positive, please describe in a few words the nature of your interaction.

“We mainly discussed some of the topics which were not clear and we helped each other with the homeworks” or discussed “issues that weren't understood during the course”.

12. Please comment on what you most liked about this course.

The ability to learn on your own and “how the lecturer carries out the material of the course”.

13. Please indicate areas or items which could be improved.

“More interactions with the [teaching assistant] in person” and “more infromation in the lecture slides”.

14. Please write why you chose to take the on-line course?

Most students took the course since it is mandatory for their degree. One student took it to test e-learning experience.

1. Fundamentals of NanoBiotechnology

2. Is this your first formal online educational experience?

45% answered positively.

3. Did you complete 100% of course requirements?

73% answered positively. The semester was not over for all courses at the time the survey was taken.

4. If answer to previous question was no, did you view more than 50% of the course?

100% answered positively.

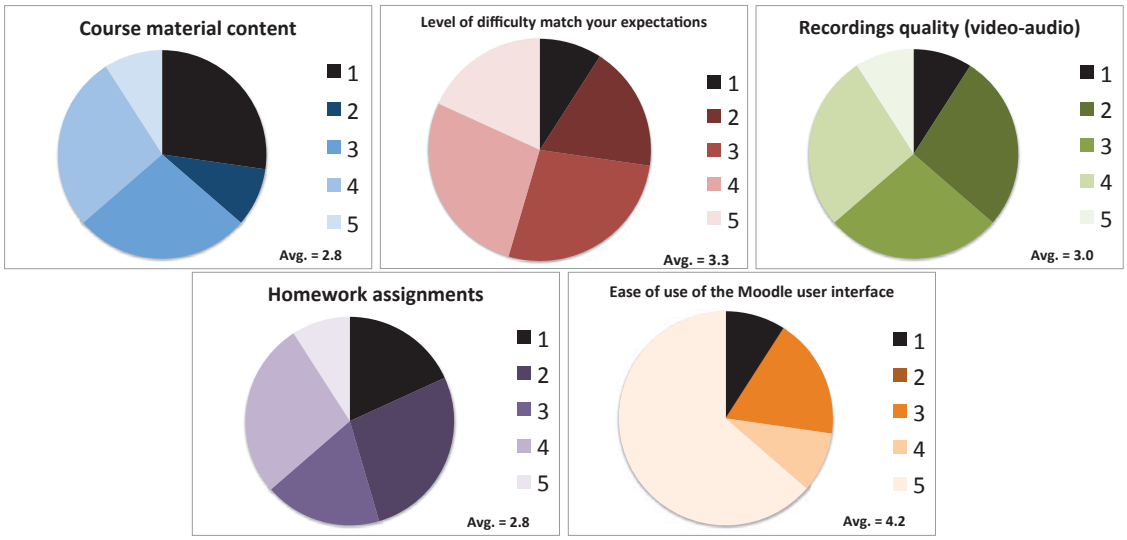
5. Did this course offer subject matter not available in your university?

36% answered positively. Courses in the departments of Biology Biomedical Engineering, and Food and Biotechnology have some overlap.

6. Are you taking this course for credit?

100% answered positively.

7. Please rate the following on scale of 1 – 5. (poor = 1, excellent = 5)



The current Moodle website is much more organized and all course lectures are present. This was not the case at the time the students participated in the course, and hence we expect the feedback to improve significantly in the future.

8. Did you encounter difficulties (technical or other) during the course - if so what, and were they adequately resolved?

67% answered negatively. However, one student had difficulty working with Mac. While the website is accessible on Safari, the videos do not load. Some of the

videos given by the teaching assistants had “low quality of recorded video” and students encountered difficulty hearing the student lectures.

9. Please write a few words about your impression of this mode of learning relative to frontal (face-to-face) learning: advantages and disadvantages.

The main reported advantage is the ability to study on their own and at their own pace, as well as the ability to review the original material many times. The disadvantage was the inability to ask questions in real time, ad some students found that the assignments were not fully explained on the site. The course format, which relies heavily on youtube videos of worldwide experts in the field and reading of articles, did not appeal to one of the students. In addition, the some students complained of unreasonably long artilces (up to 150 pages) that they were required to critically summarize in a week.

10. Did you have interactions with the other students?

67% answered positively. For one of the students, a “big disadvantages [is] that I can't collaborate with other students.”

11. If you answered positive, please describe in a few words the nature of your interaction.

Interaction among students included “knowledge sharing and assignment discussions.” As one student put it: “We developed discussions around the topics. We consulted with each other on how to approach the homework assignments.”

12. Please comment on what you most liked about this course.

This is a unique course to the Technion in both its content and its format. Several students “found the material interesting” and “like[d] the general content and ideas the course convey[ed].” Students “learned new things [that they] had no interaction with durring bachlores and masters.” As one student wrote: “[The] multidisciplinary topics … really opened my mind to new research approaches.” In addition, the course was considered relatively straight forward and not difficult. “Being able to review the same lecture several times at the speed of choice while at home” was also an advantage.

13. Please indicate areas or items which could be improved.

Most student complaints were regarding the organization of the lectures and assignments. The majority of the students complained that the requirements of the weekly assignments were unclear, and that some required disproportional investment that could not be accomplished within one week. In addition, topics can be ordered more sensibly, as some terminology that was required for understanding of the topics appeared only later on in the course.

The students had difficulty with the multiple video styles. In addition, since most lectures that are now on the Moodle website were not accessible to the students, the lack of lectures by the professor was a big drawback. Students were perhaps most frustrated with the poor feedback on the assignments the insufficient accessibility of the teaching

assistants. Finally, as this is a course in a multidisciplinary program, some requests were made to “make the course more relevant to students from the electrical engineering background,” which comprise a significant fraction of students in the program for which the course was designed.

14. Please write why you chose to take the on-line course?

Most students took the course since it is mandatory for their degree. One student took it to test e-learning experience. Other reasons include: “course is in the field of interest, especially because of combination of biology and nanotechnology” or that “the area of nanobiotechnology is very interesting.” And as previously said: “You have more control over the progression of the information, allowing you to study more efficiently,” and “on-line courses let me plan research and homework time [on] my own.”

EDU NANAO project- Ben Gurion University Final report

1. Dissemination Activities

BGU took part in most of the dissemination events:

1. Invited lecture by Dr. Tsiona Elkayamr from BGU about future drugs- based on the Edunano course: "Nanotechnology- Journey through time and space towards the future drugs"
2. IVS conference in Israel via booth describing the activities.
3. Presentation at NanoIsrael conference 2016 in Israel via booth describing the activities

Student Mobility Feedback

Torino Program

The workshop started as scheduled at the morning of Monday 18/7, Prof. Demarchi was kind enough to wait for us at the entrance to the university as everyone arrived.

It seems there was a bit of miscommunication with regards to the structure of the course:

Before arriving we were told that we would have to choose between the two parts of the workshop, yet upon arrival Prof. Demarchi told us that the workshop's parts are inseperable, this was somewhat problematic as most (if not all) students only did one of the two preliminary courses online.

The first part of the workshop which focused around Theoretical models for molecular devices was very interesting, and taught Core definitions which were important for the following classes.

The second day (EE-BESD and MotorDuck) was interesting, yet I think much more could have been gained if everyone did not need to learn everything from the complete beginning – from my impression none of the students had any relevant background in atomic (or molecular level) simulations, or any background in working with Octave.

Due to the lack of experience on our part – I feel we gained very little from the simulation classes. So I would recommend either changing the content to more basic learning material or make sure the students have a more relevant background.

All the rest of the classes (NanoGaps, Laboratory Tours etc) were fascinating and showed a lot of very interesting characterization methods which definitely expanded my knowledge and interest in this field.

Grenoble Program

Experience at Minatec Workshop, Grenoble France

Our over experience was very good, Grenoble is nice city with nice atmosphere and landscape.

The workshop itself were four days

Day 1 and 2 : Clean room facility : integrated semiconductor device fabrication

Day 3 : Electrical characterization of integrated semiconductor devices

Day 4: Computer fabrication simulation

During all the workshop we worked on small groups of 4-8 people, which made the experience very nice and comfortable, we felt free to ask questions, and to leave comments.

Day 2 were full day and the other days were half days, we had weekend off in the middle of the Workshop, during the first days we worked in the teaching dedicated clean rooms, and got all the necessary equipment for the fabrication process.

The workshop transmitted by 3 different persons, all of them had good English skills, everything they explained was very clear, and every question we asked, got answered.

We made friends from different universities across Israel and we learned about their research.

For conclusion, we feel the workshop very contributed to our knowledge.

EduNano survey results

In the framework of the EduNano program, two different courses were offered in a pilot project at Ben Gurion University:

1. **Advanced Topics in Photonics and Electrooptics**

   Students participate regular classes first and were provided with a recorded version of the lecture afterwards. It enable them to review the class as often as they wanted and hence, repeat what they might not have grasped the first time

2. **"Nanotechnology- Journey through time and space towards the future drugs"**

   Flip-course: students were asked to watch the recorded lecture before the lecture and in the following class there was a short overview of the main subjects of the lecture and based on that a discussion on advanced issues and research questions on the same topic.

Pilot course session survey results:

After completion of the courses, the students were asked to fill in a survey to evaluate the quality of recordings and the added value of on-line learning.

- Fourteen questions asked the students to grade the quality of the course in term of If it was interesting, if it expose them to new different features of the courses on a scale from 1 to 5 .
- Furthermore, they could write comments on the combination of the recorded lessons with the standard courses.

1. **Advanced Topics in Photonics and Electrooptics**

   The course was tested 2 times with 19 students participating- in total.

   The overall score of the course was 4.6 out of 5!

2. **"Nanotechnology- Journey through time and space towards the future drugs"**

   Out of 17 students that participate in this course, 12 answer the survey. The overall score of the course was 5.42 out of 6!

   In their comments, students wrote that it was anew studying experience for them and stated that they enjoyed it and that they think this model should be adopted to other courses (App. 2 in Hebrew).

   The following table summarizes the profile and the numbers of participates in each course.

Course Title		Advance topics in nano-photonics	Journey through time and space toward the futures drugs
Course Level	BSC		X
	MSC	X	
	PhD	X	
	Industrial		
	Teachers		X
	High School		X
Participants in Pilot Test (Course Attended by)	Total	19	18
	Females	1	16
	Males	18	2
Grade Distribution (in %)	A - Excellent	30	7
	B - Very Good	55	7
	C - Good	10	1
	D - Passed	5	0
	F - Failed		3

The students agreed that the recorded sessions, should be used as start point for each lecture and that during the lectures an advanced issues should be discussed – base on the knowledge they gain from the recorded lectures.

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Conclusion

In a world where technology is making giant strides, teaching methods must adapt, evolve, and take advantage of advanced technologies. The ability to use videotaped lectures allows us to expose an unlimited number of high school students and students to the best experts and lecturers in every field. But most important, it and allows lecturers to evolve from a "source of knowledge" to guides that help students explore new ideas and provide data processing tools and ultimately educate a generation of thinking people who can acquire knowledge before entering the classroom and use the lecture time for advanced discussions.

Student Mobility Feedback

Torino Program

The course topics were highly innovative and were orientated to students from various disciplines with little experience in the research field but needing to understand the field more in depth.

The lecturers were extremely vivid and kept the audience captivated.
The host Prof. Danilo Demarchi was extremely pleasant. He and his team took great care of the students and spent quality time with them. They formulated interactions between the group which was beneficial both on a social and academic level. The Tempus project facilitated better acquaintance for internal collaborations and with other universities in Israel and in Europe. One student noted in particular that this type of intense interaction is far more powerful that any conference because the student has more time to interact with other researchers and exchange ideas in various topics

Grenoble Program

Bio-technology Session

Excellent training on AFM. The guide was full of knowledge and willingness to teach and give in-depth answers to all questions. Preparation of the DNA microarrays was organized were very professionally. There was an opportunity to be exposed to equipment that was unfamiliar to some students and help to better understand the preparation process and try it.

The opportunity to meet other researchers in the field was important and allows for collaboration and consulting. Beyond the educational aspect, the planning and timetable were well planned and the reception was warm and inviting.

Clean-room and Fabrication Session

This session included fabrication of MOS field-effect-transistors and characterization of their electrical properties. Over the sessions students were exposed to a huge variety of a high standard equipment. The multiple stage process was very inspiring and opened their minds to new techniques useful for their current research. In addition, the interaction with skilled professionals from other institutions who guided us along the workshop and taught us about the facilities and mechanisms that were required to the fabrication process (and also the

alternatives techniques, at specific stages) was very enlightening. Even students who had previous experience in clean room environments found that this experience was really extraordinary due the really high quality process and the endless options of fabrication and research.

EduNano survey results

In the framework of the EduNano program, two different courses were offered in a pilot project at Bar-Ilan University. One was called *Nano-science and nano-technology. "Why is "nano" different and how is it useful?"* and the other "*Kinetics of Materials".* For both courses, two different options were available. In the first option, students went to their regular classes first and were provided with a recorded version of the lecture afterwards. That way, they could review the class as often as they wanted and hence, repeat what they might not have grasped the first time **(1)**. The second option was a so-called flip-course. This means that before the students went to their regular class, they were asked to watch the recorded lecture. Sometimes, the following class would then consist of what the students had already learned in the recorded lecture or it would build upon it and require the recorded session as background knowledge **(2)**.

1st pilot course session survey results:

After completion of the courses, the students were asked to fill in a survey to evaluate the quality of recordings and the added value of on-line learning. The first survey combined both the *Kinetics* and the *Nano* course in the 1st format (first frontal lecture and afterwards possibility of reviewing it).

- Three questions asked the students to grade different features of the courses on a scale from 1 to 5.
- Furthermore, they could write comments on the combination of the recorded lessons with the standard courses.

Kinetics of Material

Six people evaluated the *Kinetics*-course. All categories were graded above average. The helpfulness of the recorded lessons reached an average grade of 3.7. The students' understanding of the lessons' subject matter without the regular lectures reached an average grade of 3.6. The quality of the recordings came off best, the respondents gave it an average grade of 4.2. One student commented on the combination of the recorded lessons with the standard courses. He liked the frontal course very much and according to him, the recorded lessons were only helpful when he did not manage to come to class.

Nano-science and nano-technology. Why is "nano" different and how is it useful?

The *Nano*-course in the first format was graded by ten students. In general, it scored slightly worse than the *Kinetics*-course, however, all categories scored above average again. The helpfulness of the recorded lessons reached an average grade of 3.3. The respondents rated their understanding of the subject matter without frontal lectures with an average grade of 3.1. Once again, the quality of the recordings reached the highest score, this time a 4.1. In their comments, the students agreed that even though they liked the recorded sessions, in general, these cannot replace frontal lectures as they do not offer the possibility of discussing with their fellow students or asking questions. It was pointed out that the recorded lessons are exactly like the frontal lectures and hence only enjoyable and helpful if the lecturer is good. One respondent criticized that the lessons were not well organized and that he did not know which assignments to hand in and when.

Conclusion

Summing everything up, even though the quality of the recordings generally achieved good grades, the students' evaluations show that their understanding would be lacking if they did not have the frontal lectures. Among others, this is due to the fact that a recorded lesson does not offer the possibility of asking questions or discussing with fellow students.

2nd pilot course

The second survey asked those students who attended the flip-course where the recorded lecture was provided before attending the frontal course to evaluate their experiences. This time,

- Five components of the course should be rated on a scale from 1 to 5.
- The students were asked to evaluate the course material content and whether the level of difficulty matched their expectations. Furthermore, they had to rate the quality of the recordings, the homework assignments and the ease of use of the Moodle user interface.
- In addition to grading the courses, six further questions allowed the students to leave short comments.

