Education in Nanotechnologies (EDUNANO)

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Final evaluation report

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The EDUNANO final evaluation report follows the structure of the intermediate report to indicate the developments that have taken place between the two periods of time. This feedback, which is supposed to have more summative elements than the intermediate report, is still formative in nature as it provides recommendations for some improvements and suggestions for future work. To make it more convenient for the reader the report is written in such a way as to show explicitly the link of current report with the EDUNANO Quality Assurance and Quality Control Plan (QAQC) and the findings of the intermediate report. First, the set of criteria for each theme is presented, then evidence for it as reported in the intermediate report is recollected before discussing changes that happened after the intermediate report. The evidence for the final report is in cursive style in case the reader opts to jump immediately to the information regarding the final report only. It must be underlined that the criteria as established by the QAQC is advisable, not compulsory.

Quality criteria Project Management

1. Describe clearly all project activities, deliverables, milestones, time frames, way of reporting, and partners' responsibilities. All these need to be discussed by partners and accepted by project's Steering Committee.
2. Set up an easy to use web-based project management environment with the necessary functionality, tools and services for managing the project. The system is checked before being opened for partners and EC agency. The system is reliable and partners feel comfortable with it. A Help system and written Guide are available. Establish the project's Steering Committee with a representative from each partner organization. The

Steering Committee works closely with the coordinator for the operational management of the project.

3. The project's Steering Committee establishes a procedure and a set of criteria for evaluating the deliverables. There should be two peer-reviews of each deliverable according to a predefined evaluation schema.
4. Describe briefly "What if" scenarios and draw contingency measures to deal with potential risks. Examples are: What if recording of laboratory practices is not possible? What if a partner is overspending? What if a university authority does not want to sign the agreement for a sustainable development of the nanotechnology curricula?
5. Draw a conflict resolution procedure. It includes a list of possible conflict situations, steps and responsibility of the parties involved.

Evidence Intermediate report

A web-based project management environment is developed which provides a very transparent overview of all project documents, activities, deliverables, presentations and minutes to date.
A project Steering Committee has been established. Three face-to-face and four virtual meetings had been organized. A good idea was to have a local institution (TAU) mediating communication between the project's coordinator and other Israeli partners.
All project's products have been peer-reviewed by all partners.
Estimation of risks was not done in a prescribed structured way, as suggested by the criteria, but discussions to address potential risks had been carried out.
Although a conflict resolution does not seem to exist, handling the problems "on fly" (e.g. purchasing equipment, including a new partner) has been impressively good with the joint effort of the coordinator, partners, EU project's officer and Erasmus+ Israel. It represents a good example of how to deal with such situations. It seems that coordination and communication among the project's partners is good as evidenced by the NEO field visit. The conflict situations were handled professionally and with care based on the experience of the coordinator and the partners.

Evidence Final report

The web-based project management environment continues to work effectively and efficiently. It is useful source of information for both the project's partners and interested parties outside. In

general, all the necessary information can be found there but it would be helpful if conference presentations, proceedings' papers and book chapters can also be made available on the web site.

The Steering Committee had been meeting regularly, either online or face-to-face, to manage operationally the project.

It is not clear to me whether a procedure for peer reviewing of the deliverables had been established and applied throughout the project.

There is sufficient information reported to conclude that the coordination and communication between different stakeholders (inside and outside the project) and efforts made for resolving emerging issues have been effective.

Quality criteria Needs, domain and job analyses

1. Communicate clearly and coordinate effectively the partners' needs analysis tasks. Use predefined templates.
2. Select appropriate methods for the needs analysis data collection. Examples are: survey through questionnaires; interviews with teachers, students, employees from enterprises and educational managers; focus group with partners representatives; interview with experts; review national documents on nanotechnology strategic development; technological forecast.
3. Conduct job analysis in nanotechnology enterprises.
4. Conduct domain analysis for trends in nanotechnology.
5. Investigate trends in labour market and technology development.

Evidence Intermediate report

A comprehensive need analysis survey addressing all of the issues referred by the criteria had been conducted involving nanotechnology industry to identify what is expected from students in terms of knowledge, skills, problem solving and attitudes. This is a very important activity, often underestimated as my experience with other projects indicates. Defining reference situations of microelectronics education, that is the professional fields where the students will be applying their knowledge and skills, should be done before formulating learning outcomes. Learning outcomes must reflect the reference situations. It is also important to maintain a close relationship with industry and to be constantly informed about what is going there. In this respect keeping the

survey open is an unusual but a smart idea. This would have a positive effect on sustainability of the project as well. The local Israeli coordinator has been quite active in establishing and maintaining good relationships with industry.

