

## ***Junior College Utrecht: a working place for innovative science teaching***

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### **Introduction**

Traditionally, in Dutch senior secondary schools little attention is paid to differences in abilities within a class. To talented students, this can have negative effects. The happy part of this group needs little effort to get high marks and they are successful in passing the exams. However, quite a few of them do not develop a good working attitude and study skills and have therefore many problems in tertiary education. The unhappy part of the talented students do not get enough challenges and may become under-achievers, losing motivation and getting low marks. Thus, talents may be spoiled, in particular in science, as learning science and mathematics costs much effort. Students should be supported by science teachers that are interested in getting the best out of all their students. However, Dutch secondary schools and their science and mathematics departments are not sufficiently equipped to challenge students with science talents.

In 2004, Utrecht University and schools from the Utrecht region decided to develop a radical initiative to tackle this issue: the Junior College Utrecht JCU. This is a school for the last two years of VWO (pre-university education). JCU started in 2004 with 25 VWO students that were selected from 13 schools. It is located at the University College Utrecht campus. JCU-students follow all their physics, chemistry, biology and mathematics lessons in the JCU. The other lessons are followed in their own schools. A special two year curriculum has been developed, taught by eight secondary teachers from partner schools and by a number of university teachers.

The initiative was planned as a pilot project for 3 years. In 2005, the 2004 group passed to 6VWO a second group of 50 students (two classes) was selected. Now, April 2006, the first group is preparing for the final examinations.

The JCU initiative has been successful. The students appreciated the JCU programme and the atmosphere in the JCU very much; the partner schools and the university were content and so it is decided to continue the JCU. This implies that we are going to select a new group of 50 students for the August 2006 start. Many students are interested in participating in the JCU. The 'JCU open day' attracted 170 interested students and their parents. About 75 students are selected by their schools to apply for the JCU. They will be invited for an interview and about 50 students will be selected to start in the 2006/07 course.

In this paper, I will describe the curriculum and elaborate some examples in the field of Physics. Furthermore, I will indicate what the intended effects on JCU partner schools are and how JCU and its partners want to contribute to science curriculum innovation in the Netherlands.

## The JCU curriculum

The JCU has two main goals, one aiming at the education of talented students and one at the innovation of science education in upper secondary schools:

- To offer an interesting and challenging science education program to talented and motivated students (age 16 – 18)
- To provide a working place to partner schools for innovation of the science and mathematics curricula

The JCU curriculum has five characteristics that are different from science curricula in regular VWO schools.

### 1. Accelerated pace

This implies that subject matter from the national VWO syllabuses biology, physics, chemistry and mathematics is taught in a shorter time than on usual VWO schools. Thus, a half year time is saved to study topics beyond the syllabuses.

### 2. More comprehensive

In spite of the accelerated pace, the curriculum is taught in a more comprehensive and profound way than at the regular VWO-schools. E.g. the students do lab work using university laboratory facilities; more attention is paid to theoretical and research backgrounds of syllabus subject matter.

### 3. focus on coherence of sciences

As all JCU-students study the full science and maths curriculum, it is possible to pay much attention to the coherence of the sciences. Among others, this has resulted in including interdisciplinary projects in the curriculum.

### 4. stimulating students' inquiring attitude

Students that are interested in the sciences should get much room for asking their own questions and finding answers, for developing their inquiring mind. Therefore, in the JCU-curriculum an inquiry curriculum line is implemented. That implies open inquiry assignments in the subjects as well in interdisciplinary projects. This line results in two big investigation assignments guided by researchers from Utrecht University:

- the pre-thesis at the end of the 5Vclass
- the JCU thesis half way the 6V class

The JCU thesis agrees with the 'profielwerkstuk' that is part of VWO examination, but it counts 120 instead of the regular 80 student hours.

<b>Title of JCU thesis</b>	<b>Physics Domain</b>
<i>Holografie visueel bedrog</i>	Holography
<i>El Niño, het probleemkind</i>	Meteorology/oceanography
<i>Reflectie het middel tot perfectie</i>	Solar cells
<i>Voortaan met de boot en niet met de trein?</i>	Fluids

Some titles of JCU theses covering physics domains. Full reports (in Dutch) can be found on the JCU-site [www.JCU.uu.nl](http://www.JCU.uu.nl), (click 'voor JCU-leerlingen').

### 5. Enriched program

In addition to the VWO syllabuses, topics beyond the syllabuses are taught. In the 5V classes these have the form of a seminar or a lecture on a topic, of an excursion to a university lab, or of a project. In the 6V class, university modules of a large size are taught by university specialists, elaborating issues at the front of research.

Titles of some interdisciplinary projects	Titles of the university modules
DNA (biology and chemistry) Human perception (physics and biology) Luminescence (physics and chemistry) GPS (physics and mathematics)	Modeling Astrophysics HIV/AIDS Nanoscience

To give an impression of innovative parts in the JCU curriculum, I will elaborate two examples:

- an interdisciplinary project in 5V: GPS
- a university module in 6V: nanoscience.