Kinetics of Material

Four students evaluated the *Kinetics* course. As an average, all areas except for one achieved at least a 4.0, the adequacy of the level of difficulty with regard to the students' expectations was even rated with an average grade of 4.2. The ease of use of the Moodle user interface reached an average grade of 3.8. According to their answers, none of the respondents encountered any difficulties (technical or other) during the course. Being asked about the advantages and disadvantages of this mode of learning relative to frontal lessons, the students described it as a good opportunity in case they missed a class. They also like the professor and saw benefits in

the online materials. All of them interacted with other students during the course and evaluated this interaction positively. It for example helped them while studying for the exam. With regard to what they liked most about the course, they named for example the applications and using older exams to study for the upcoming one. With regard to what could be improved, one student wished for more tutorials and another one for a provision of filmed exercises. The other two would have liked a shorter exam and the coverage of the topic of materials science respectively. The students had chosen the online-course because they were on the one hand interested in the topic and on the other hand appreciated the possibility of reviewing sessions they had missed free of charge.

Nano-science and nano-technology. Why is "nano" different and how is it useful?

Five students took the opportunity to evaluate the *Nano* course. Once again, all evaluations were above average, however, in comparison to the *Kinetics* course, they tended to be less positive. Once again, the adequacy of the level of difficulty with regard to the students' expectations achieved the best grade, with an average of 4.6. The quality of the recordings reached an average grade of 3.8 and the homework assignments a 3.6. Again, the ease of use of the Moodle interface scored the lowest with an average grade of 3.4. In their comments, the students criticized the navigation of the website. Regarding the advantages and disadvantages of this mode of learning relative to frontal lessons, students saw the advantages in learning at their own pace and repeating parts they did not understand well even though it also impeded concentration. The students' comments mirrored that some of them had problems with the arrangement of the course. Not all of the respondents interacted with their fellow students. The others either talked to them during the course or during homework. Being asked what they liked most about the course, two students named the teacher. The others mentioned the choice of subjects and the possibility of watching the lectures in their spare time. As suggestions for improvements, the respondents asked to enhance the quality of the recordings and the lectures. Through their answers it was not evident whether this means the same. Once again, the interface and navigation of the website were criticized. Furthermore, according to the respondents, the homework should be sent on time and some of the presentations should be organized better. Most of the respondents took the course because it was obligatory for them. Only two stated that their interest in the subject was the reason for taking the course.

Conclusion

As a conclusion, even though both courses were rated above average in the flip-course format, the *Kinetics* course came off better. The possibilities of the online lessons could be expanded to providing more recorded tutorials. The attendants of the *Nano* course were more critical, mostly with regard to technical issues, such as the Moodle interface. Even though they saw advantages, it became evident that they found organization and implementation of the course lacking.

Conclusion 1 & 2

Bringing together the first and second type of pilot courses, through the students' evaluations it does not become obvious that there was a difference in design (watching the recordings after/parallel to the frontal lecture vs. watching them before). The respondents see the recordings as a good opportunity for everyone to learn at their own pace. Apparently, for some they are only relevant if they did not manage to come to class. The quality of the recorded lectures was generally seen positively, however, the interface on the Moodle website could be enhanced. Regarding the organization of the courses there is also still room for improvement. As will become clear in the following, these points were improved

Amendments

According to the survey results it became obvious hat amendments in

1 the Moodle interface and its navigation

2 organization of the course and homework assignments needed to be made.

Adaptation of recorded lectures after pilot testing

The students' feedback was acknowledged and the Moodle website was re-organized accordingly. The different PowerPoint presentations and recorded lectures were organized under separate modules with specific titles. These facilitate the students' orientation. Furthermore, a new separate category for homework assignments was established. This way, it is easy for the students to see what they should prepare for the next session. The syllabus provided gives them information on what the course consists of and how it is assessed.

Lecturer's assessment of this type of learning.

On-line learning platforms is a new mechanism of learning and is still foreign to most lecturers today. More assistance needs to be given to lectures to build on-line teaching skills and more emphasis on staff costs needs to be geared towards consulting for on-line course teaching skills. This is very different to frontal learning and needs to be addressed. This was not addressed during this project.

This platform of recording classes that are happening live and giving a feature of free access to registered students is beneficial for revision purposes and for making up missed classes. Since these pilot tests did not allow for use of the materials without the face-to-face meetings of the lecturers it is difficult to determine whether there is more added value to the recordings than a regular face to face course.

Final Report for The Hebrew University of Jerusalem (HUJI)

Dissemination:

At the Hebrew University 2 courses were produced: "Macroscopic Quantum Coherence in Engineered Nano-Systems" and "Nano in service of humanity".

The materials produced (courses/recordings) are already being used as platforms for future courses. HUJI is now undergoing a significant transition by improving its international teachings and collaborations. Thus this English language material, of high quality, is of great use for this initiative.

We intend to give these courses and expand the student base further, to reach most of our Physics (PhD level) students (with the "Macroscopic Quantum Coherence in Engineered Nano-Systems" course) and to extend and reach also international students coming each year to HUJI, with the "Nano in service of humanity" course.

At our center many industry workers come to use our facilities. Many of them were interested in taking the online courses and some enrolled to the TAU online course.

The Hebrew University- Pilot test included the following courses:

1) The Course “Nanotechnology in Service of Humanity” was offered to bachelor students. This course, originally given as a regular course in Hebrew was recorded in English by many lecturers for the purpose of the consortium and was taken by 8 students. Some impressions of those students who took the online course will be described below. In addition, the course was taught during the last two years and is being taught this year as well. The number of students in this course is impressive. The data of the students who took the frontal course at HUJI and used the on-line materials to repeat a lesson will be presented later..

2) Pilot test of the Course "Macroscopic Quantum Coherence in Engineered Nano-Systems" offered by the Hebrew University to graduate students in Physics. (6 students).

3) Pilot of Course “Surface Science” from Tel Aviv University was promoted at HUJI so that 12 students and some industry employees took the course.

Nanotechnology in Service of Humanity- Pilot test

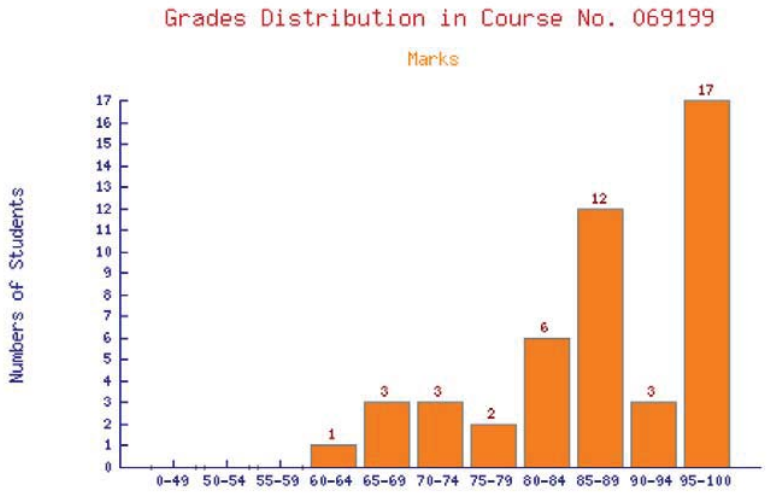
1. The course " Nanotechnology in Service of Humanity" was given to Bachelor students. It is structured according to ECTS
2. The target group of the course were the general Bachelor student population at HUJI (including humanities and social sciences).

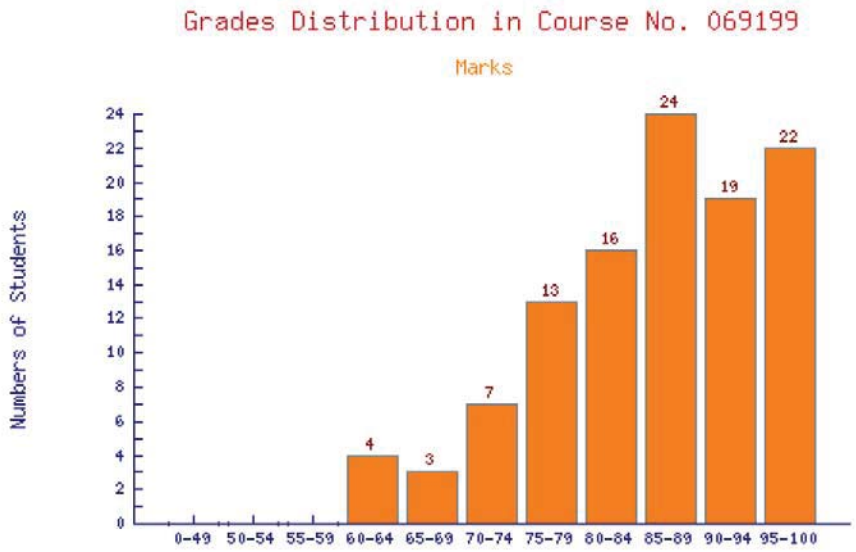
3. The material produced are based on recorded lectures, quizzes, exams and interactive forums within the moodle framework.
4. Courses are reviewed and approved by the HUJI administration, both prior and post teaching.
5. Each course undergoes student evaluation via the standard HUJI evaluation process.

During the first year of 2014/15 55 students participated in the course. 47 of them took the exam and the average grade was 88. 68% were male and 33% female.

In 2015/16 the number of students increased to 124 and 108 of them took the exam. The average score was 84. 46% were male and 54% female.

In the year 2016/17, 83 students participated in this course and the course still is running.





Responses of students:

"The course was very enjoyable and enriched me about the field of Nanoscience and Nanotechnology..The course was presented in a clear and simple language so that anyone can understand, even if he is not a scientist. I learned what Nano is, its importance and what applications it could provide for mankind. The course was presented nicely. The diversity of the speakers made it even more interesting."

"I would like to thank you very much for your wonderful course on the science of nano for non-scientists. As someone interested in science I find it very difficult gaining access to scientific knowledge for people lacking the necessary scientific background. Your course was fascinating and a wonderful introduction to the nano world. Particularly advantageous were the many topics you managed to cover by inviting many researchers to talk about their fields of interest.

The course was basic but not superficial and opened new worlds for me. The quality of the films was good and the PPT worked smoothly and were nicely visible as well."

Macroscopic Quantum Coherence in Engineered Nano-Systems

1. The course "Macroscopic Quantum Coherence in Engineered Nano-Systems" was given to PhD students (mainly in physics and engineering).
2. It is structured according to ECTS
3. HUJI is part of the European network for ECTS recognition.
4. The target group of the course were the physical sciences PhD student population at HUJI
5. The material produced are based on recorded lectures, quizzes, exams and interactive forums within the moodle framework.
6. Courses are reviewed and approved by the HUJI administration, both prior and post teaching.
7. Each course undergoes student evaluation via the standard HUJI evaluation process.

Responses of students:

"The course "Macroscopic Quantum Coherence in nano-engineered systems" was a very positive and learning online experience for me. I'm a physics student, but I spend a lot of time in the clean room, thus feeling that I sometimes distance myself from the physics and work more like a technician. The course discusses some of the major important ideas in quantum physics relevant for nano-systems, and therefore connects my experimental work with the theoretical background of the last years of my education. The only point of improvement, I would suggest, is more questions to check the student's understanding of the material. Say, after each video-class, two-three questions would be in place".

"It was a very interesting course which gave me a lot of ideas concerning to my research field. I found it very comfortable to take a course online, it gives you the opportunity to tune your work time between the research and the courses."

Student Mobility Feedback

Torino Program

Eight of HUJI students participated in the Torino Program. All of them were from the physics and Applied Physics Departments, except one student who is affiliated to the Life Sciences Department. Three of them are Msc. students and the other 5 students are PhD candidates.

Responses of students:

The course topics were highly innovative and were orientated to students from various disciplines with little experience in the research field but needing to understand the field more in depth.

The lecturers were extremely vivid and kept the audience captivated. The host Prof. Danilo Demarchi was extremely pleasant. He and his team took great care of the students and spent quality time with them. They formulated interactions between the group which was beneficial both on a social and academic level. The Tempus project facilitated better acquaintance for internal collaborations and with other universities in Israel and in Europe. One student noted in particular that this type of intense interaction is far more powerful that any conference because the student has more time to interact with other researchers and exchange ideas in various topics

Grenoble Program:

Five of our students participated in two courses given by CIME. All the students are affiliated to the Faculty of Medicine. All of them were MSc. Students.

The courses given at Grenoble were:

1. MOS transistor manufacturing, with practices on clean room processes, processing technology simulation and MOS transistor electrical characterization.
2. Nano-biotechnology labs, with practices on DNA extraction from a bacteria, DNA labeling by fluorescence, DNA hybridization on an oligonucleotide and AFM manipulation, which can also be used on biological materials.

Responses of students:

Bio-technology Session

A well organized and very educational seminar that taught new methods that students were not familiar with. This experience will benefit the students during their studies and in research. A very interesting and profound lecture on AFM was given first. The lecturer was very nice and enriched us with his vast knowledge. We experienced with lab work on DNA microarray:

DNA was fluorescently labelled and hybridized to an oligonucleotide microarray to detect level of expression. I had experience with PCR but fixing DNA on the chip in order to distinguish DNA impairments was new to me and it was interesting to see this new applications. The lecturer was very professional and explained everything clear and fluent, with patience.

These sessions were well organized in terms of time allotted, background materials provided and instructions. The CIME team was pleasant and helpful. Beside the educational part they provided lunch every day and made a very nice welcoming event. They help us to find accommodation and answer any question we had whether about the lab work or about their scientific background and Grenoble.

This was a unique experience to me. I learned a lot and met interesting researchers from Grenoble and also student from all over my count

Clean-room and Fabrication Session

"This session included fabrication of MOS field-effect-transistors and characterization of their electrical properties. Over the sessions students were exposed to a huge variety of a high standard equipment. The multiple stage process was very inspiring and opened their minds to new techniques useful for their current research. In addition, the interaction with skilled professionals from other institutions who guided us along the workshop and taught us about the facilities and mechanisms that were required to the fabrication process (and also the alternatives techniques, at specific stages) was very enlightening. Even students who had previous experience in clean room environments found that this experience was really extraordinary due the really high quality process and the endless options of fabrication and research. "

Pilot test description/feedback on 3 courses and lab recordings video repository, by Tel Avi University

The courses are:

1. **Introduction to surface sciences**
2. **Micro-Nano Technologies**
3. **Atomistic Simulation of Materials**

The lab video recordings repository was on fabrication of Microelectromechanical System (MEMS) Devices

Introduction to surface sciences

The course was taught and recorded for 2 times. During the second time an extra effort was put on the improvement of the face2face teaching environment and the video recordings quality.

35 students from Tel Aviv University attended to the Face2Face instance of the course, in addition to students from: CIME(2), Polito(7), Weizmann (16).

The pilot test reports from students taking the course remotely will be submitted by their own institute. Some of students from TAU preferred to learn from the course recordings on their own pace, though the Face2face class was available for them.

Students gaining credit by attending courses on other than their own institute, is quite new practice in Israel and from this perspective EduNano consortium is implementing an innovative approach.

The assessment process of remote students was done by homework's and final assignment via Skype.

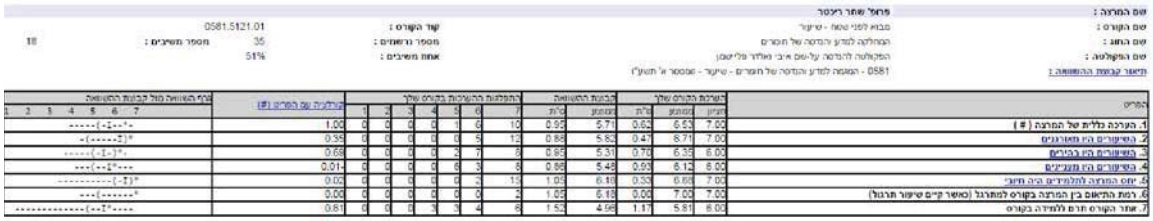
Remote student credits were provided by their home institute. The accreditation approval process was led by consortium contact point at student's institute of origin.

Students evaluated very highly the continent of the course and some of the concepts visualized by the lecturer. The live demonstrations during the lectures made the classes more intersting.