Evidence final report

First, I would like to reiterate how important needs analysis is for curriculum development and instructional design decision making. Second, the follow up needs analysis survey is really a very good idea. However, it was difficult to me to see how the results of the analyses affected the courses, not only in terms what to include (content), which is the case, but also how the course designs (the way of teaching and learning) reflected the nanotechnology community of practice.

Quality criteria Curriculum development and instructional design

1. Prepare a competence matrix for each course. Formulate competences as expected outcomes in terms of behavior action and measurable standards to achieve.
2. Describe all courses using a specific template (learning outcomes, entry requirements, sequence of tasks, support for tasks, assessment methods, and European Credit Transfer System - ECTS).
3. Peer review of the courses. All partners are involved in critical and constructive feedback of the courses' descriptions.
4. All syllabi refer to European Credit Transfer System (ECTS) and European Qualification Framework (EQF). Organise training workshops on ECTS.
5. The curricula as a whole reflects the multidisciplinary character of nanotechnology.
6. Check existing Open Educational Resources (OER) and MOOC in nanotechnology to eventually borrow content or tasks from there or simply make references to OERs and MOOCs resources in the syllabi description.

Evidence Intermediate report

All of the referred criteria above have been covered thoroughly. On the project's Youtube channel there is a presentation on a MOOC 'Nanotechnology and Nanocensors: Promoting innovative thinking and motivation to learn in international learning teams'. Not only OER and MOOCs have been used as reference points and reusing learning content but it seems a MOOC has been developed as well.

The learning outcomes of most of the courses are formulated very professionally. The link to ECTS is shown explicitly in each course syllabus. I found a negligible inconsistency between the guide of how to formulate learning outcomes used as a reference in the project, and the requirement for creating a competence matrix. The Guide suggests to avoid using the term 'competence'.

Evidence Final report

The syllabi of twenty-four courses have been developed and peer reviewed, which is an impressive achievement. A series of workshops and individual consultations have been organized to support the definition of learning outcomes and the ECTS appending to the courses. I picked up randomly some of these courses and found that in some of them the learning outcomes were formulated very well, while others did not follow strictly the guidelines for formulating learning outcomes.

What concerns the instructional design approach, there are some positive movements toward more innovative approaches (e.g. the attempt to define whole-task practices, classes of learning tasks, and using modeling examples, to mention some) but overall the e-learning approach has been quite traditional (mostly online lectures and multiple-choice test evaluation).

I am a firm supporter of using Open Educational Resources, including MOOCs, for designing smaller-scale courses. These online resources could be referred to in an online course or be part of a kind of blended learning approach (e.g.,'flipped' classroom'). A MOOCs could be followed as well (entire course or part of it). In the intermediate report I referred to a MOOC course whose presentation was available on the youtube channel of the EDUNANO project ('Nanotechnology and Nanocensors: Promoting innovative thinking and motivation to learn in international learning teams'). I thought it was very good and expected to see it in the list of courses or at least a reference to it in some courses. I did not find any use of it but it could be that I simply overlook it. Searching for nanotechnology MOOCs is useful for several reasons. First, as said, a MOOC can be used as a resource or be added to the list of courses. Second, the instructional design (ID) of the EDUNANO courses can be compared to the approaches applied in these MOOCs. Third, the research carried out on some ID aspects in MOOCs is of high quality and it is published in a high impact journal. I have noticed that some of the EDUNANO courses integrate presentations of experts found on the internet, which is good. However, the

Internet proposes much more to domain specific knowledge presentation, for example, remote laboratories and instruments, some of them cloud-based (see nanoHUB: https://nanohub.org/).

Quality criteria EDUNANO web-based learning environment and content repository

1. The environment conforms to technical specifications ("build the product right").
2. Test the utility and usability of the NANOEDU learning environment initially with the consortium partners.
3. Test the utility and usability of the web-based learning environment with at least five students or five enterprises/research centres employees at the partner institutions concerned ("build the right product"). Prepare Evaluation Script (purpose, background, informed consent, tasks, interview questions and prompts. Use a variety of methods: software-walkthrough, interview, usability questionnaire, heuristic evaluation.

