Co-funded by the Erasmus+ Programme of the European Union

Project Title: MicroElectronics Cloud Alliance

Project Number: 562206-EPP-1-2015-1-BG-EPPKA2-KA

EXPLOITATION REPORT

Introduction

The aim of the mClouds project is the definition and development of cloud-based European infrastructure and organisation for education in micro- and nanoelectronics providing a range of open educational resources, remote access and sharing of educational and professional software, remote and practice-based learning facilities.

To responds to the needs for training new skills for new jobs identified during the need analysis, in this project 18 higher education institutions (HEIs) and small and medium enterprises (SMEs) shared their infrastructure, technological and human resources and developed Cloud-based European infrastructure and organisation for education in microelectronics providing a range of open educational resources (OERs), remote access and sharing of educational and professional software, remote and practice-based learning facilities.

The last year of the project was devoted to the implementation of the shared IT infrastructure, educational software and e-learning materials.

After the successful pilot test, the courses were improved according to the suggestions of participants, e.g. self-evaluation test were added after some topics, the content was presented in modules to meet the needs of advanced learners who do not need to follow the entire course and of beginners, downloadable materials for offline learning were uploaded. During one PSC virtual meeting it was decided that the contents for the MSc students and for the trainees for the business should be more job-oriented and training workshops with business partners in different countries and subject matter were planned.

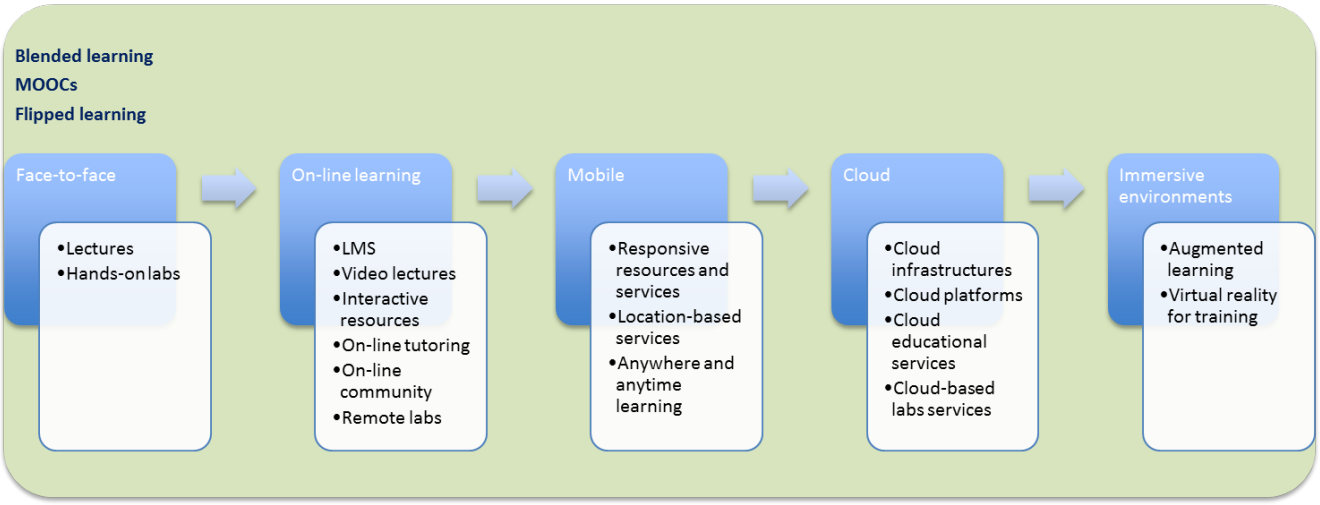
The partners from the enterprises provided real cases from their practice for the students' projects in microelectronics. Job-specific training modules were jointly developed and another four courses designed by the experts from the enterprises and implemented as e-learning modules for the educational mClouds system. Three courses to train transversal skills were developed, as in the need analysis survey all business representatives considered of highest importance.