The Open University of Israel and Tel Aviv University successfully negotiated for mutual use of Introduction to Surface Sciences course. According this memorandum of understanding: the Surface Sciences course (which its instance uploaded on EduNano consortium learning management system, the Open University will send list of students to be registered to the

EduNano LMS and they will use the online course materials in the framework a same course at their university. All teaching learning workload, including homework/assignments inspection, exams and course content update will be done by the professor in charge of the course at the Open University

The students filled course evaluation report on the university platform



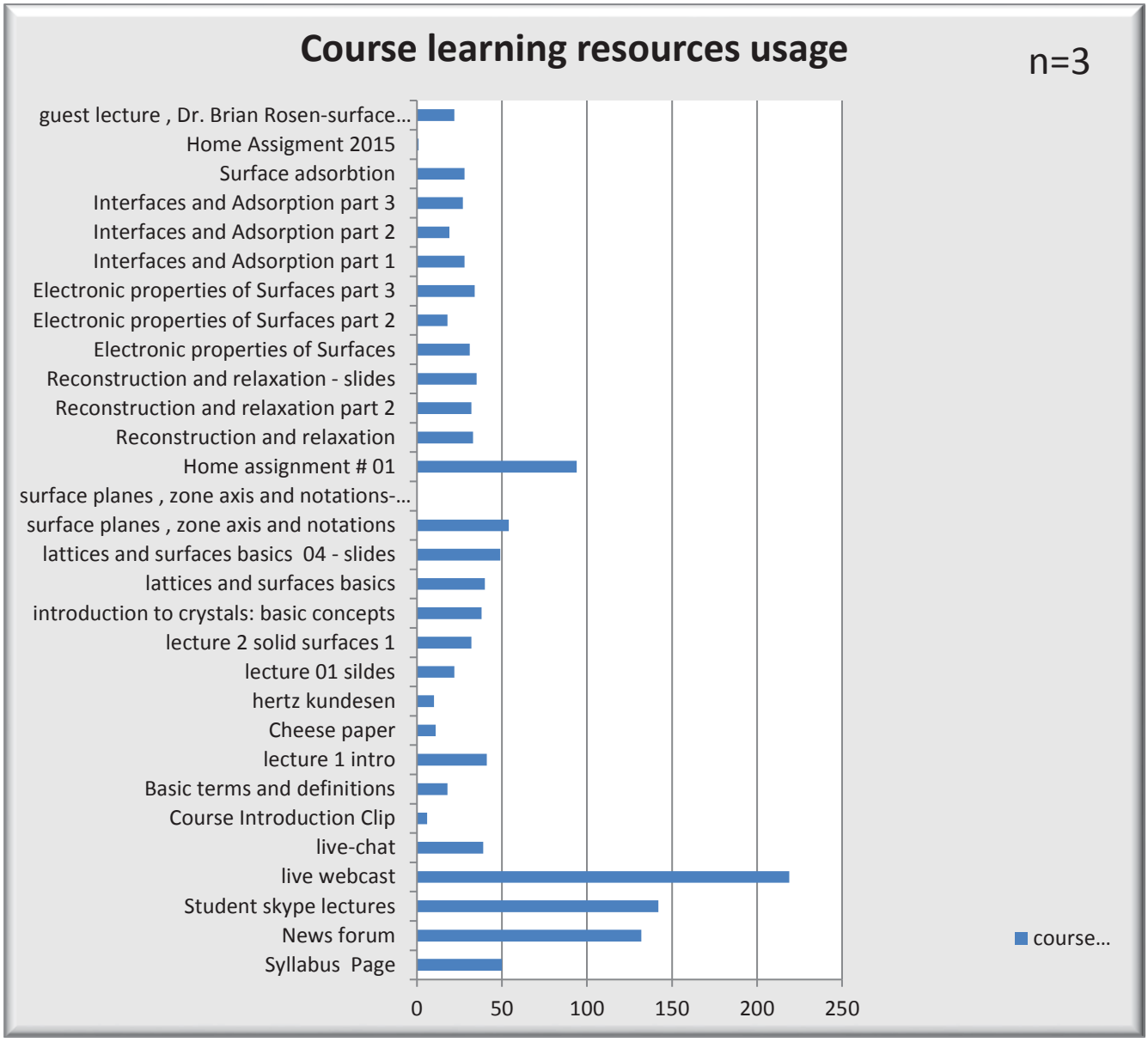
שם המרצה :	פרופ' שחר ריכטר
שם הקורס :	מבוא לפסיכולוגיה - שיעור
שם החוג :	הפקולטה למדעי ההנדסה של חומרים
שם הפקולטה :	הפקולטה להנדסה על-שם איבי מולדר פלייטמן
תיאור קבוצת ההשוואה :	0581 - הפקולטה למדעי ההנדסה של חומרים - שיעור - סמסטר א' תשע"ו

קוד הקורס :	0581.5121.01			
מספר נרשמים :	35	מספר משיבים :	18	
אחוז משיבים :	51%			

פריטים	רשימת הקורס שלך: ממוצע	סטית	קבוצת ההשוואה: ממוצע	סטית	התפלגות ההשלכות בקורס שלך: 1	2	3	4	5	6	7	ציון קבוצת ההשוואה	הערכה של המרצה (#)	צורת השוואה מול קבוצת ההשוואה: 1 2 3 4 5 6 7
1. הערכה כללית של המרצה (#)	7.00	6.53	5.71	0.62	0	0	0	0	1	0	10	0.95	1.00	-----[-+-]*-
2. השיעורים היו מאורגנים	7.00	6.71	5.83	0.41	0	0	0	0	0	0	12	0.86	0.55	-(-----]*
3. השיעורים היו ברורים	6.00	6.35	5.31	0.75	0	0	1	0	2	1	8	0.95	0.68	-----(-[-]*-
4. השיעורים היו מעניינים	6.00	6.12	5.48	0.93	0	0	0	0	0	3	8	0.86	0.01	---(--]*---
5. יחס המרצה לתלמידים היה חיובי	7.00	6.65	5.33	0.55	0	0	0	0	0	2	11	1.05	0.05	----------[-]*)
6. רמת ההיאום בין המרצה בקורס למתרגל (כאשר קיים שיעור תרגול)	7.00	7.05	6.18	0.00	0	0	0	0	0	0	2	1.05	0.00	---[------*
7. שאר הקורס תרם ללמידה בקורס	6.00	5.81	4.56	1.17	0	0	1	3	3	4	6	1.52	0.61	----------[--]*----

Higher resolution image attached to this document by the name “Surface pilot evaluation”

Resource usage chart from project LMS



Some comments citations made by not TAU students taking this course completely online

Did you encounter difficulties (technical or other) during the course - if so what, and were they adequately resolved?

“Yes. The online course wasn't always available. I entered after it was fixed. “
“problems logging . addressed quickly and well by staff”

“Many couldn't watch lectures from home (because it was a weekend or because we didn't log-in from
the institute).”
“some problems with uploading the videos which were solved very fast”

Please write a few words about your impression of this mode of learning relative to frontal (face-to-face) learning: advantages and disadvantages.

“Advantages: Numerous choices for schools; Disadvantage: Not all courses required to complete the degree may be offered online”
“I can learn from home”
“As a PhD student it has many advantages. The largest one is that I can arrange my time properly. “
more accessible, can pause -positive. asking questions is ca bit clumsy
It was very similar to sitting in a lecture, only that I could stop and replay a certain
section I didn't understand.
“This was I can access the lecture at my convenience and concentrate better. “

Micro-Nano course

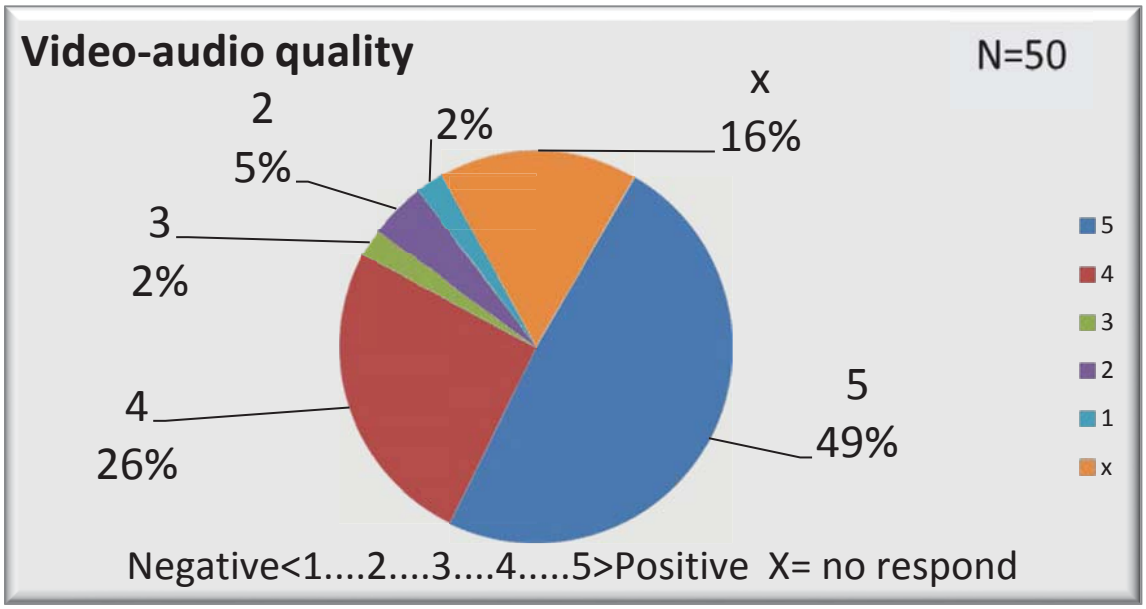
The course was taught in the first semester of 2015-2017 academic year and over 90 students from TAU attested the course Face2Face and remotely. In addition to TAU, students from Polito and Mechon Lev Jerusalem remotely attended the course.

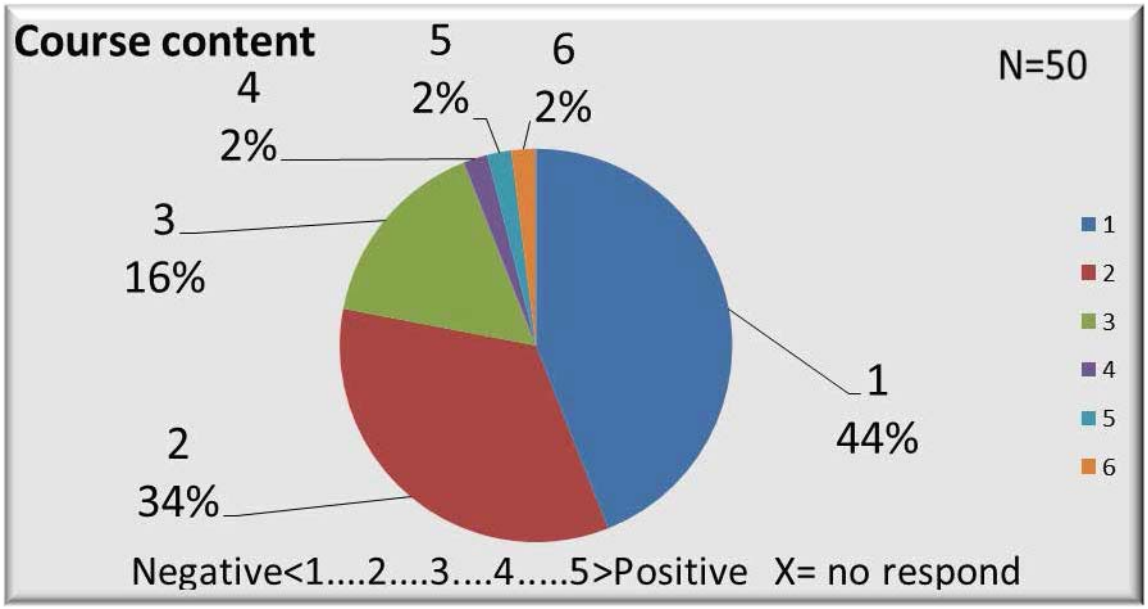
The course was live webcasted during the semester on every Tuesday from 16:00-19:00. Though the course was taught frontally (during which it was video recorded for production of the online content to be placed on EduNano LMS) many of the students preferred to follow the lectures either via live webcasts or using the recordings on EduNano LMS (VOD). The recordings of Face2Face lectures were uploaded to the project LMS by the end of the very same week.

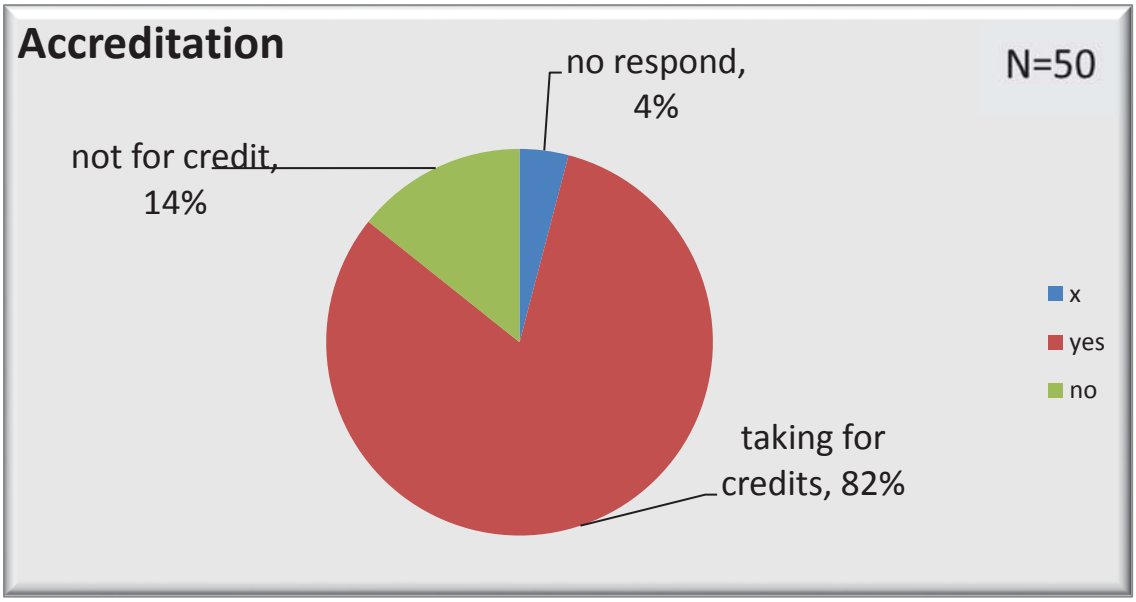
Already in the early stages of course preparation, cooperation among universities of TAU, POLITO and EPFL stablished by using different communication means as Zoom, Skype and email exchange among the professors in order to coordinated the course content. 4 different lecturers delivered lectures during the course. Most of the lectures delivered by prof. Yosi Shacham (the author of the course) and Yakov Rosin from Tower Jazz semiconductors. Prof. Danilo Demarchi (POLITO) and Prof. Sandro Carrera (EPFL) delivered their lectures remotely using skype in front of live student audience at TAU.