Evidence Intermediate report

All courses are available in The EDUNANO Learning Management System, including technical trainings given to support the course authors in recording a lecture and implementing multimedia materials. It is perhaps useful to give meaningful names of the lectures and topics on the left overview panel, rather than call them simply 'lecture' or 'topic' identifiable only by a number.

Evidence Final report

It is immediate evident that the project has made efforts to improve the Moodle Learning Content Management environment (LCM) as suggested in the intermediate report (e.g. all courses and topics have been given meaningful names). However, there are some technical issues that need be addressed. The links to video lectures and experts' interviews do not work properly. I suspect it has to do with some browsers security issues with regard to the Flash Player (I checked it only with Chrome and the Firefox). A short visible instruction would do in case people experience such a problem. A well-working usable LCM system is crucial for the sustainability of the project. It is important that it will be kept on a partner server for three years and that modules can be transferred or converted to other systems. More importantly, however, is that the EDUNANO LCM environment remains competitive to other online alternatives because people will, intentionally or unintentionally, make comparisons.

Quality criteria Implementation of the courses and formal field trials

1. Provide sufficient time (at least two semesters) for the field user trials.
2. Draw a brief plan to guide implementation of the courses and field trials. The plan describes the research methodology, sampling, and measurement instruments. Involve different types of participants (students, employees, teachers, curriculum designers and educational managers), different data collection methods (questionnaire, interview, software-walkthrough, observation, performance test). Include where possible a control group to compare the results.
3. Discuss the plan with the project partners.

Evidence Intermediate report

The evaluation is in progress and evidence how this set of criteria has been met will be reported in the final evaluation report

Evidence Final Report

The number of the courses developed is impressive: twenty-four courses on domain specific nanotechnology content, one on Moodle technical training and one on defining learning outcomes. The content-specific courses have been evaluated by applying qualitative (self-reflection and observation) and quantitative (questionnaires) measures.

Quality criteria Mobility

Evidence Final Report

Students and high school teachers mobility in project partners' organisations is a significant achievement of the project. Certainly the quantity indicators are noteworthy to refer to but I would like to emphasize specifically on the quality of provided training and the satisfaction and excitement expressed by the visitors and representatives of the hosting organisations as it is evident from the mobility evaluation reports.

Quality criteria Dissemination and Sustainability

1. Use various channels for distributing the project results: a project web portal, information on the partner institutions web sites, conferences' presentations and workshops, publications in high impact journals, professional networks, social networks.

2. Try to present the project's results in high profile conferences (an acceptance rate up to 25 %).
3. Try to publish at least two papers in an ICI (indexed) journals (formal measures such as 5-years impact factor of at least 2.5 and an influence score of 0.5).
4. Use social media to promote the project's results (e.g., LinkedIn Higher Education group).
5. Implement courses in the regular university curricula or enterprises training programmes.
6. Maintain the project web site after the project's end.

Evidence Intermediate report

The project is really exploring all possible channels, both nationally in Israel and internationally, for distributing the project's results so far. The work in this respect has been impressive. The project presence on youtube is outstanding. Perhaps more attention should be given in the near future to presenting the project's results at scientific conferences and especially publishing in scientific journals.

Measures have been planned for sustaining the project activities after the project end in terms of maintaining the learning Management System, courses constantly being updated, integrating of the courses in higher education institution curriculum and training plans of companies.

Evidence Final Report

The project builds upon the very good job done in the previous evaluation period and described in the intermediate report. The list of dissemination events, either national (in Israel) or international, at different management levels and involving different target groups, has extended and it is really impressive. Certainly the number of accredited courses is worth mentioning. I was particularly impressed by two more achievements that go beyond what was initially promised: (a) the ambition to broaden the collaboration geographically reaching countries such as China, India, Malaysia and South Korea; and (b) efforts for popularizing the nanotechnology at schools (see Blonder, R. (May 2017). Nano goes to school: Bridging the gap between contemporary research and school science). I still believe the project has collected reach data that could be further analyzed and synthesized in journal publications.

Conclusion

The project has achieved a lot, which lays solid foundations for expanding and deepening the collaboration between the project's partners in the future. I have the chance to speak to some of the induvial partners and witnessed great potential for building a successful international community of practice in nanotechnology. The project is blessed with both strong domain specific expertise and competence in instructional design but the question is how to capitalize on that to improve the courses design. The quantity is there in terms of the number of courses and participants, the attention should be now turned to more qualitative aspects such as implementing more innovative design for learning. The other recommendation to consider is improving the project's online learning environment.

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