Quantum Spin-Off: how inquiry can lead to entrepreneurship

PATHWAY

Students of last stage of secondary school in the research centre for nano-electronics IMEC

Summary:

Quantum Spin-Off opens the world of modern physics to secondary school students. It shows the applications of Quantum Physics and gives them a taste of entrepreneurship for the high tech sector. The high school students are brought in contact with a world-leading research institution in nano-electronics (IMEC www.imec.be) and with large and small high tech companies like IBM-Skillteam, Xenics, SkyScan and Lumoza. The pupils first develop some basic understanding of quantum physics and its applications by inquiry based methods. Later on, they work on a specific valorisation idea in close collaboration with the researchers of the participating companies and institutions. In the second phase of the project, the pupils start to think of a product as an application of the modern science they learned. Eventually they develop a business plan for their own spin-off company with the support of real businessmen.

Aims:

Quantum Spin-Off gives secondary school students the chance to understand the link between the insights of modern physics and the opportunities in high-tech enterprising. Quantum Spin-Off aims to (a) bring pupils into contact with research in quantum physics, nanoscience and nanotechnology (b) provide opportunities to do inquiry (c) show pupils how an innovative idea at a fundamental scientific level can lead to an application, a product and eventually to a business.

Under the guidance of researchers and businesspersons, the pupils learn in an inquiry based manner to develop a technical application based on research results and to convert this into a business plan.

Main activities:

- By inquiry pupils learn the basic concepts of Quantum Physics. The learning stations are delivered via the web to the participating schools.
- At the Quantum Spin-up day at IMEC, they meet the researchers. The pupils immerse themselves in quantum physics and its applications such as LED's, flash memory, infrared cameras and medical imaging. The participating high-tech companies show how basic research and patentscan lead to fascinating applications.
- Research Day at the university: After a few weeks the pupils meet their researcher again. They attend a talk about nanophysics, they go into the nanolab and start talking more deeply about their nano-patent with their researcher.
- Research Day in Spin-Off Company: Every class visits a spin-off company with their researcher. The development of a product is at stake and the design of a technical plan is initiated. Businesspeople give insight on how to develop a good product.
- Spin-Off Day in IBM Forum in Brussels: Presentation of the valorization results and awarding the Quantum Spin-Off prizes.

Students talking with their researcher in IMEC

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Narrative:

Quantum Spin-Off gives secondary school students the chance to understand the link between the insights of modern physics and the opportunities in high-tech enterprising. By bringing school pupils in contact with real researchers and entrepreneurs in the high-tech sector, Quantum Spin-Off brings real Science and Entrepreneurship into the classroom. The students get a threefold task to perform on a very inquiry based manner:

(a) Investigate the concepts of modern quantum field theory. They are provided with Inquiry based learning material to perform this task.

(b) Investigate a patent describing an application of quantum and nanoscience. They interact with a real scientist in order to understand what the patents means.

(c) Think of a product based on a real patent and develop a technical plan for it. Develop a business plan for a spin-off company that is going to develop, produce and sell this product.

The logo of Kwantum Spin-Off in the IMEC auditorium

The project is planned in several steps:

(1) Spin-up day at IMEC
At the beginning of the school year the Spin-up day is organized at IMEC in Leuven, where the students immerse themselves in quantum physics and its applications such as LEDs, flash memory, infrared cameras and medical imaging. The participating high-tech companies show how basic research and patents can lead to fascinating applications. The students meet the researchers with whom they are going to collaborate for the rest of the project and start thinking about a possible application of a truly existing high-tech patent.

(2) Spin-off valorisation process
For several weeks the students work as in a high-tech company. They will contact the supervisors of the participating high-tech companies or research groups and create a technical and a business plan. There are at least three working days in the company and / or research institution where representatives of the class can discuss the detailed plans. Also contacts via email and phone are possible. The economy and science teachers coach their students during this process.

(3) Spin-off day
Eventually the groups of students present their technical and business plans to a jury. The jury of experts of the participating companies and research groups honours the best projects with a Quantum Spin-Off prize.

End user - involved actors
Interested pupils of the third stage of secondary education (upper secondary level) and their teachers

Location:
The project uses a combination of locations: school, university, research labs, companies and also the web

Languages available:
Dutch

Where to find the application or case:
The project website is:
www.vakdidactiek.be/spinoff

Duration:
The duration of the case for the pupils is one school year.
September 2011: introduction
October 2011: Spin-up day
November 2011 – April 2012
Valorisation process with 3 research days
May 2012: Spin-off day
Quantum Spin-Off will be repeated in the school year 2012-2013

Evaluation parameters:
Quantum Spin-Off is evaluated in a threefold way:

- By the participating students: by means of a questionnaire aiming at student's motivation and learning gains.
- By the teachers of the participating schools: by means of the questionnaires provided by the EUN, aiming at teacher's professional development on Inquiry Based Teaching Methods. In addition to this formal evaluation, a half way intervision meeting is held with the teachers to discuss the course of the project.
- By the researchers: by means of the appreciation they give to the work presented by the pupils (both on the research days as their final rewarding on the final spin-off day). In addition to this two intervision meetings are held with the researchers during the course of the year.