Four business partner institutions developed courses for mClouds:

- INOMA renovelables: "Electronics maintenance in Renewable energies"
- AMG Technology: "Design, Prototype Fabrication and Challenging Applications of Silicon Microsystems with Piezoresistive Feedback"
- INES: "Silicon Homojunction Solar Cells "
- ASTEL created a Video Lesson about main criticisms in handling semiconductor devices manufacturing. In this course the design of an optical inspection station of semiconductor wafers is presented.

The field trial was performed during the last 9 months of the project.

Different schemes were used depending on the needs of the educational or training institutions allowing very high flexibility and accessibility of learning resources.



Specific evaluation methods were used and corresponding tools designed for assessment of knowledge (e.g. knowledge tests for the basic components, assembling procedures, defaults, automated machines etc.); of skills (e.g. tasks for finding solutions for routine problems); of competences (e.g. tasks to take responsibility for completion of tasks in work or study).

Training workshops for teachers, system administrators for the use of different schemes in mClouds, scheduling the tasks for sharing the infrastructures, and job-oriented education

Training workshops on the use of different schemes in mClouds, scheduling the tasks for sharing the infrastructures, using the common educational resources and CAD systems were organised for one or two representatives (system officers or developers and teachers) of each institution and then they performed the training at each partner educational institution.

- Training workshop for teachers by Spanish industrials on job-linked education, 01-02/03/2018 INOMA Renovelables, Cadiz;
- Training seminar on the recent research results in renewable energies by French business representatives, 07-07/06/2018, INES Solaire;
- Training workshop for teachers and administrators on the use of the MECA system for administration of students and teaching activities by the expert from eWorks, Frankfurt, 08-09/10/2018, UKIM Skopje;
- Workshop for training on entrepreneurial skills and employability by the HRD experts from Hungarian enterprises in the sector, 10-11/12/2018, BME Budapest.

For the training objectives, learning outcomes trainers and trainees see the minute of the training events.

Field trial

After training teachers and trainers in the use of mCloud system, the filed trial was conducted. Each of the eight universities tested into practice the courses developed by all partners, the shared IT infrastructure and the realized remote access to the CAD systems.

The field trial was performed from 2nd May to 21st December 2018.

Purpose

The aim of the exploitation workpackage was to maximise the impact of project results by optimising their value, integrating them in a sustainable way and using them actively in systems and practices at national and European levels.

The purpose of the field trial was to test whether the developed Cloud-based open educational resources in micro- nanoelectronics met the goal of the project to offer high-quality, job-related, flexible, time- and place-independent education on microelectronics, and to increase the accessibility of course materials and flexibility of delivery for the users from the eight European countries.

Questions

- whether the flexible distance learning with CD-based interactive multimedia and WEB-based applications contribute to make the subject matter more concrete and understandable, and tuition - more efficient
- to which extent the courses can be used by the specified users to achieve the specified goals with effectiveness, efficiency and satisfaction in the context of microelectronics education , i.e. how usable are the learning services and the course modules.
- to which extent the needs of the end users (learners and business organizations) were met.
    - Is the delivery environment, using Cloud technology, really increasing the accessibility of course materials and flexibility of delivery for the users?
    - Does the flexible distance or blended learning with interactive multimedia and remote access to laboratories contribute to make the subject matter more concrete and understandable, and tuition - more efficient?
    - Does mClouds system and the learning environment and the course modules reach the usability criteria and satisfy users' needs and expectations?

Sample

The target groups concerned are:

- students in micro- nanoelectronics engineering education;
- university teachers and trainers in HRD departments, universities and colleges;
- representatives of the business;
- e-learning environment developers and administrators.

The samples included students and teachers at the partner institutions, engineers and managers from SMEs :

- Students from the MSc degree, especially in their first year and from the bachelor degrees in electronics, which are potential users of the courses from the next year. These are students at POLITO, TUS, INSA, BMU, UNED, TUB, UKIM;
- professionals and managers from enterprises in micro- nanoelectronics and microsystems, electronics packaging and communication from all participating countries;
- teachers in micro- nanoelectronics from all participating countries;
- system administrators at the universities and enterprises involved.