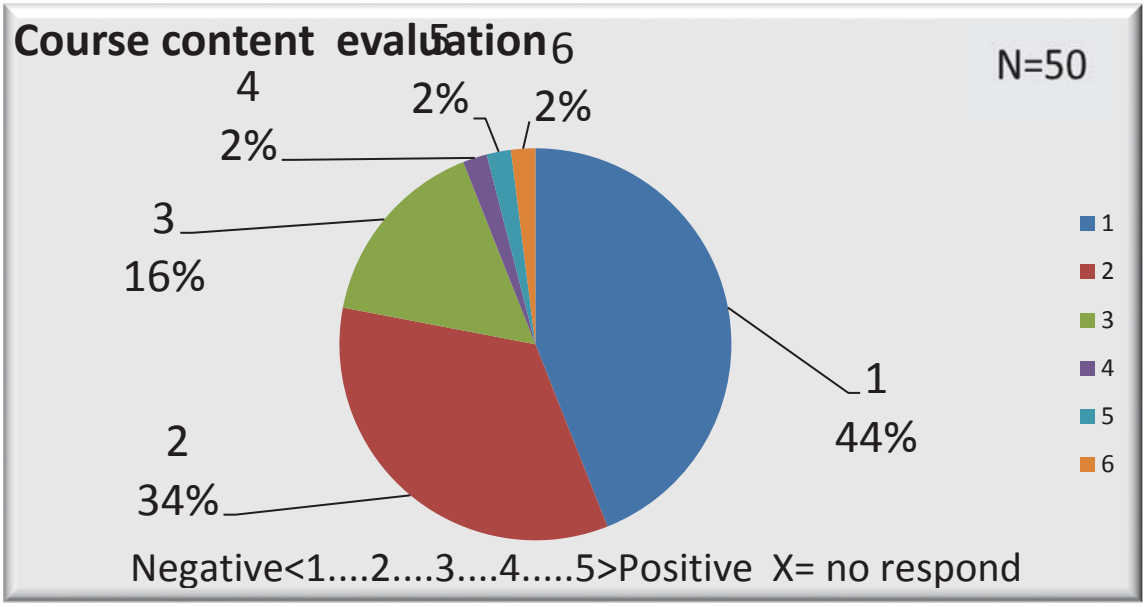
The analysis of students feedback based on a form filled after the course final exam:

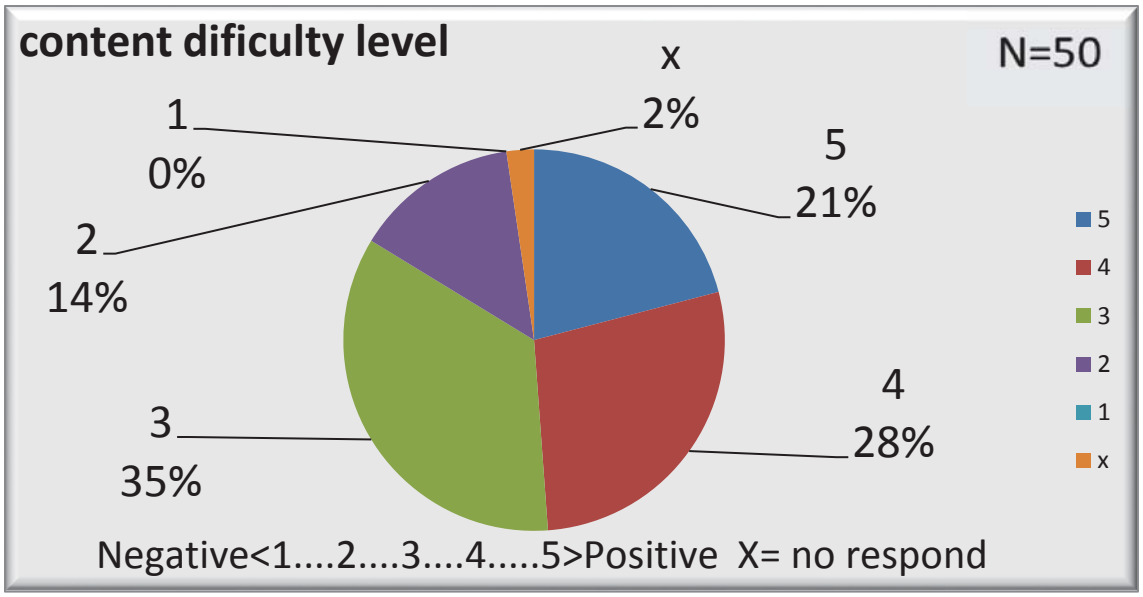
The survey questions/statements had 5 degree of freedom where: 1 most negative up to 5 indicating most positive attitude






Accreditation
N=50
no respond, 4%
not for credit, 14%
taking for credits, 82%
x
yes
no


Course content evaluation
N=50
4
2%
5
2%
6
2%
3
16%
2
34%
1
44%
1
2
3
4
5
6
Negative<1....2....3....4.....5>Positive X= no respond



Some comments citations from project LMS online survey form:

Did you encounter difficulties (technical or other) during the course - if so what, and were they adequately resolved?

"Sometimes it took a few days for the videos to be uploaded, but issue was solved quickly by technical staff"
"no, this course was performed well"

Please write a few words about your impression of this mode of learning relative to frontal (face-to-face) learning: advantages and disadvantages.

"Very convenient and flexible in hours"
"It depends on your self-discipline, you could take many breaks or stop whenever you want, but you can also rewind"
"It is easier to focus in a frontal learning environment, but the lecture recordings can be viewed later."
"it is good for those who cannot be at the frontal lectures such as myself"

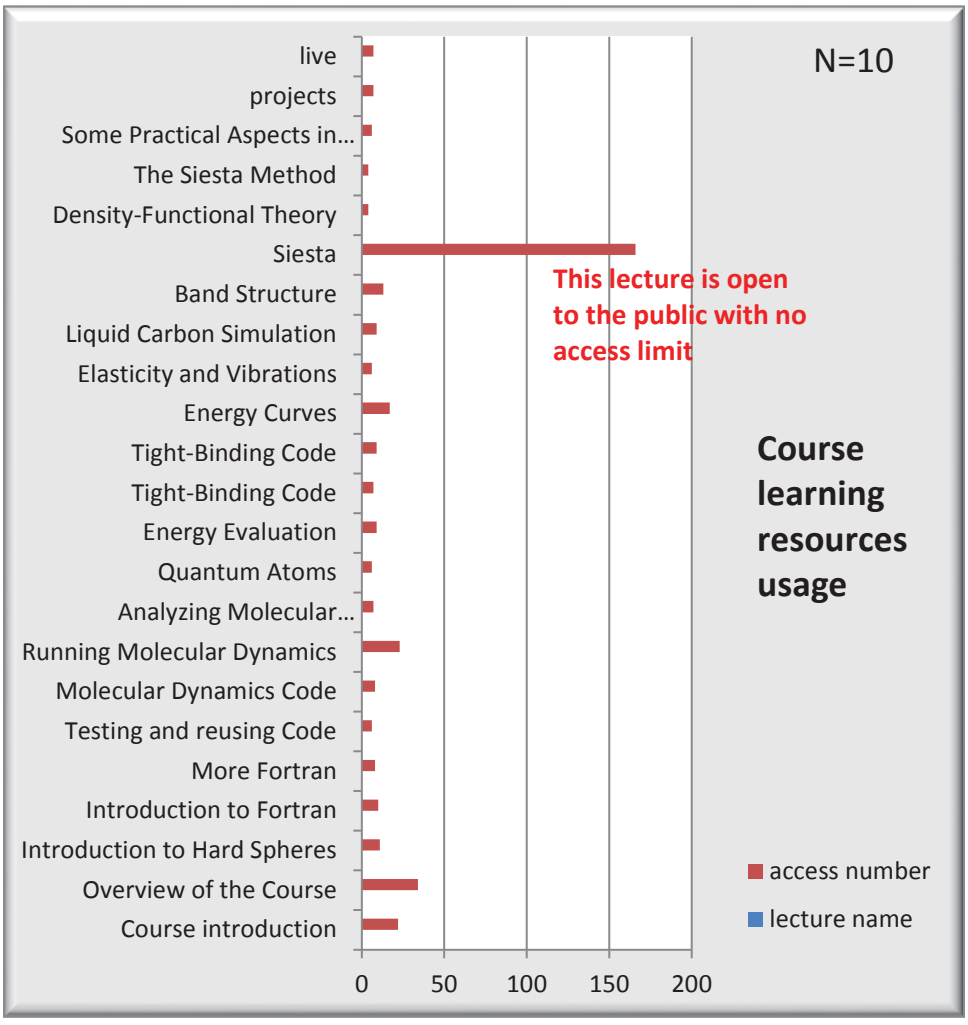
Atomistic Simulations:

The course is completely theoretical course in the framework of master degree and less than 10 students were registered. The course also video recorded in face2face class at tau on the second semester of 2014-2015.

All the course material including the video recording of frontal lectures, the lecture slides and the homework's uploaded to the project LMS and students made use of the online instance of the course by the next semester (the co.

The course recording and all other resources were uploaded simultaneously to the Tel Aviv University and EduNano project LMS, we couldn't enforce the users to choose our platform

Course learning resources usage chart taking from EduNano LMS logs



Data the course evaluation report from TAU course assessment survey:

שם המרצה : **ד"ר אוסבלדו דיאגז לופז**

שם הקורס : סימולציה אטומיסטית של חומרים - שיעור **קוד הקורס :** 0581.5221.01

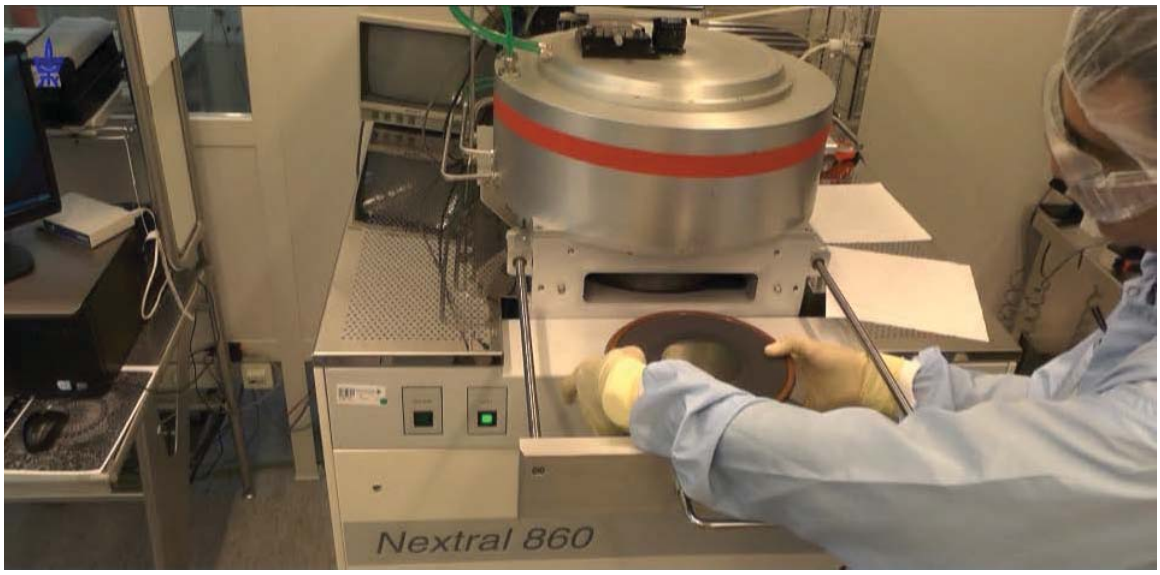
שם החוג : המחלקה למדע והנדסה של חומרים **מספר נרשמים :** 9 **מספר משיבים :** 2

שם הפקולטה : הפקולטה להנדסה על-שם איבי ואלדר פליישמן **אחוז משיבים :** 22% **שים לב כי אחוז המשיבים נמוך מ - 40%**

תיאור קבוצת ההשוואה : 0581 - המגמה למדע והנדסה של חומרים - שיעור - סמסטר ב' תשע"ו

הפריט	הערכת הקורס שלך		קבוצת ההשוואה		התפלגות ההערכות בקורס שלך							קורלציה עם הפריט (#)	גרף השוואה מול קבוצת ההשוואה
	חציון	ממוצע	ס"ת	ממוצע	ס"ת	7	6	5	4	3	2	1	1 2 3 4 5 6 7
1. הערכה כללית של המרצה (#)	6.50	6.50	0.71	5.42	0.92	1	1	0	0	0	0	0	--*-(---)----
2. השיעורים היו מאורגנים	6.50	6.50	0.71	5.45	0.96	1	1	0	0	0	0	0	--*-(-I-)----
3. השיעורים היו בהירים	6.50	6.50	0.71	5.03	0.98	1	1	0	0	0	0	0	--*----(I--)-
4. השיעורים היו מעניינים	5.50	5.50	0.71	4.97	1.06	0	1	1	0	0	0	0	------*-I--)----
5. יחס המרצה לתלמידים היה חיובי	7.00	7.00	0.00	5.98	0.97	2	0	0	0	0	0	0	------(-I--)*
6. רמת התיאום בין המרצה בקורס למתרגל (כאשר קיים שיעור תרגול)	0.00	0.00	0.00	6.16	0.59	0	0	0	0	0	0	0	--(I-)
7. אתר הקורס תרם ללמידה בקורס	6.50	6.00	1.41	5.45	0.94	1	0	1	0	0	0	1	--(-I-)*-----

Cleanroom – Nano fabrication lab procedures recordings:



A video recordings repository of Nano Fabrication procedures were recorded at TAU center cleanroom facilities in the framework of Edunano project.

The recordings are uploaded as part of Learning Objects (LO) repository to the project LMS. The recordings will be integrated in the relevant courses to be developed in the future to visualize and support theoretical learning.

During the recording process a special efforts has been done to connect various cutting edge lab equipment with recording computer and camera to capture high quality images from the equipment and their computer controlled interfaces.

Recording made by TAU team in previous projects also inserted in this lab recording repository

EduNano

“Education in NanoTechnologies”

Pilot Tests and Field Trials done at Politecnico di Torino, Italy

Danilo Demarchi, Politecnico di Torino

Tel: +39.011.090.4122, E-mail: danilo.demarchi@polito.it

The Courses of Politecnico di Torino

Politecnico di Torino in EduNano prepared 3 courses:

- CAD for micro systems with teachers
  - Danilo Demarchi
  - Beatrice Miccoli
  - Alessandro Sanginario
  - Paolo Centaro
- Bio-Nanoelectronic Devices for BioSensing with teachers
  - Sandro Carrara
  - Danilo Demarchi
- Molecular Electronics for the Realization of Novel Nanoelectronic Devices with teachers
  - Gianluca Piccinini
  - Mariagrazia Graziano
  - Danilo Demarchi

For the 3 courses, different ways of piloting and tests were done, depending on the type of course.

CAD for micro systems

This course was held in the Master program of Politecnico di Torino, for Electrical and Biomedical Engineers. The tests were organised in online quizzes. The statistics of the course, taken from the online EduNano website are reported in the following tables.

The total number of students participating to the pilot was **69**.

Course Views

In Table 1 is reported the list of users who followed the courses and their number of accesses.

Table 1: number of course views for CAD for Microsystems

User	Course Views
Ahmed Abbas	92
Alessandro Nadal	82
Alessandro Novello	124
Amine Alouch	160
Andrea Caizzone	182
Andrea Cupertino	118
Andrea Mucchietto	156
Antoine Le Cordier	50
Antoine Pissis	126
Antonin Macquart	98
Antonio Sclocchi	120
Avichai Marcovici	2
Benjamin Houang	69
Benjamin Miller	75
Celine Bounioux	8
Clara Garnier	114
Cristiana Patella	138
Cristina Pinneri	108
Damien Lamaison	134
Daniele Busacchio	121
Emmanouil Mandrakis	104
Eugenio Maggiolini	154
Evan Rmy	81
Fabio Bertuccio	110
Fabio Grassi	121
Fabio Mattiussi	105
Fabrizio Gota	86
Fedele Tagarelli	117
Francesco Capirci	96

Gabriele Bongiovanni	79
Gabriele Lodi	126
Giorgio Cristiano	99
Giovanni Catania	113
Giovanni Pellegrino	30
Giuliano Caruso	32
Giuseppe Libero Bufi	99
Guillaume Herment	87
Jiao Yang	16
Joaquim Luque	88
Lorenzo Lombardo	127
Louis Kit How Chan	55
Luca Camellini	107
Luca Capua	155
Lucrezia Maini	109
Luis Angel Cubero Montealegre	124
Marco Santonocito	3
Martina Mascia	51
Massimo Giordano	131
Matteo Collura	85
Matteo Hirsch	122
Mattia de Girolamo	28
Maya Hayek	111
Omar Sakr	84
Outman Akouissi	114
Renato Domingues	174
Sakher AlHammouri	53
Salvatore Collura	102
Sebastiano Trani	19
Shervin Vahid Dastejerdi	69
Stefano Iuliano	128
Stefano Sarao	145
Valentina Marie Paggi	137
Valentina Ruozi	164
Xavier Hurtaud	132
Yan Wolff	63
Yossi Keydar	7
Younes Bouhadjar	154
Yuri Ardesi	197
Zhentao Liu	152
Grand Total	**6922**

The number of visits is very interesting and the feedback of the students was very positive.