### Example 1: project GPS-day

The GPS-day was an interdisciplinary project developed by the physics and mathematics sections of JCU. In the morning, the students got lectures about the physics of satellites, the mathematics of the projection of satellite orbits on the earth and theory on determining positions on the earth using satellites. The students did a practical about centripetal forces and used an applet on satellite orbits around the world. At the end of the morning, they studied in groups, using internet, an aspect of GPS and presented their results to their peers.



*Slides from the powerpoint presentation about GPS by JCU students*

In the afternoon, groups of three students got GPS apparatus and an instruction where to go using the apparatus. There were three meeting points. Applying the GPS knowledge in

practice appeared to be very instructive. All groups arrived at the meeting points, however some of them using the mobile telephone because they had missed the right route.

## Example 2: the nanoscience module

Nanoscience was a module in 6V. It consisted of four morning sessions, each including a lecture and student activities. It was developed and taught by university specialists. In the first meeting, the topic was introduced, in particular the area/volume ratio and dimensionality. Further, groups were formed that would study and present future applications of nanoscience. The meeting ended with a workshop, applying the theory by doing assignments.

In the second meeting, a lecture about the characteristics of nanoscience materials was taught and a workshop was given.

During the third meeting, the students made gold nanocrystals and studied their behaviour.

In the last meeting, a lecture on biomedical applications was given.

In between the sessions the students worked on the application assignment. One group studied self-cleaning windows, another shape memory alloys and a third utility fogs. The student groups presented the results of their search for applications and their possible effects on society. Beneath, some slides from a student presentation are shown.

**Forget spark plugs,  
start your car with nanotubes**

Door Karel, Geretta & Quirine

**Werking**

Andres de la Guardia

- Flits
- Knal
- Ontbranding

**De mogelijkheden**

- Meetapparatuur
- Explosieven
- Vaste raketbrandstof
- In brandstof voor auto's:
  1. Volledig
  2. Gelijktijdig

*Slides from a student powerpoint presentation about nanoscience applications*

## Development of modules

The JCU wants to play a prominent role in curriculum innovation. It wants to disseminate the ideas about and practise with seminars, projects modules and thesis to the regular VWO-schools. Curriculum innovation as promoted by the innovation committees like Nina and the new science subject 'Nature, life and technology'. So, future curriculum development in the JCU will be geared with the plans of these committees.

JCU has a new curriculum development and implementation approach. First, JCU teachers and UU specialists develop a module about an interesting topic and teach it at JCU. That 'JCU-version' will be evaluated and adapted for a second trial at JCU. At the same time it is adapted for use in the partner schools, in co-operation with partner school teachers, ('partner school version'). The experiences in the partner school will be evaluated and a final version will be made that every school can use.

Preliminary titles for NLT modules to be developed by JCU are:

- DNA
- Nanoscience
- Astrophysics
- Energy flows in the house
- Biomedical technology
- A geographic module (e.g. the changing earth)

Titles of discipline-specific modules are to be discussed with the innovation committees like NiNa.

## Evaluation of JCU experiences

During the past months, the JCU experiences of students, teachers and partner schools have been evaluated. All groups are very positive about JCU and its curriculum, although many suggestions for further improvements were given.

The students enjoy the open and stimulating atmosphere in the JCU. The accelerated and enriched JCU curriculum has appeared to be feasible to them. Results vary from medium to high marks. But all students have got more interested in the sciences. A typical student reaction (from a 6V student) explaining why says: *'how could you change mathematics? For maths you just have to make many many exercises? Forget it! In the JCU we do it in a more comprehensive way! Of course you do exercises in the JCU as well, but you do more. Sometimes you work on issues with your peers. Then you have to present your solution on the blackboard. That results in interesting discussions!'*

The secondary JCU teachers experience their teaching in the JCU as a real challenge. They have experienced that teaching the JCU curriculum is feasible to them, however it is complicated because, among others, complex organisation (e.g. using university facilities in different buildings) and co-operation with university teachers. They have been inspired to change their teaching in their own schools and to inform their school colleagues about their experiences.

The JCU partner schools have various motives of participating in the JCU, ranging from giving their students more opportunities for learning to promoting curriculum innovations in the school. When the participation in JCU started, the science teachers had mixed feelings because they missed the talented students in their classes. Having heard their experiences in the JCU, they realised that they could never give them what JCU means for these students. Moreover, they see some competition in their 4V classes: students striving at being selected for JCU! So the support of the JCU in the science departments has been growing. It results in science teachers taking part in the curriculum innovation activities of JCU.

At this moment, new schools are applying for partnership in the JCU. We have to think how we are going to cope with that.

### **The future of JCU**

The co-operation of Utrecht University and the partner schools in JCU will continue in the years to come. JCU will get a regular place in the Science Faculty.

Now we know the strengths and the challenges of the JCU curriculum. So, some features will be changed. E.g. more emphasis in class 5V on 'enriching' and less on 'acceleration'. And intensifying the co-operation with the partner schools by developing innovative modules and implanting them not only in the JCU, but also in the partner schools.

[www.jcu.uu.nl](http://www.jcu.uu.nl)