Instrumentation

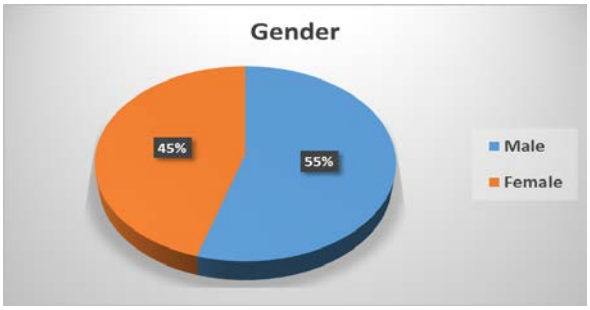
- On-line questionnaire
- Knowledge test for each course

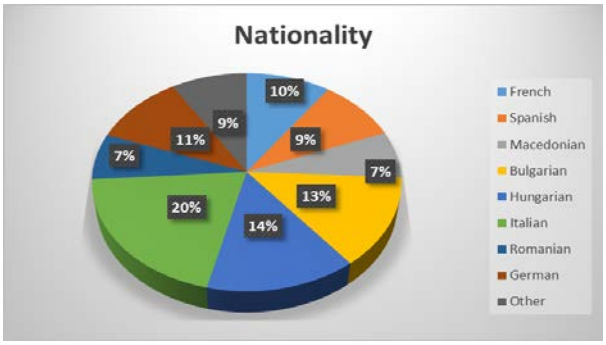
Survey results

The questionnaire was published on-line with a link from the mClouds learning environment.

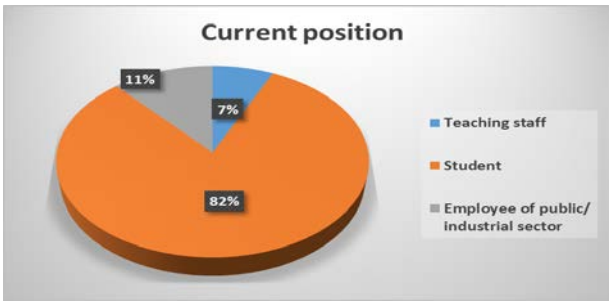
In the field trial we have collected 826 answers.