Type of Visits

In Table 2 are reported the number of accesses for the different type of contents. As it is evident, the quizzes were done and all the students, some of them after few attempts, successfully did them.

Table 2: type of visits for Cad for Microsystems

Type of Visit	Accesses
Chapter viewed	52
Course module instance list viewed	33
Course module viewed	2958
Course viewed	2231
Grade overview report viewed	9
Grade user report viewed	35
Grader report viewed	1
Log report viewed	12
Participation report viewed	3
Quiz attempt preview started	16
Quiz attempt reviewed	244
Quiz attempt summary viewed	311
Quiz attempt viewed	1576
Quiz edit page viewed	73
Quiz report viewed	4
User list viewed	84
User profile viewed	14
Grand Total	**7657**

Quizzes

Three quizzes were done during the course. They were linked to the most important topics of the course:

1. *Preliminary Concepts*, where were tested the learnt concept in MEMS modelling;
2. *Design Process & CAD Components*, in which the students had to demonstrate if they understood how to face a design of a MEMS and which are the available tools for the simulation of MEMS;
3. *FEM Introduction*, where were tested the concepts in the mathematical approach of Finite Element Method and its application to the construction of a MEMS model.

In following tables are presented the statistics of the quizzes, reporting the **attempts** and the **results obtained, student by student**.

Statistics of Quiz1 Preliminary Concepts

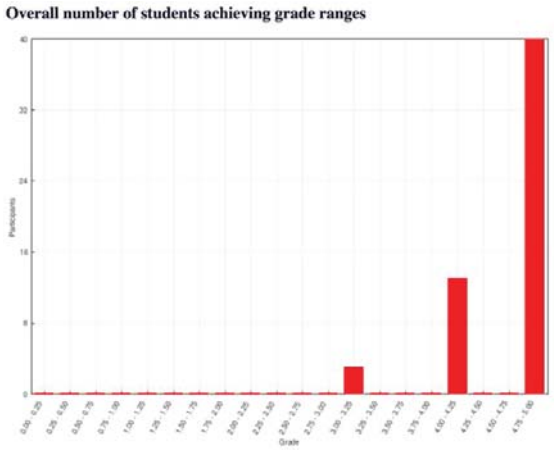
The questions in Quiz 1 were :

1. A Lamped Element is?
2. In the Mechanical Domain?
3. Two Lamped Elements in series share?
4. In a Parallel Plate Capacitor at the Pull-In?
5. In Magnetic Domain the Inductor is?

And there were 5 answers each, 1 correct only.

Action	Attempts
Quiz attempt reviewed	58
Quiz attempt started	56
Quiz attempt submitted	56
Quiz attempt summary viewed	80
Quiz attempt viewed	450
Grand Total	**700**

Results of Quiz 1



Detailed answers to Quiz 1

Surname	First name	Grade	Q. 1	Q. 2	Q. 3	Q. 4	Q. 5
Le Cordier	Antoine	5	1	1	1	1	1
Tagarelli	Fedele	5	1	1	1	1	1
Vahid Dastejerdi	Shervin	4	1	1	0	1	1
Sarao	Stefano	5	1	1	1	1	1
Lamaison	Damien	4	1	1	1	1	0
Novello	Alessandro	4	1	1	1	0	1
Garnier	Clara	4	1	1	1	1	0
Cubero Montealegre	Luis Angel	5	1	1	1	1	1
Houang	Benjamin	5	1	1	1	1	1
Rmy	Evan	5	1	1	1	1	1
Herment	Guillaume	5	1	1	1	1	1
Collura	Salvatore	4	1	0	1	1	1
Catania	Giovanni	5	1	1	1	1	1
Macquart	Antonin	3	1	1	1	-	0
Bouhadjar	Younes	5	1	1	1	1	1
Pinneri	Cristina	5	1	1	1	1	1
Liu	Zhentao	4	1	1	1	1	0
Cupertino	Andrea	5	1	1	1	1	1
Wolff	Yan	3	1	1	1	-	-
Busacchio	Daniele	5	1	1	1	1	1
Ruozi	Valentina	5	1	1	1	1	1
Sclocchi	Antonio	5	1	1	1	1	1
Patella	Cristiana	5	1	1	1	1	1
Capua	Luca	5	1	1	1	1	1
Capirci	Francesco	5	1	1	1	1	1

Hayek	Maya	4	1	1	1	1	0
Mucchietto	Andrea	5	1	1	1	1	1
Alouch	Amine	4	1	1	1	1	0
Pissis	Antoine	5	1	1	1	1	1
Chan	Louis Kit How	5	1	1	1	1	1
Luque	Joaquim	5	1	1	1	1	1
Bertuccio	Fabio	5	1	1	1	1	1
Hirsch	Matteo	5	1	1	1	1	1
Lombardo	Lorenzo	5	1	1	1	1	1
Mattiussi	Fabio	5	1	1	1	1	1
Cristiano	Giorgio	5	1	1	1	1	1
Sakr	Omar	4	1	1	1	1	0
Akouissi	Outman	5	1	1	1	1	1
Paggi	Valentina Marie	5	1	1	1	1	1
Collura	Matteo	5	1	1	1	1	1
Bongiovanni	Gabriele	5	1	1	1	1	1
Ardesi	Yuri	5	1	1	1	1	1
Gota	Fabrizio	5	1	1	1	1	1
Hurtaud	Xavier	5	1	1	1	1	1
Nadal	Alessandro	5	1	1	1	1	1
Domingues	Renato	5	1	1	1	1	1
Caizzone	Andrea	5	1	1	1	1	1
Grassi	Fabio	4	1	1	1	0	1
Iuliano	Stefano	4	1	1	1	0	1
Camellini	Luca	4	1	1	1	1	0
Maggiolini	Eugenio	5	1	1	1	1	1
Miller	Benjamin	3	1	1	1	0	0
Maini	Lucrezia	5	1	1	1	1	1
Lodi	Gabriele	4	1	1	1	0	1
Mandrakis	Emmanouil	5	1	1	1	1	1
Giordano	Massimo	5	1	1	1	1	1
Overall average		4,66	1	0,98	0,98	0,88	0,82

Statistics of Quiz2 Design Process & CAD Components

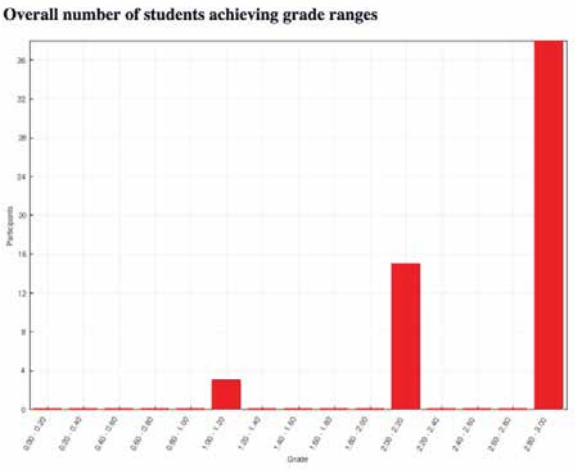
The questions in Quiz 2 were :

1. A Layout Editor is used for?
2. The Design of the Package is?
3. Top Down Top-Down Design means?

And there were 5 answers each, 1 correct only.

Action	Attempts
Quiz attempt reviewed	59
Quiz attempt started	60
Quiz attempt submitted	58
Quiz attempt summary viewed	72
Quiz attempt viewed	296
Grand Total	**545**

Results of Quiz 2



Detailed answers to Quiz 2

Surname	First name	Grade/3.00	Q. 1 /1.00	Q. 2 /1.00	Q. 3 /1.00
Giordano	Massimo	3	1	1	1
Cubero Montealegre	Luis Angel	2	1	0	1
Vahid Dastejerdi	Shervin	2	1	1	0
Le Cordier	Antoine	2	0	1	1
Chan	Louis Kit How	3	1	1	1

Macquart	Antonin	2	1	0	1
Lombardo	Lorenzo	3	1	1	1
Hurtaud	Xavier	3	1	1	1
Catania	Giovanni	3	1	1	1
Hirsch	Matteo	3	1	1	1
Mattiussi	Fabio	3	1	1	1
Patella	Cristiana	3	1	1	1
Ruozi	Valentina	3	1	1	1
Miller	Benjamin	1	1	-	-
Maini	Lucrezia	3	1	1	1
Pinneri	Cristina	3	1	1	1
Mandrakis	Emmanouil	3	1	1	1
Pissis	Antoine	3	1	1	1
Capirci	Francesco	3	1	1	1
Wolff	Yan	3	1	1	1
Busacchio	Daniele	2	1	0	1
Luque	Joaquim	1	0	0	1
Domingues	Renato	3	1	1	1
Bouhadjar	Younes	2	1	0	1
Cristiano	Giorgio	3	1	1	1
Rmy	Evan	2	1	0	1
Capua	Luca	2	1	0	1
Herment	Guillaume	3	1	1	1
Hayek	Maya	2	1	0	1
Tagarelli	Fedele	3	1	1	1
Garnier	Clara	2	1	0	1
Collura	Salvatore	3	1	1	1
Novello	Alessandro	2	1	0	1
Lamaison	Damien	2	1	0	1
Mucchietto	Andrea	2	1	0	1
Sarao	Stefano	2	0	1	1
Maggiolini	Eugenio	3	1	1	1
Alouch	Amine	3	1	1	1
Liu	Zhentao	2	1	0	1
Cupertino	Andrea	3	1	1	1
Akouissi	Outman	3	1	1	1
Bongiovanni	Gabriele	3	1	1	1
Gota	Fabrizio	3	1	1	1
Collura	Matteo	3	1	1	1
Paggi	Valentina Marie	3	1	1	1
Camellini	Luca	3	1	1	1
Bertuccio	Fabio	3	1	1	1
Caizzone	Andrea	3	1	1	1
Houang	Benjamin	3	1	1	1

Ardesi	Yuri	3	1	1	1
Sakr	Omar	3	1	1	1
Grassi	Fabio	3	1	1	1
Sarao	Stefano	3	1	1	1
Nadal	Alessandro	1	0	0	1
Busacchio	Daniele	3	1	1	1
Iuliano	Stefano	2	1	0	1
Lodi	Gabriele	3	1	1	1
Cubero Montealegre	Luis Angel	-	-	-	-
Sclocchi	Antonio	2	0	1	1
Luque	Joaquim	-	-	-	-
Overall average		**2,6**	**0,91**	**0,72**	**0,97**

Statistics of Quiz3 FEM Introduction

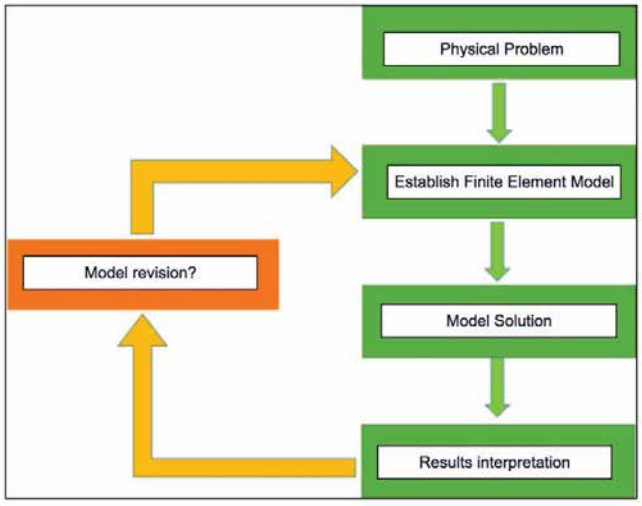
The questions in Quiz 3 were :

1. Meshing is the procedure where?
2. At each node of the Mesh Elements?
3. FEM can be used in (more than 1 answer is correct)?
4. FEM Modeling is useful for?
5. FEM Schematic Fill the scheme describing the FEM analysis steps

For answers 1, 2 and 4 there were 5 answers each, 1 correct only.

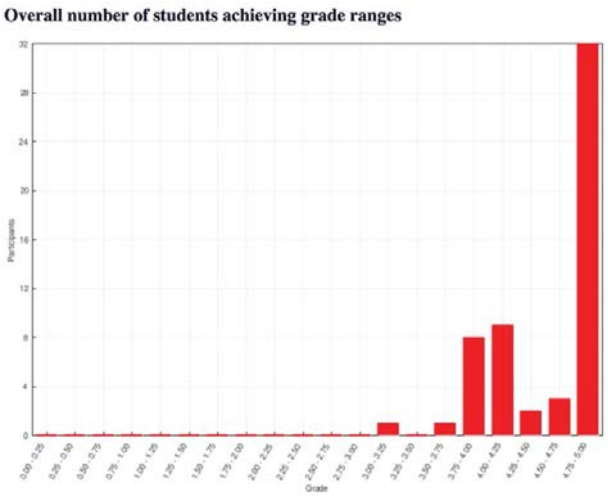
At question 3 more than 1 answer was correct.

In question 5 was used the graphical tool of Moodle, where was possible to ask to correctly build the graph with the right fields contained in the boxes:



Action	Attempts
Quiz attempt reviewed	63
Quiz attempt started	57
Quiz attempt submitted	57
Quiz attempt summary viewed	80
Quiz attempt viewed	596
Grand Total	**853**

Results of Quiz 3



Detailed answers to Quiz 3

Surname	First name	Grade	Q. 1	Q. 2	Q. 3	Q. 4	Q. 5
Le Cordier	Antoine	5	1	1	1	1	1
Cubero Montealegre	Luis Angel	5	1	1	1	1	1
Chan	Louis Kit How	5	1	1	1	1	1
Hurtaud	Xavier	4	1	1	1	0	1
Lombardo	Lorenzo	4	1	1	1	0	1
Hirsch	Matteo	4,75	1	1	0,75	1	1
Mattiussi	Fabio	3,75	1	1	0,75	0	1
Vahid Dastejerdi	Shervin	3,75	1	1	0,75	0	1
Miller	Benjamin	3,5	0	1	0,5	1	1
Macquart	Antonin	5	1	1	1	1	1
Pissis	Antoine	5	1	1	1	1	1
Luque	Joaquim	5	1	1	1	1	1
Mandrakis	Emmanouil	5	1	1	1	1	1
Wolff	Yan	4,25	1	1	0,25	1	1
Maini	Lucrezia	5	1	1	1	1	1
Bouhadjar	Younes	3,75	1	1	0,75	0	1

Lamaison	Damien	4,6	1	1	1	1	0,6
Rmy	Evan	5	1	1	1	1	1
Pinneri	Cristina	4	1	1	1	0	1
Herment	Guillaume	5	1	1	1	1	1
Sarao	Stefano	5	1	1	1	1	1
Capua	Luca	4	0	1	1	1	1
Patella	Cristiana	5	1	1	1	1	1
Mucchietto	Andrea	5	1	1	1	1	1
Capirci	Francesco	3,75	1	1	0,75	0	1
Garnier	Clara	5	1	1	1	1	1
Cristiano	Giorgio	5	1	1	1	1	1
Ruozi	Valentina	4,75	1	1	0,75	1	1
Tagarelli	Fedele	4	0	1	1	1	1
Domingues	Renato	4	1	1	1	0	1
Hayek	Maya	4,5	1	1	0,5	1	1
Catania	Giovanni	4	1	1	1	0	1
Busacchio	Daniele	4,75	1	1	0,75	1	1
Maggiolini	Eugenio	4	1	1	1	0	1
Liu	Zhentao	3,75	1	0	0,75	1	1
Akouissi	Outman	5	1	1	1	1	1
Collura	Salvatore	4	1	1	1	0	1
Alouch	Amine	3,75	1	1	0,75	0	1
Collura	Matteo	5	1	1	1	1	1
Bongiovanni	Gabriele	5	1	1	1	1	1
Houang	Benjamin	3,75	1	1	0,75	0	1
Ardesi	Yuri	5	1	1	1	1	1
Paggi	Valentina Marie	5	1	1	1	1	1
Camellini	Luca	5	1	1	1	1	1
Bertuccio	Fabio	5	1	1	1	1	1
Caizzone	Andrea	4,25	1	1	0,25	1	1
Sakr	Omar	4,5	1	1	0,5	1	1
Nadal	Alessandro	5	1	1	1	1	1
Lodi	Gabriele	5	1	1	1	1	1
Novello	Alessandro	4,75	1	1	0,75	1	1
Cupertino	Andrea	5	1	1	1	1	1
Grassi	Fabio	5	1	1	1	1	1
Giordano	Massimo	4	1	1	1	0	1
Gota	Fabrizio	3,95	1	1	0,75	1	0,2
Iuliano	Stefano	5	1	1	1	1	1
Domingues	Renato	5	1	1	1	1	1
Sclocchi	Antonio	3	1	0	1	0	1
Overall average		**4,52**	**0,95**	**0,96**	**0,89**	**0,74**	**0,98**

Results of the Assessment and Feedbacks

The students were accessed by the preparation of a CAD Tutorial in Comsol Multiphysics and received the degree in Italian grades, where the maximum evaluation is 30/30.