Connection with the curriculum:
The project connects to official learning goals as:

- Learning by inquiry
- Learn modern physics
- Learn to enterprise

Teachers' Competencies

1	subject matter/content knowledge	x
2	nature of science	x
3	Multidisciplinary	x
4	knowledge of contemporary science	x
5	variety of (especially student-centred) instructional strategies	x
6	lifelong learning	x
7	self-reflection	x
8	teaching/ learning processes within the domain	x
9	using laboratories, experiments, projects	x
10	common sense knowledge and learning difficulties	x
11	use of ICTs	x
12	knowledge, planning and use of curricular materials	x
13	Information and Communication Technologies with Technological Pedagogical Content Knowledge	

Mapping best practices with main principles

1. Building interest in natural science phenomena and explanations:

Quantum physics is an enormously fascinating and intriguing branch of physics, which is present in our everyday life with many applications but unfortunately not covered at all in Flemish schools. The understanding of the basic ideas of quantum physics, of its history and of its everyday life applications achieved by the pupils with this project has a great potential to boost their interest for science.

2. Building up informed citizens: Students understanding the nature of Science & Science in society:

The average citizen believes quantum physics is some crazy scientist's thing that has nothing to do with real life. The same average citizen has a dvd player, a laser pointer, tiny size electronics and might need a CT or MRI scan sometime. This project aims at increasing awareness of the connection between fundamental science and long term benefits for the society in the new generation of citizens.

3. Develop multiple goals:

- **understanding big ideas in science including ideas of science, and ideas about science**
- **scientific capabilities concerned with gathering and using evidence**
- **scientific attitudes**

Direct contact between pupils and real researchers in a real research environment (university, research labs and high-tech spinoffs), gives the pupils a feel of what real science is and who does science, helping eradicate misconceptions about science and scientists. The fact that pupils have to contribute with their own ideas to go from science to product stimulates them to think of science as deeply connected to the society.

4. Understanding students' concepts and learning style about of science phenomena:

The pedagogical method of inquiry applied throughout the project gives opportunities for learners of different learning styles. In fact the learners are more or less considered as real co-researchers working together with a real researcher from the university, from a research lab or from a high-tech company. The working places in the research labs and in companies bring pupils out of their normal place and role. The pupils are made responsible for the valorisation project and for their own business plan.

5. Relevance of the content to daily life of students:

Modern pupils are technological pupils who often ask themselves no question about all the technology they use and more generally about what happens around them. With this project the pupils see what is behind many of the finished products and techniques they use everyday. This can open the door to a new way of experiencing reality where there is more space for curiosity and questions and where less is given for granted.

6. Understanding science as a process not as stable facts. Using up to date information of science and education:

Our inquiry based learning stations on quantum physics let the pupil understand its history and conceptual development. It is important for pupils to understand that the validity of the classical physics they have studied in the standard program at school is limited to a certain scale of physical phenomena and that physics in general evolves in such a way that new, more fundamental theories generalize (and so include) older ones.

7. Activities for gaining knowledge, not for entertainment, nor for simple imitating of results:

This whole project is about activities that are out-of-the-ordinary for the pupils and meant for gaining knowledge. Visiting research labs, interacting with real scientists, see experiments of quantum physics in action, work in teams to try to understand a scientific patent and try to make a product out of it, make a business plan: all of this is a full immersion in the science and technology world where pupils play an active role.

8. Doing science: experimenting, analyzing, interpreting, redefining explanations:

Our learning stations about quantum physics contain many questions. We let the pupil analyze the results of experiments and their implications to give his/her own interpretation and draw at the end his/her own conclusions. We guide the pupil step by step through beautiful derivations by asking small questions. The pupil goes through the derivation himself/herself and understands the logical importance of every step.

9. Assessment: formative ~ of students' learning and the summative ~ of their progress:

Formative:

- Over contacts with their researchers
- Over a forum on the website

10. Cooperation among teachers and with experts:

Many groups from different schools, and therefore many science teachers, participate together in the project. They get the opportunity to learn more about quantum physics and its applications and to interact with each other and with the researchers who support them. A forum is organized on the project website where questions from pupils and teachers can be answered by the researchers.