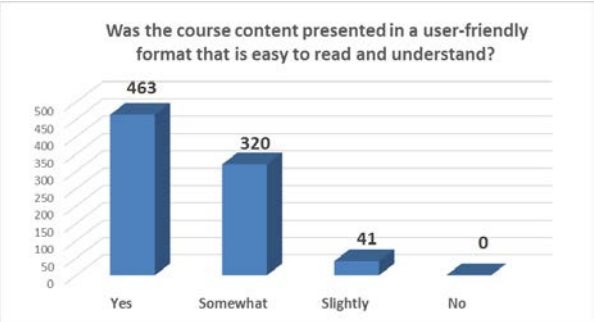
General questions

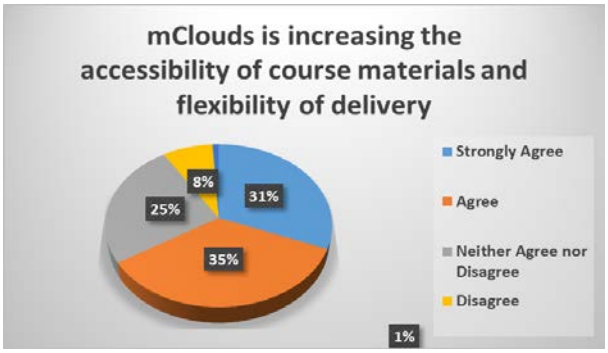


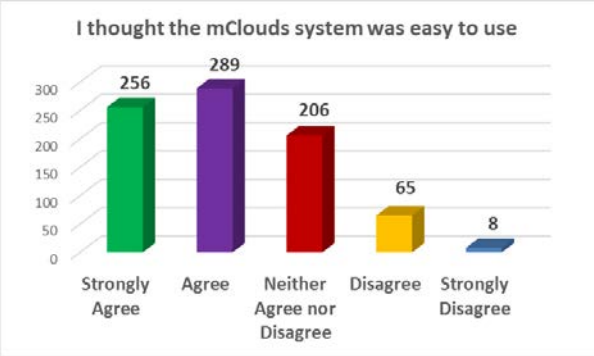


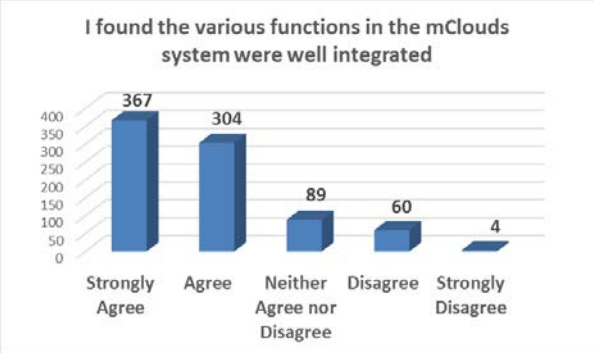
Other: Serbian, Montenegrin, Colombian, Albanian, Argentinian, Chinese, Indian, Thais, Iranian, Ecuadorian, American, Venezuelan .

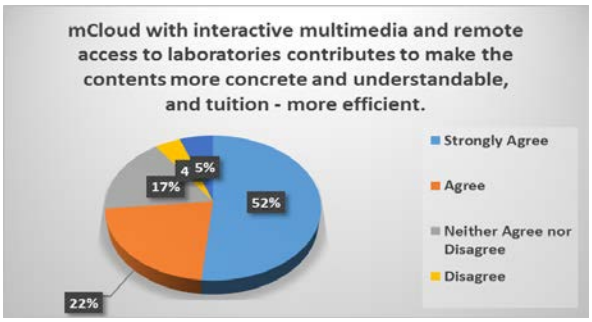


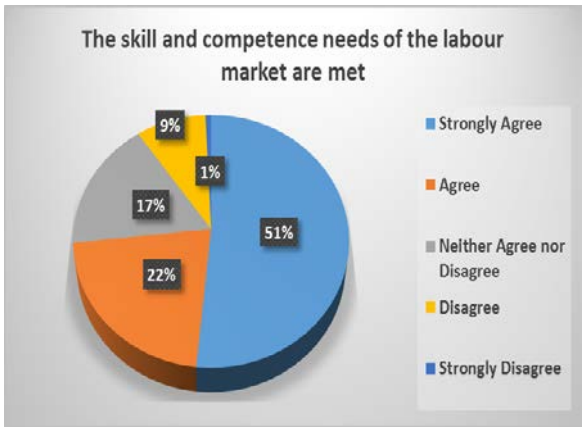

Was the course content presented in a user-friendly format that is easy to read and understand?
463
320
41
0
500
450
400
350
300
250
200
150
100
50
0
Yes
Somewhat
Slightly
No

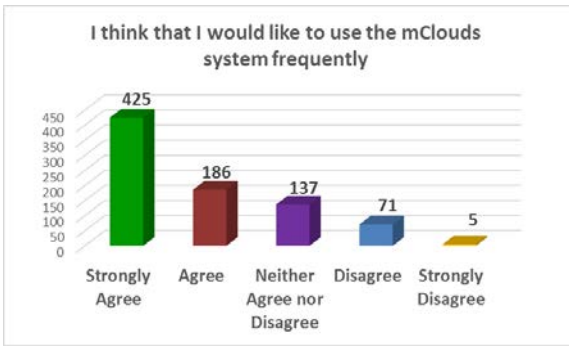

mClouds is increasing the accessibility of course materials and flexibility of delivery
8%
31%
25%
35%
1%
Strongly Agree
Agree
Neither Agree nor Disagree
Disagree