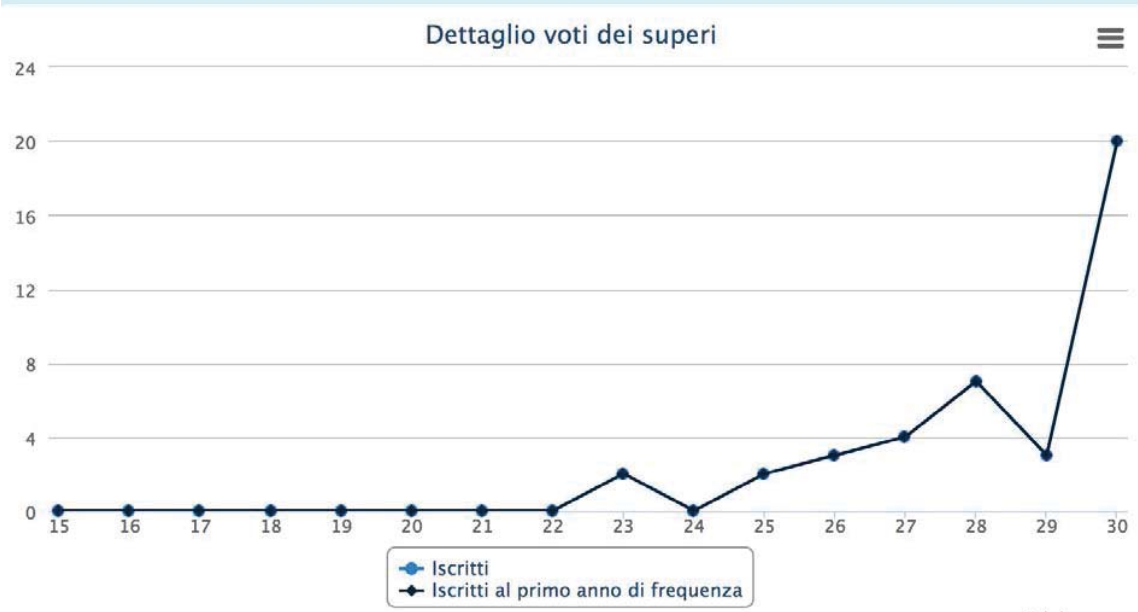


Figure 1: Grades of Students in CAD for Microsystems

The results of the student exams are reported in Figure 1.

Bio-Nanoelectronic Devices for BioSensing

This course was held for two PhD programs, Electronics and Biomedical Engineering, and it was given access to it to a set of master Students in Electronics and Biomedical Engineering.

It is one of the courses too of reference for the Hands-On sessions held in Torino.

The assessment was done including in the EduNano portal the exams, asking to the students to do a Written Report related to the requested topics.

For these reasons, *it is not possible to present statistics related to an online assessment*.

The total number of students who participated to the pilot was **44**, of which 36 were students of Politecnico di Torino and 8 the ones participating to the EduNano Hands-on session in Torino.

Course Views

User	Course Views
Adan Azem	1
Ahmed Abbas	1
Alessia Botta	1
Amir Ziv	72
Antonia Silvestri	1
Avichai Marcovici	44
Avner Neubauer	30
Ayelet Yashar	33
Celine Bounioux	13
Chen Tzur	116
Clara Garnier	1
Cristiana Patella	3
Damien Lamaison	1
Daniel Itshak	35
Gabriele Bongiovanni	1
Giuseppe Libero Bufi	7
Hadas Navenzal	67
Haim Sazan	21
Jiao Yang	2
Kian Kadan	1
Lilach Saltoun	47
Luca Capua	1
Marco Farina	39
Maya Hayek	1
Nava Shmoel	15

Netanel Barhanin	30
Nir Sukenik	69
Olga Chuntonov	3
Samuel Goldstein	72
Shir Shahal	29
Valentina Marie Paggi	2
Xavier Hurtaud	1
Yael goldfinger	10
Yossi Keydar	34
Yuri Ardesi	7
Zhentao Liu	2
Grand Total	**813**

Type of Visits

Type of Visit	Accesses
Course module instance list viewed	8
Course module viewed	407
Course searched	1
Course viewed	408
Grade overview report viewed	2
Grade user report viewed	10
Individual Responses report viewed	1
Grand Total	**837**

Results of the Assessment and Feedbacks

Table 3: Student Feedback Table for Bio-Nanoelectronic Devices for BioSensing Course

	Bad	Poor	Good	Very Good	Excellent
Overall Organization of the Course					
Quality of Teachers					
Quality of Lab Experience					
Fitting with Expectations					

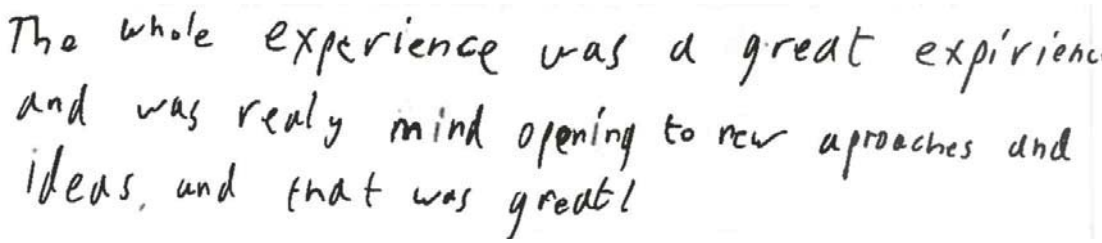
Also in this course to the students was requested to indicate their feedbacks as in Table 3.

The obtained results are reported in Table 4.

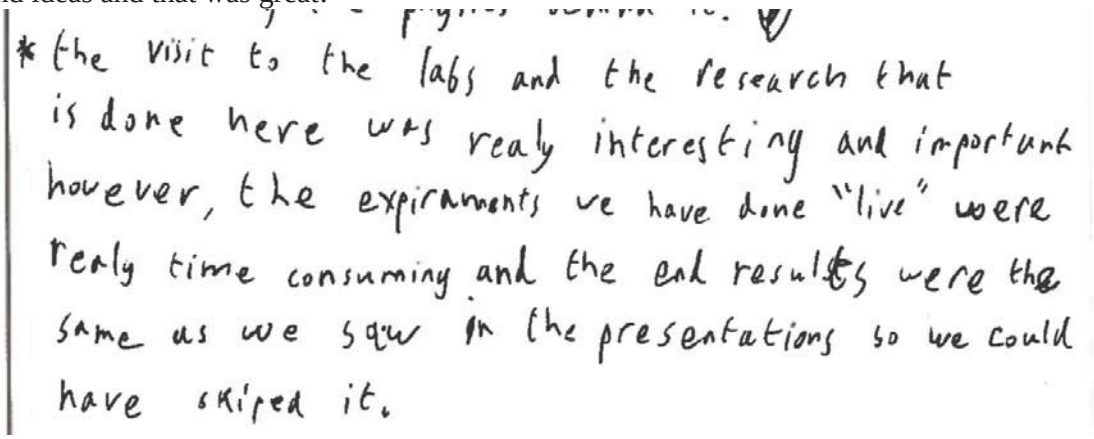
Table 4: Feedback Results in percentage for Bio-Nanoelectronic Devices for BioSensing Course

	Bad	Poor	Good	Very Good	Excellent
Overall Organization of the Course	0%	0%	0%	50%	50%
Quality of Teachers	0%	0%	0%	12%	88%
Quality of Lab Experience	0%	0%	0%	50%	50%
Fitting with Expectations	0%	0%	0%	25%	75%

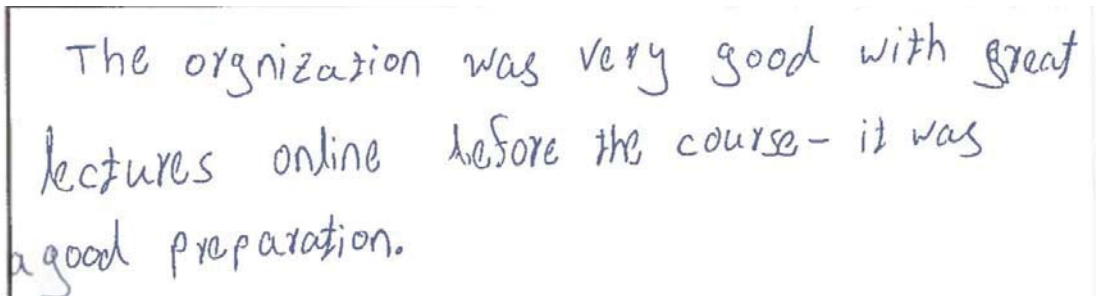
The students had a space in the form with the possibility of inserting their own comments. We report some of them, for taking the opportunity of adding some more comments about the course effectiveness and for learning how to improve it.



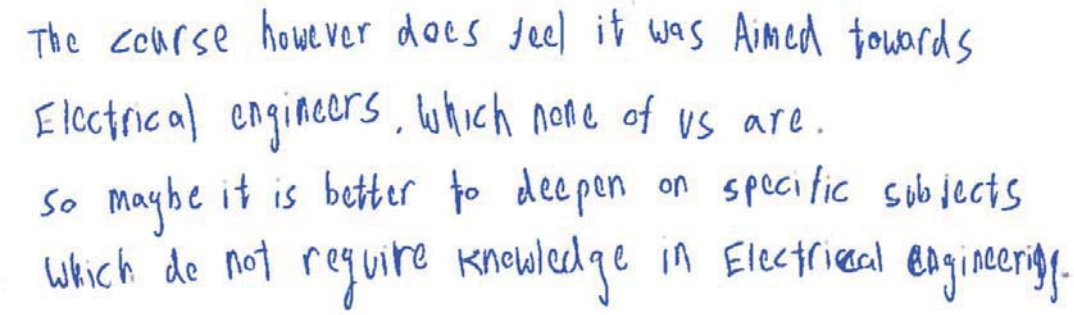
"The whole experience was a great experience and was really mind opening to new approaches and ideas and that was great!"



"* the visit to the labs and the research that is done here was really interesting and important however, the experiments we have done 'live' were really time consuming and at the end the results were the same as we saw in the presentations so we could have to skip them".



"The organization was very good with great lectures online before the course – it was a good preparation".
This comment is very important, highlighting the effectiveness of the preparation by following the online courses before the hands-on.



The course however does fill it was aimed towards Electrical engineers, which none of us are so may be it is better to deepen on specific subjects which do not require knowledge in Electrical engineering".
This comment is not completely right, because the student did not know that the course in designed for Electrical Engineering (EE) too, and some other students of course are from EE. In any case this comment is useful indicating that it is important to give more attention to explain in case better some basic concepts in EE, useful for course comprehension. This is possible and of course will be one of the improvements of the course for next editions.

Exam Certificate

All the students passed the exam that had as result a *Passed* or *Rejected*.

All of them received credits from their own institutes. In Politecnico di Torino the Course was counted as 5 ECTS.

To each student was prepared a Certificate of Achievment as the one in Figure 2.

Figure 2: Exam Certificate for Molecular Electronics for the Realization of Novel Nanoelectronic Devices Course

Molecular Electronics for the Realization of Novel Nanoelectronic Devices

This course was held in the PhD programs of Electronics and Physics and the tests were organised in Written Reports presented from the students.

It is one of the courses too of reference for the Hands-On sessions held in Torino.

As for previous course, **the assessment was done including in the EduNano portal the exams, asking to the students to do a Written Report related to the requested topics**.

For these reasons, *it is not possible to present statistics related to an online assessment*.

The total number of students who participated to the pilot was **19**, of which 5 were PhD students of Politecnico di Torino and 14 the ones participating to the EduNano Hands-on session in Torino.

Course Views

User	Course Views
Ahmed Abbas	1
Alessia Botta	2
Amir Ziv	83
Antonia Silvestri	1
Avner Neubauer	41
Ayelet Yashar	47
Chen Tzur	2
Daniel Itshak	12
Eugenio Maggiolini	1
Hadas Navenzal	2
Haim Sazan	87
Kian Kadan	15
Lilach Saltoun	32
Marco Farina	2
Nava Shmoel	28
Nir Sukenik	64
Samuel Goldstein	46
Yael Goldfinger	11
Yuri Ardesi	2
Grand Total	**479**

Type of Visits

Type of Visit	Accesses
Course module viewed	216
Course viewed	322
Grand Total	**538**

Results of the Assessment and Feedbacks

All the students passed the exam that had as result a *Passed* or *Rejected*.

All of them received credits from their own institutes. In Politecnico di Torino the Course was counted as 5 ECTS.

Table 5: Student Feedback Table for Molecular Electronics for the Realization of Novel Nanoelectronic Devices Course

	Bad	Poor	Good	Very Good	Excellent
Overall Organization of the Course					
Quality of Teachers					
Quality of Lab Experience					
Fitting with Expectations					

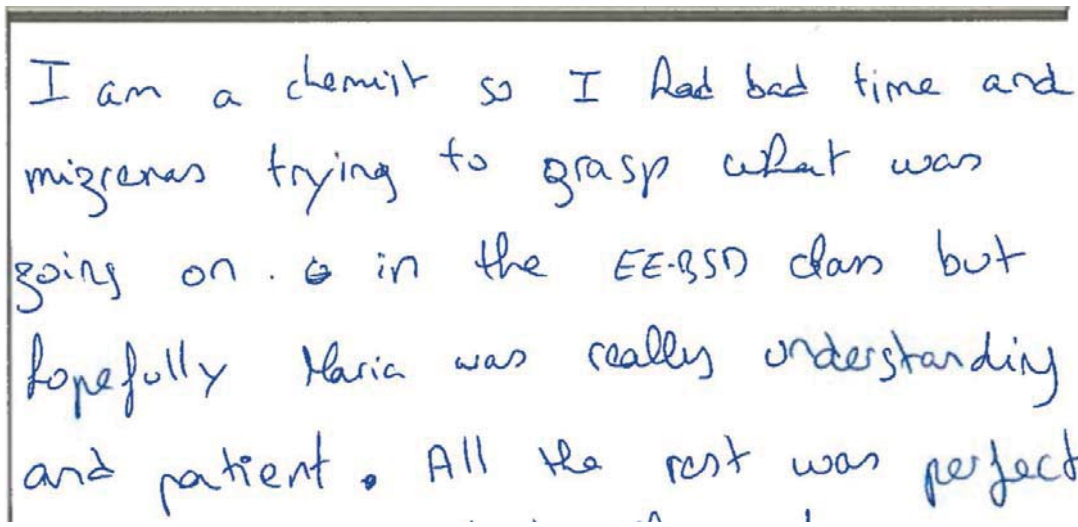
To the students was requested to indicate their feedbacks as in Table 5.

The obtained results are reported in Table 6.

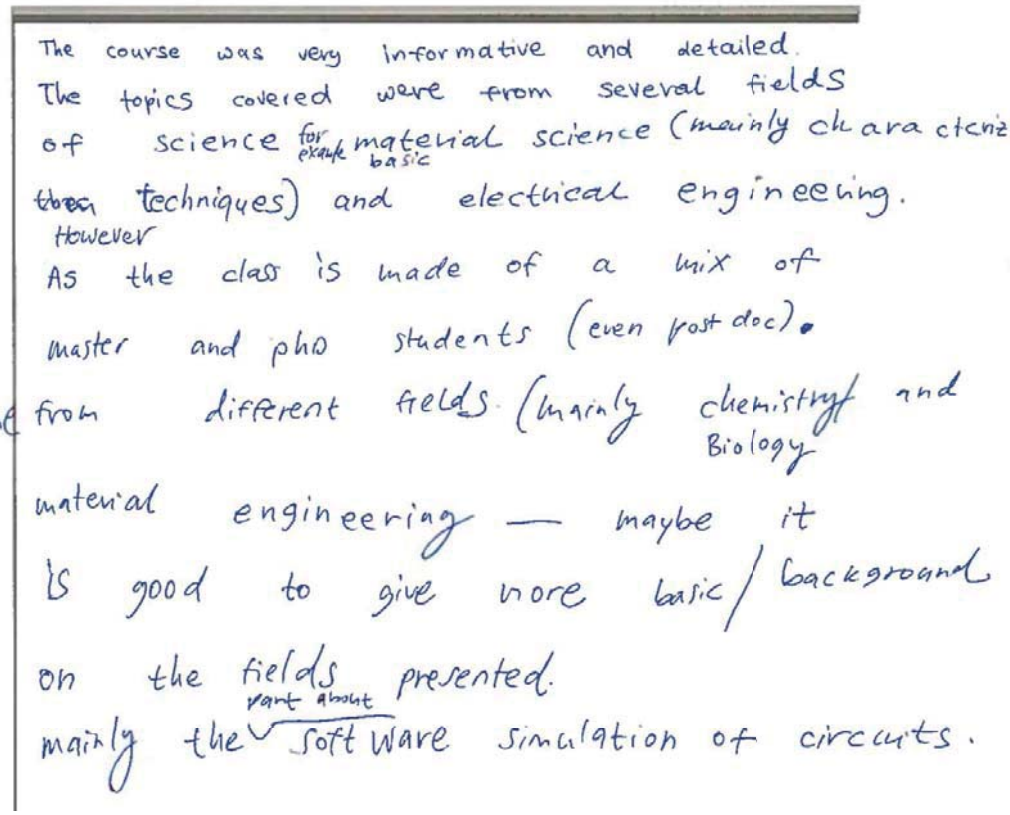
Table 6: Feedback Results in percentage for Molecular Electronics for the Realization of Novel Nanoelectronic Devices Course

	Bad	Poor	Good	Very Good	Excellent
Overall Organization of the Course	0%	0%	0%	43%	57%
Quality of Teachers	0%	0%	7%	7%	86%
Quality of Lab Experience	0%	14%	29%	21%	36%
Fitting with Expectations	0%	0%	14%	29%	57%

The first important information from this results is that the Lab Experience has to be improved. From the feedbacks that will be reported in the following section it is clear a problem that not-EE students found, so both for theoretical lectures and for hands-on it is important to integrate the contents with more introductory concepts.


I am a chemist so I had bad time and migranas trying to grasp what was going on. in the EE-BSD class but hopefully Maria was really understanding and patient. All the rest was perfect

"I am a chemist so I had bad time and ??? trying to grasp what was going on in the EE-BSD class but hopefully Maria was really understanding and patient. All the rest was perfect."
This message raises the point of considering that in the topic can be interested students non only from EE and so, as in the course about Biosensing, some basic concepts are missed and so it is interesting to integrate them, with some preparation videos too.


The course was very informative and detailed.
The topics covered were from several fields of science for example basic material science (mainly characterization techniques) and electrical engineering.
However
As the class is made of a mix of master and phd students (even post doc).
who come from different fields (mainly chemistry and Biology
material engineering — maybe it is good to give more basic / background on the fields
part about
mainly the software simulation of circuits.

"The course was informative and detailed. The topics covered were from several fields of science for example basic material science (…) and electrical engineering. However as the class is made of a mix of master and phd students (even postdoc) who come from different fields

(…) may be it is good to give more basic/background on the fields presented. Mainly the part about software simulation of circuits".
Also here is pointed out the importance of integrating the course for not-EE people. And in this case the importance of eLearning lectures is highlighted. In fact it is easy and effective to add to the course some basic introductory lectures that can be used by the not experts, and so the students can arrive to hands-on aligned and ready to follow the presented concepts.

Exam Certificate

All the students passed the exam that had as result a *Passed* or *Rejected*.

All of them received credits from their own institutes. In Politecnico di Torino the Course was counted as 5 ECTS.

To each student was prepared a certificate as the one in Figure 3.

Figure 3: Exam Certificate for Molecular Electronics for the Realization of Novel Nanoelectronic Devices Course

Conclusions

It is possible to conclude that the courses were appreciated and effective. The eLearning was very much used and appreciated, but what was emerging also from direct comments from the students, it is that the eLearning experience itself is not the best option. It is fundamental to combine it with classroom work and interactions.

The use of remote teaching or in general eLearning must be associated with classical classrooms, in which in particular the hands-on sessions are carried out. And the use of eLearning becomes strategic for preparing in the best way the students for the laboratories.

Project 543861-TEMPUS-1-2013-BG-TEMPUS-JPCR
Education in Nanotechnologies

EduNano project
CIME Nanotech pilot test report

CIME Nanotech as a partner involved in the EduNano project contributed by providing two video recorded lectures in the field of Spintronics and Nanobiotechnologies. In addition, CIME Nanotech offered four one week lab sessions organized in July 2016 and December 2016.

Lectures (statistics):

The lectures have been extensively used by the student of the Grenoble Institute of Engineering. They used the questions and the problem given in the lectures in order to improve their skills. You will find below the statistics corresponding to the connections.

Spintronics

Computed from logs since Sunday, 23 February 2014, 6:20 AM.

Activity	Views	Related blog entries	Last access
Spintronics Part 1			
lecture 01	51	-	Friday, 12 May 2017, 2:39 PM (7 mins 28 secs)
Spintronics Part 1 pdf	21	-	Friday, 12 May 2017, 2:39 PM (7 mins 15 secs)
Questions Part 1	52	-	Friday, 12 May 2017, 2:39 PM (7 mins 3 secs)
Spintronics Part 2			
lecture 02	29	-	Tuesday, 28 March 2017, 9:47

Activity	Views	Related blog entries	Last access
			PM (44 days 16 hours)
Spintronics Part 2 PDF	7	-	Monday, 3 April 2017, 3:03 PM (38 days 23 hours)
Questions Part 2	37	-	Friday, 12 May 2017, 2:36 PM (10 mins 17 secs)
Spintronics Part 3			
lecture 03	15	-	Tuesday, 28 March 2017, 9:48 PM (44 days 16 hours)
Spintronics Part 3 PDF	8	-	Monday, 3 April 2017, 3:03 PM (38 days 23 hours)
Questions Part 3	34	-	Friday, 12 May 2017, 2:37 PM (9 mins 2 secs)
Problems	97	-	Friday, 12 May 2017, 2:37 PM (9 mins 29 secs)

Protein & DNA modular design and supramolecular assembly

Computed from logs since Sunday, 23 February 2014, 6:20 AM.

Activity	Views	Related blog entries	Last access
Protein & DNA modular design			
lecture 01	37	-	Friday, 28 April 2017, 2:57 PM (13 days 23 hours)
course 1 modular structure of proteins	-	-	
Surface fictionalization and protein assembly			
lecture 02	8	-	Wednesday, 8 February 2017, 1:57 PM (92 days 23 hours)
course 2 protein-nanoparticle assembly	-	-	
Specific and non-specific interactions			
lecture 03	5	-	Wednesday, 8 February 2017, 1:57 PM (92 days 23 hours)
course 3 non-specific interactions	-	-	
Nanoparticles for medical imaging and therapy			
lecture 04	10	-	Monday, 3 April 2017, 5:22 PM (38 days 21 hours)

Activity	Views	Related blog entries	Last access
course 4 Nanoparticles in medicine	-	-	
Hands on :preparing and using a DNA microarray			
lab 01	8	-	Wednesday, 8 February 2017, 1:57 PM (92 days 23 hours)
lab 02	6	-	Friday, 28 April 2017, 3:03 PM (13 days 23 hours)
lab 03	4	-	Wednesday, 8 February 2017, 1:58 PM (92 days 23 hours)

List of the students from the Grenoble Institute of Technology

The following students participated to the pilot test of the Lectures. You will find their feedback in the sequel.

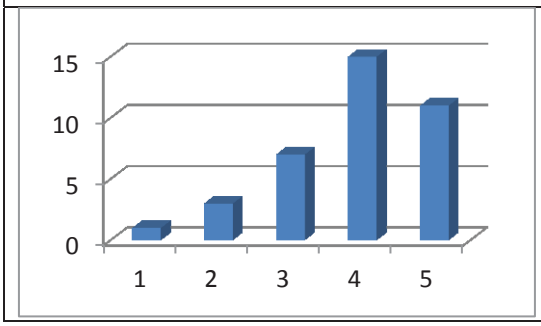
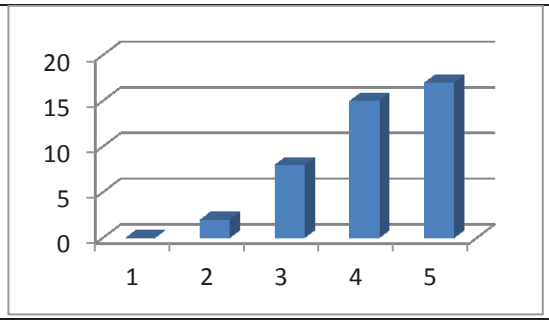
	First name	Name
1	amine	allouche
2	younes	bouhadjar
3	louis-kit-how	chen
4	clara	garnier
5	maya	hayek
6	guillaume	hermet
7	Benjamin	Houang
8	damien	lamaison
9	antoine	lecordier
10	joaquim	luque
11	antonin	macquart
12	Shervin Vahid	Dastejerdi
13	benjamin	miller
14	antoine	pissis
15	evan	remy
16	omar	sakr
17	yan	wolff
18	Outman	Akouissi
19	almeida	r.
20	Gabriele	Bongiovanni
21	Luca	Camellini
22	Luca	Capua
23	Matteo	Collura
24	Salvatore	Collura
25	Giorgio	Cristiano
26	Andrea	Cupertino
27	Mattia	DeGirolamo
28	Massimo	Giordano
29	Fabrizio	Gota
30	Matteo	Hirsch
31	Xavier	Hurtaud
32	Zhentao	Liu
33	Lorenzo	Lombardo
34	Eugenio	Maggiolini
35	Lucrezia	Maini
36	Emmanouil	Mandrakis
37	Fabio	Mattiussi
38	Andrea	Mucchietto
39	Alessandro	Novello
40	Valentina	Paggi
41	Fedele	Tagarelli
42	marco	ghezzi

List of the students in Spintronics who use the online lectures

Lectures with the student from the Grenoble Institute of Technology

Course Title		Nanobiotechnology	Spintronics
Course Level	BSC		
	MSC	X	X
	PhD		
	Industrial		
	Teachers		
	High School		
Participants in Pilot Test (Course Attended by)	Total	37	42
	Females	19	5
	Males	18	37
Grade Distribution (in %)	A - Excellent	29,73	40,48
	B - Very Good	40,54	37,71
	C - Good	18,92	19,05
	D - Passed	8,11	4,76
	F - Failed	2,70	

Evaluation of the pilot test

Nanobiotechnology	**Spintronics**
	

Practices at CIME (statistics)

The CIME Nanotech provides facilities for both Research and Education. In the framework of the EduNano project, students from the Grenoble Institute of technology attended the practices in our labs but also students from Israel in July 2016. Moreover, notice that a group of 8 Israeli teachers from the secondary school attended specific practices dedicated to the high-schoolers in December 2016. This December session also included a meeting organized with teachers from the secondary schools in France and the management team of the Nano@school program (Nano@school is specific program for high schoolers organized since several years by the academia from the Grenoble area, CEA and CIME Nanotech)

List of attendees and evaluation of the regular students of the Grenoble University

Practices in Clean Room under the supervision of Prof. Ahmad bsiesy

Name	First Name	Grade (/20)
BERG	Cécile	15
BOSSAN	Jordi	16,5
CHEN	Bao	14
CHEN	Xialolei	14
CHEVILLOTTE	Yoan	15,5
COPPA	Mélissa	15
CURTET	Alexandre	16
DELATTRE	Emmanuel	15,5
DESAGES	Coralie	14,5
DESAIGUES	Vincent	15,5
DOUSSIN	Paul	14
FIGUEIRA	Gustavo	16,5
FLOCH	Léa	16,5
GBODOSSOU	Louis	14,5
GUIGLINI	Julie	16,5
OUGIER	Michaël	16,5
PINEDE	Mael	14,5
POUGET	Mathieu	14,5
PRINTEMPS	Alexandre	16
ROBERT	Guillaume	14
ROUGE	Corentin	14
SANTOS DA SILVA	Julianny	13
SAVIARD	Félix	15,5
SEMPERBONI	Julien	13
TABARD	Lucie	14
TISON	Matthias	16,5
TOURAILLE	Pierre-Jean	13
VIVOT	Noé	13

Practices on the Biotechnology platform

Name	First Name	Grade (/20)
BASSET	LEO	18
BELLOIR	HUGO	17
BONIZIO	AURELIE	15
CHAMPON	AMELIE	14
CHIROSSEL--MORAND	ANTOINE	16
CITRONI MOURAO (DD)	AMADEU ARON	15
CONTIN DE MELO (DD)	GUSTAVO	15
CROS	ELISA	14
DELACROIX	HUBERT	16
DULONG	ALEXIS	16
ESPANET	MARIE	14
EYNARD-MACHET	SANDRA	14
FATHI	YOUSRA	14
GAI	TE	14
GAUTHIER	QUENTIN	16
GRANGER	CLAIRE	14
KLEIN	ANAEL	14
LOYER	CAMILLE	15
MACEDO ALVARES (DD)	EBERT DANIEL	15
MARTIN	FLORIAN	15
MOTA DE OLIVEIRA (DD)	THAIS	15
NIEPCERON	ANNE-LAURE	18
PROUDHOM	ANAIS	18
RICHEZ	MEGANE	18
ROCAMORA	MAXIME	17
SAVIARD (RED)	FELIX	15
TINOUNA	MOUHCINE	17

Practices on the Nanoworld Platform (Atomic Force Microscopy)

Name	First Name	Grade (/20)
BAFFOU	THIBAULT	14
BARRE	KEVIN	17
BERRADA	HAMZA	15
BOISTARD	MAXIME	16,5
BUFFET	CLAIRE	15
CHABERT	LAURENT	17
CHANG	YONGLIANG (BEN)	13
CLAVEAU	GUILLAUME	16
CLAVEL	MATTHIEU	15
CUINE	THOMAS	13,5
DE VERNEJOUL	MANON	15
DESTANDAU	JULIE	15
FAO		14
FIL	NICOLAS	16
GILBERT	PIERRIC	14
GUILTAUX	KEN	14
HILARIO	FANNY	16
KOZA IBRAHIMI	FAOZIYATH	15
LIU	YU (JADE)	14
LOPEZ	CLEMENCE	15
MONNET	THIBAULT	13
MOURRE	GUILLAUME	15
NICOUD	SARAH	14
NOWAKOWSKI	MATHIAS	14
SADKAOUI	ZOUHOUR	15
SEILLER	ROMAIN	16
SOLIER	NOLWENN	15
VEYRE	SARAH	16
ZERZOUR	BRUNO	16,5
ZHANG	TIANYU (JEAN)	13

List of the attendees (at the July Session)

This session has been specially organized for students coming from the Israeli partner universities and institutions. The Bio and MOS marks correspond to the orientation given to the practices.

Bio: Nanobiotechnology oriented

MOS: MOSFET fabrication oriented

EduNano

Univ.	First name	Name	Lab	Contact	
Technion	Heidi	Leonard	Bio	Simcha	4 Bio
Technion	Sofi	Arshevski	Bio	Simcha	
Technion	Boris	Simakhov	Bio	Simcha	
Technion	Reef	Enoch	Bio	Simcha	
Weizmann	Eran	Mishuk	MOS	Sidney	2 MOS
Weizmann	Olga	Kranis	MOS	Sidney	
TAU	Yonatan	Vaknin	MOS	Jack	6 MOS
TAU	Assaf	Peled	MOS	Jack	
TAU	Ronen	Dagan	MOS	Jack	
TAU	Giorgia	Fiaschi	MOS	Jack	
TAU	Richa	Pandey	MOS	Jack	
TAU	Tali	Dotan	MOS	Jack	
Bar Ilan	Tony	Yamin	MOS	Yael	5 MOS
Bar Ilan	Erez	Zion	MOS	Yael	
Bar Ilan	Efrat	Roth	Bio	Yael	1 Bio
Bar Ilan	Anat	Yitzhak	MOS	Yael	
Bar Ilan	Tali	Sharabani	MOS	Yael	
Bar Ilan	Yael	Goldfinger	MOS	Yael	
HUJ	Hadas	Han	Bio	Tirza	5 Bio
HUJ	Dvir	Dror	Bio	Tirza	
HUJ	Itamar	Peled	Bio	Tirza	
HUJ	Shani	Koshrovski	Bio	Tirza	
HUJ	Tal	Stern	Bio	Tirza	
BGU	Nir	Yarza	MOS	Tziona	3 MOS
BGU	Hadas	Lupa	MOS	Tziona	
BGU	Ofir	Shmolovich	MOS	Tziona	

July practices (people count):

CIME Teachers: 7 males and 3 females

Israeli Students: 10 males and 15 females

Some feedback from the attendees

Our over experience was very good, Grenoble is nice city with nice atmosphere and landscape.

The workshop itself were four days

Day 1 and 2 : Clean room facility : integrated semiconductor device fabrication

Day 3 : Electrical characterization of integrated semiconductor devices

Day 4: Computer fabrication simulation

During all the workshop we worked on small groups of 4-8 people, which made the experience very nice and comfortable, we felt free to ask questions, and to leave comments.

Day 2 were full day and the other days were half days, we had weekend off in the middle of the Workshop, during the first days we worked in the teaching dedicated clean rooms, and got all the necessary equipment for the fabrication process.

The workshop transmitted by 3 different persons, all of them had good English skills, everything they explained was very clear, and every question we asked, got answered.

We made friends from different universities across Israel and we learned about their research.

For conclusion, we feel the workshop very contributed to our knowledge.

By Ofir Shmulevich,Nir Yarza ,Hadas Lupa

Practices dedicated to secondary course teachers in Israel

These practices, as mentioned, have been specially organized for high teachers. This means that the content of the practices targeted labworks for high schoolers.

December practices (people Count):

CIME Teachers: 3 males and 4 females

Israeli High School teachers: 4 males and 4 females

Feedback from Professor Ron Blonder (in charge of the High school teacher program)

Even though the course is not ended – I must write you that the teachers enjoy every moment! They appreciate your hospitality and the high quality of the teachers!

I am sure that today will even increase their enthusiasm

Co-funded by the Tempus Programme of the European Union

Pilot Test and Field Trial at TUS Results

Project 543861-TEMPUS-1-2013-BG-TEMPUS-JPCR

Education in Nanotechnologies

This project has been funded with support from the European Commission.
This report reflects the views only of the authors, and the Commission can not be held responsible for any use which may be made of the information contained therein.

Pilot tests at TUS

- January 2016 - January 2017
- 29 students
- Face-to-face lectures + HTML courses for supporting project design
- 3 months projects on nanoelectronics CAD with distant access to the software at the university
- Knowledge tests and project evaluation for skills and competences
- Regular one semester course with 5 credits

- *Reflective questionnaire* to measure attitudes of users towards the new training approach and materials.

Pilot test January 2016 – June 2016

- 7 students-volunteers participated

Suggestions for improvement

- To improve the quality of the images and the descriptions in relation to technical issues.
- The course should be improved including therein more practical advices and case studies.

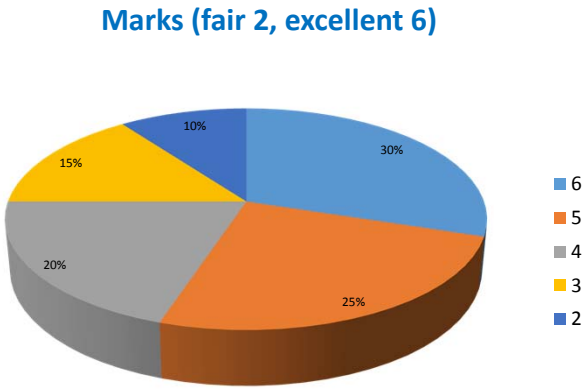
Field trial September 2016 – January 2017

- 7 students-volunteers participated

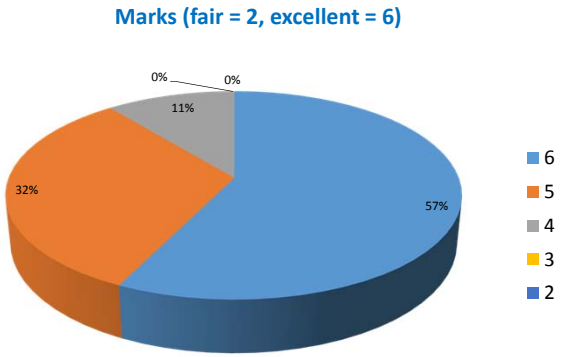
Improvements of courses with regard to the results of the pilot test

- More practical content added
- Cases from the practice added as examples
- Some graphics and pictures improved
- New videos added

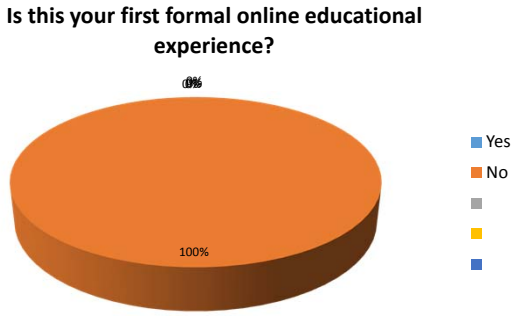
Marks. Evaluation of projects of the pilot test



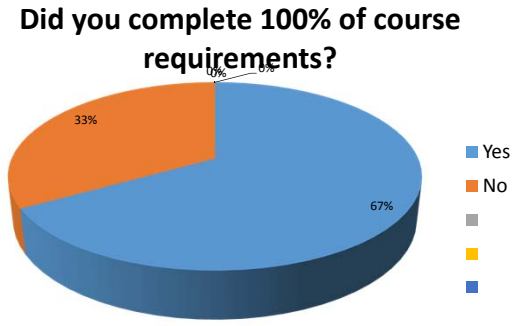
Marks. Evaluation of projects of the field trial



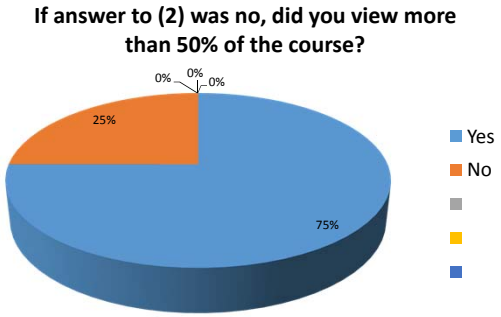
Reflective questionnaire



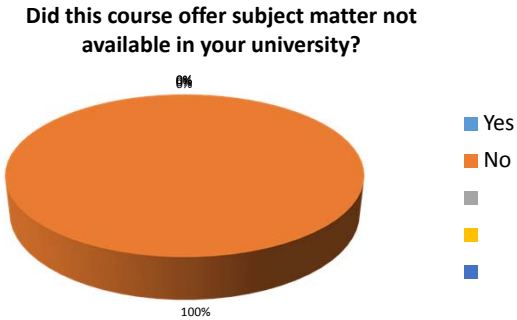
Reflective questionnaire



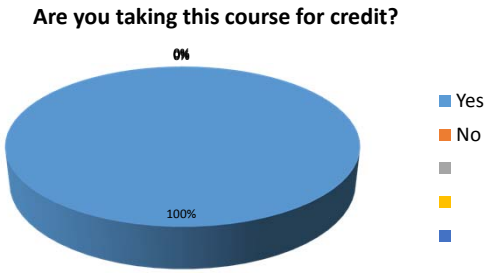
Reflective questionnaire



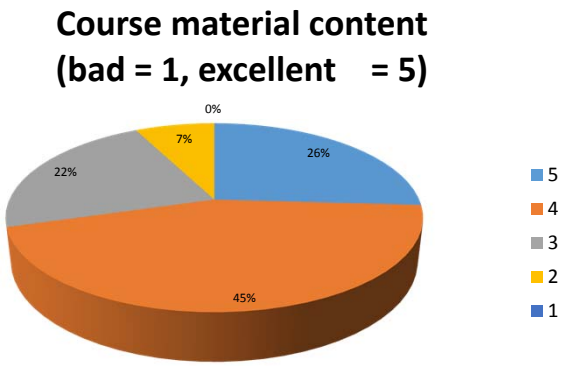
Reflective questionnaire



Reflective questionnaire

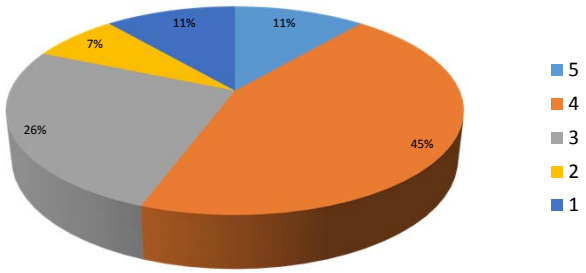


Reflective questionnaire



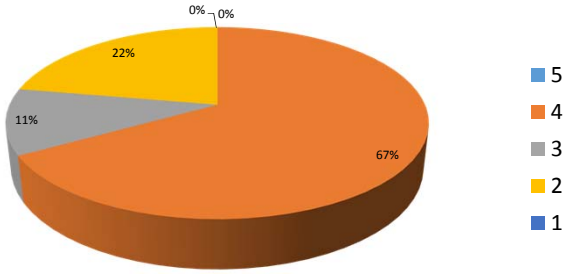
Reflective questionnaire

Level of difficulty
(1 = very easy, 5 = very difficult)



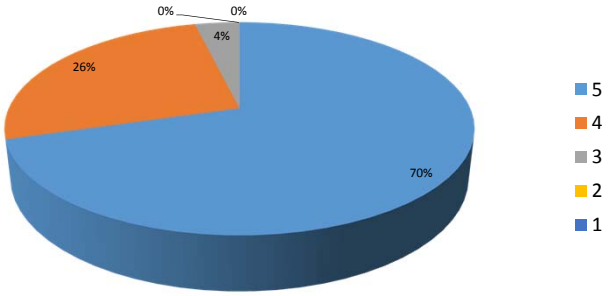
Reflective questionnaire

Quality of HTML content and distant access to CADENCE (pictures, graphics, examples – bad = 1, excellent = 5)



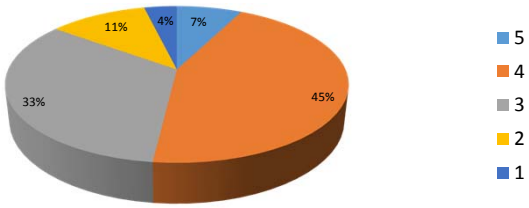
Reflective questionnaire

Usefulness of homework assignments (1 = not useful 5 = very helpful)



Reflective questionnaire

Ease of use of the Moodle interface (1= cumbersome, 5 = very smooth and intuitive)



Reflective questionnaire

Did you encounter difficulties (technical or other) during the course - if so what, and were they adequately resolved?

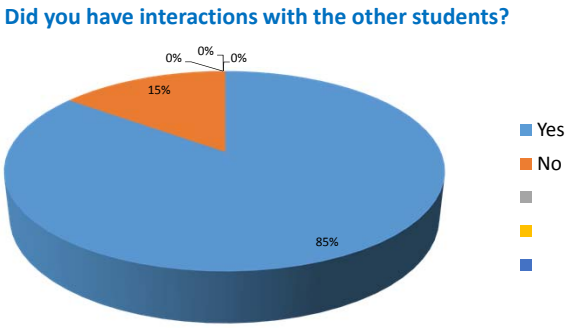
- To improve the quality of some images
- More practical advices are needed
- Case studies to be added
- More examples for the different designs

Reflective questionnaire

Please write a few words about your impression of this mode of learning relative to face-to-face learning: advantages and disadvantages

- Face to face learning allows for interactivity
- Face-to-face – more feedback, more support is provides
- HTML course is helpful in the project development
- E-learning is useful for supporting the learning
- CAD HTML modules with examples and case studies – very useful for the circuits design

Reflective questionnaire



Reflective questionnaire

Please comment on what you most liked about this course

- Examples for the last technologies, design rules
- Self learning, freedom of time and place
- Collaborative learning, group work on projects
- Distant access to CADENCE and Synopsis – possibility to work at home

Reflective questionnaire

Please indicate areas or items which could be improved

- More feedback from the tutors
- To produce the chips and to test them
- To add animations
- To add interactive assignments

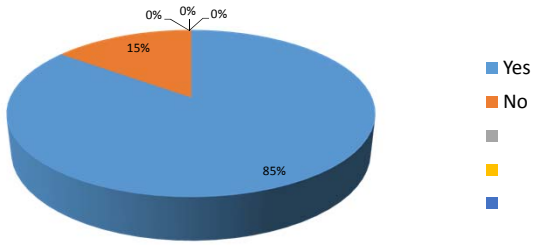
Reflective questionnaire

Please write why you chose to take the on-line course

- It is mandatory
- It is a hybrid mode, lectures laboratory practice and then – project design with HTML course and distant access to the software

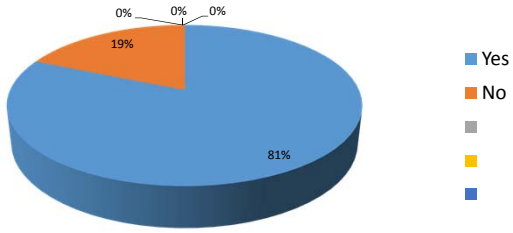
Reflective questionnaire

Did you have interactions with the other students?



Reflective questionnaire

Would you be interested in participating in other online courses in the future?



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Conclusions

- 7 students did the pilot test
- 22 students did the filed trial

- Good rating of the web and structure of the course (89 % agree), better than the pilot test (78% agree)

- Very good rating of the course contents (9,1/10), better than the pilot test (8,8/10)

- Good grades of the students

- Overall good results of the field trial