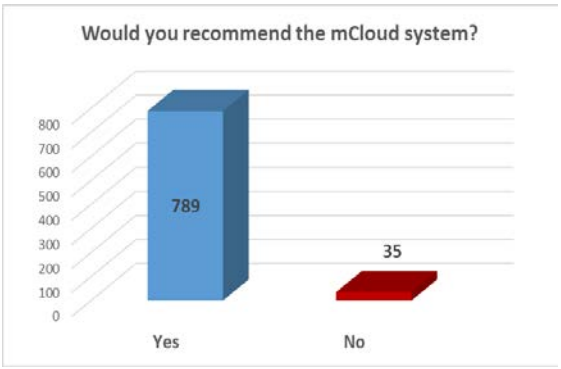

I thought the mClouds system was easy to use
256
289
206
65
8
300
250
200
150
100
50
0
Strongly Agree
Agree
Neither Agree nor Disagree
Disagree
Strongly Disagree


I found the various functions in the mClouds system were well integrated
367
304
89
60
4
400
350
300
250
200
150
100
50
0
Strongly Agree
Agree
Neither Agree nor Disagree
Disagree
Strongly Disagree









General positive aspects

- Well structured
- There are quick links and is easy to orient.
- Easy learning
- Easy-to-use platform

- Easy to navigate and to read the courses.
- Accessibility
- It has everything needed: Modules, simulations, distant access to laboratories, evaluation tests
- User-friendly
- Very didactic

Negative aspects

- Too much information
- More pictures, videos etc. would make it more interesting.

Some of comments and suggestions for some specific courses with remote access to laboratories

- "This course helped me to better understand the principles and the methods of Microelectronics Packaging, thanks to the useful support of the animated pictures. It gave me the ideas of what I could find in a laboratory in terms of machines and equipment"
- "I found the course very useful because it allowed me to deepen the basic principles of microelectronic packaging techniques thanks to interactive animations that accurately describe all processes, machines and their operation"
- "I would need more time to understand susceptibility simulation."
- "Discussions & on-line help of professors resulted in a better focus and more efficient use of IC-EMC".
- "This course had a big impact on the focus of my PhD subject. Before I was overwhelmed with the domain."
- "This course does not only transfers knowledge but enriches it with the transfer of experience and skills."
- "About this course I have learnt more in details MEMS and sensors devices and their related technologies. What I have really enjoyed has been the section of Packaging technologies because I have never come across it before. I have also improved my knowledge about MEMS biosensors, because this topic has been more detailed and the animations have helped my learning"
- The best results were obtained by "Evaluations for Multi-Media Enhancement of Teaching Sensors and MEMS" and "Evaluations for Virtual Laboratory Support for Microelectronics Packaging Education" showing the interest for interaction and the possibility of having a virtual laboratory available
- "Simulations provide a big advantage in contrast to practical validations, saving time and costs. Tuning several parameters and observing the EMC behaviour was great"
- "The practical labs gained insight into measurement devices and the proper methods of emissions and immunity measurements at IC level."

Conclusions

826 respondents participated, 586 more than the 240 planned.

More than 90% of the respondents declared that the course content was presented in a user-friendly format that is easy to read and understand.

More than 75% found the presentation of educational resources in mClouds consistent and the various functions in the mClouds system well integrated.

74% consider that learning mClouds with multimedia and simulations and remote access to laboratories makes the contents more concrete and understandable and the tuition – more efficient.

More than 70% consider that the courses meet the needs of the labour market and more than 95% would recommend the system to other users.

The conclusions of the field trial are that:

- The educational mCloud implemented in Moodle is effective for educational and training purposes and meets the needs of the business/labour market.
- The global feedback is very positive, so the students showed their sure interest in the teaching methodology.
- The comments are unanimously positive about animations and their effectiveness in the learning curve.

With regard to the indicators of progress showing whether and to what extent the project's specific objectives were achieved as planned in the project proposal:

- Quantitative: deliverables presented on time as planned in the proposal:
  - minimum 16 courses and practical modules developed and delivered as OER in mClouds with defined learning outcomes and credits – we developed 25,
  - minimum 240 trainees in the pilot test and field trial – we had 1128 trainees in both, pilot test and field trial,
  - at least 16 papers, presented on European conferences on project activities and results – we presented and published 18 papers on big conferences with large audience.
- Indicators for impact on:
  - target groups:
    - minimum 20 certified students for each course – in average 50 students per course;
    - minimum 50% of the participants in the pilot tests with positive attitudes to the courses – they are more than 90%;
    - minimum 50% of the participants in the pilot tests and field trials considering that the courses will provide them better opportunity for employment – more than 75%;
    - minimum 50% of the answers in the final questionnaire positive to the responsiveness of the new courses to the needs of enterprises – 73% consider the business are met;
  - geographical areas: Certified HE and courses delivered in mClouds for use in France, Italy, Spain, Hungary, Romania, Germany, FYR Macedonia, and Bulgaria – done and other five countries involved in the future use of mClouds;
    - at least 16 courses in the multidisciplinary area of microelectronics design and microelectronics technologies developed by 8 European HE institutions and delivered as OERs, i.e. available to all European and other countries – we have 25 courses as open educational resources.

During the final project meeting, an exploitation agreement was signed for the further use of courses and continuation of the collaboration at the MSc degree level.

The Cloud services and training modules developed are integrated in the regular MSc degrees in micro- nanoelectronics of the partner institutions what guarantees their sustainability. The most important success of the alliance is the creation of regional and national knowledge alliances by signing MoUs with more than 50 enterprises and 15 universities from the participating countries and involving new five countries: Portugal, Poland, Czech Republic, Slovakia, Serbia. They will be partners in the further development, update and use of mClouds. Involving 1128 users/learners of mCoulds is also a success that we even did not expect when writing the project proposal.

Other activities planned after the project end are:

AMG, Astel and POLITO are planning to submit a project to the European Call IoT4Industry. The experience done between AMG and POLITO will continue, involving in the future more students cooperating with AMG for the development of shared devices.

UPB and TUS started the discussions to sign, beginning with the 2019 – 2020 academic year, an Erasmus Agreement between the two universities, based on the MECA project, in the field of electronics and microelectronics.

UKIM and POLITO are planning to sign an Erasmus Agreement between the two Institutes.

In January 2019, after the project end the coordinator of MECA was contacted by representatives of a consortium of biggest companies in microelectronics in Europe (IMEC, SEME, X-FAB, EuroTECH, Dresden Chip Academy, Melexis etc.) to invite core university partners in a new Skill Alliance in microelectronics.

Most probably the successful realisation of the mClouds and very successful implementation will result in an European University in high technologies.

Disclaimer

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

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EuroTraining: http://www.eurotraining.net/

IDESA: http://www.idesa-training.org/

Erasmus Mundus: http://ec.europa.eu/education/programmes/mundus/

Annex 1

Questionnaires of the survey

Knowledge Alliance
562206-EPP-1-2015-1-BG-EPPKA2-KA
MicroElectronics Cloud Alliance
(MECA)

Thanks to an European project sponsored by EACEA, we had the opportunity to develop open educational resources and remote laboratory practices in the domain of micro- and nanoelectronics and we would like to get your feedback as an actor of this environment. It is anonymous targeting your complete honesty. The results will be used for all but scientific purposes. Filling this questionnaire will take you about 10 minutes.

Thank you.

General questions

Gender:
□ Female
□ Male

Nationality:

Current position:
□ Teaching staff
□ Student
□ Employee of public/ industrial sector
□ Other

Was the course content presented in a user-friendly format that is easy to read and understand?
□ Yes
□ Somewhat
□ Slightly
□ No

Please express the extent to which the statements bellow reflect your perception on the course (module) using the following scale: (1 = strongly disagree; 5 = strongly agree)

- The learning environment, using Cloud technology, is increasing the accessibility of course materials and flexibility of delivery.

- I thought the mClouds system was easy to use.

- I found the various functions in the mClouds system were well integrated.

- The e-learning mCloud with interactive multimedia and remote access to laboratories contributes to make the subject matter more concrete and understandable, and tuition - more efficient.

- The skill and competence needs of the labour market are met.

- I think that I would like to use the mClouds system frequently.

Would you recommend the mCloud system?
□ Yes
□ No

Do you have any suggestions for improvement?

Other comments: