

Perceived Differences in Teaching Science in High Ability Classrooms and in the Regular School Classroom

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Abstract

The Irish Centre for Talented Youth offers enrichment courses to students aged 6-16 years who have been identified as having exceptional academic ability. The Centre provides weekend and summer courses in a range of verbal and mathematical subject areas. Previous courses have included Psychology, Legal Studies, Mathematical Magic, Zoology, Chemistry, Philosophy, Theoretical Physics, Engineering and Neuroscience. This paper looks at the differences observed by teachers who have taught on science courses at both the Irish Centre for Talented Youth and to students in the general school-going population.

Keywords. Teaching Science, Gifted students, Regular students.

Background

The Irish Centre for Talented Youth (CTYI) was established at Dublin City University in November 1992, with the support and assistance of the Center for Talented Youth at Johns Hopkins University. CTY Ireland was the first CTY to be established outside of the United States and has since been followed by CTY Spain, CTY Bermuda and CTY Thailand and the National Academy for Gifted and Talented Youth in the UK.

CTYI caters for students with exceptional academic ability in either or both mathematical or verbal reasoning between the ages of 6 and 16 years. CTYI currently caters for over 3,500 students, however there are estimated to be over 25,000 students amongst this cross-section of the population in the gifted and talented category.

These accelerated courses at CTY Ireland are attractive to students for a number of reasons. Primarily it offers them increased challenge and stimulation, compared to regular school. Many of these students find themselves unchallenged by the mainstream curriculum. They quickly become bored and discontented. Some grow to resent school altogether and the whole notion of education and learning, and ultimately underachieve. Others silently shoulder the boredom and make the best of school, however unhappy and academically dissatisfied. In stark contrast to the national curriculum CTY Ireland offers exciting courses in diverse subject areas that run at a much faster pace than what is typical. As the curriculum is defined by each

individual instructor, it provides more leeway in terms of content, and permits student interests to be interwoven into the course without difficulty.

One of the most valuable aspects of these programmes is that it groups together students of similar ability. This is beneficial on two counts. Firstly, high academic ability becomes the norm rather than the exception as it is often regarded in school. Students are given the opportunity to work with their academic, as opposed to age, peer group, and therefore do not experience the same derision that they often experience. Secondly students find it much easier to make friends in such groupings where students share the same interests as themselves.

Instructors of courses operated by CTY Ireland are chosen from a wide pool. Each instructor has shown themselves to have achieved highly in their own specialised area. They must possess a fervent interest in their specific subject area, but most importantly enjoy teaching children and young people. Not all instructors are schoolteachers, and neither are all schoolteachers necessarily chosen as instructors.

Assessment and Eligibility Criteria

To be eligible to attend courses at CTY Ireland students must qualify through assessment. CTY Ireland uses different forms of assessment at each of the different age levels. Internationally out-of-level testing has been shown to be the most appropriate means of assessing students with exceptional academic ability. Students wishing to participate in CTY Ireland courses must first prove their ability in verbal and mathematical, and in some cases, abstract reasoning.

6-7 Year Olds

Young Student Programme

Students in this age group take assessment in Verbal and Abstract Reasoning. These students must reach the 95th percentile in either areas to be eligible to participate.

8-12 Year Olds

Young Student Programme

Students in this age group take assessment in Verbal, Numerical and Abstract Reasoning. These students must reach the 95th percentile in any of the three areas to be eligible to participate.

13-16 Year Olds

Older Student Programme

Students in this age group take assessment in Verbal and Numerical Reasoning. These students must reach the 97th percentile in either area to be eligible to participate.

Psychological Assessment

CTY Ireland is acutely aware that some students in the gifted and talented population may also bear a

learning difficulty. The Centre welcomes the participation of these students, making the necessary modifications to suit their individual learning needs.

Students on the Older Student Programme may only choose courses from their defined area of academic competence. Students on the Young Student Programme can choose from the complete list of courses, regardless of their ability once they have shown appropriate aptitude in one area.

Academic Courses

CTY Ireland's enrichment courses span across virtually all subject disciplines. The Centre is only constrained by two variables in what courses it can offer – facilities available at the university and access to appropriately qualified instructors. Table 1 shows the wide variety of science courses offered at CTY Ireland over the past number of years. In 2006, 62% of courses offered to students were in science. The proportion of science courses offered to students over the past number of years is given in Table 2.

Table 1: Science courses offered by CTY Ireland in 2005-2006

Aeronautical Engineering	Archaeology	Astronomy	Biology
Biomedical Diagnostics	Brain Investigations	Bugs & Stuff	Chemical Engineering
Chemistry	Computer Applications	Criminology	Electronic Engineering
Engineering	Experimental Physics	Forensic Science	Genetics
Investigative Science	Maths Magic	Me & My Body	Mechanical Engineering
Marine Biology	Microbiology	Modern Maths	Neuroscience
Medicine	Physiotherapy	Psychology	Robotics
Pharmacy	Science of Tomorrow	Superhero Science	Theoretical Physics
Rocket Science	Veterinary Science	World Geography	Zoology

Table 2: Number of Science courses available
 (Note: 12-16 year old students only attend courses during the summer period)

Term	Courses for 6-7 Year olds		Courses for 8-12 Year olds		Courses for 12-16 Year olds	
	Count	Percentage	Count	Percentage	Count	Percentage
Spring 2004	3 of 8	38%	15 of 35	43%	-	-
Summer 2004	4 of 8	50%	27 of 54	50%	13 of 31	42%
Autumn 2004	3 of 6	50%	12 of 33	36%	-	-
Spring 2005	3 of 6	50%	26 of 43	60%	-	-
Summer 2005	4 of 9	44%	37 of 63	59%	14 of 30	47%
Autumn 2005	7 of 11	64%	23 of 43	53%	-	-
Spring 2006	6 of 10	60%	27 of 45	60%	-	-
Summer 2006	9 of 10	90%	43 of 63	68%	10 of 29	34%
Autumn 2006	-	-	23 of 42	55%	-	-

Science courses are by far the most popular courses amongst the 6-12 year old group. Science is less appealing amongst the 12-16 year old group, with only 52% choosing it as their first choice in 2006.

Much of the time courses are masterminded by the Centre itself, however some of our instructors have suggested courses that they feel would work well with the age group.

The uptake of science courses is shown in Table 3, which also includes the breakdown into male and female uptake.

From this table it is clear to see that there is a high uptake, by both male and female students, amongst the 6 – 7 year old students. This is most likely caused by parents making course choices for their children. The trend across the 8 – 12 year old students is changeable (Fig. 1). The slow decline toward a low in 2004 is evident across both gender groups. The 12 – 16 year olds show a flatter line (without the 2004 drop) (Fig. 2) however the percentage points have dropped considerably for both male and female students. In both graphs boys appear to show a higher preference for science than girls.

Table 3: Participation in Science on summer programmes from 2003 – 2006

		2006 % Participation	2005 % Participation	2004 % Participation	2003 % Participation
	Age Group				
Male	6 to 7 years	100%	76%	100%	100%
Female	6 to 7 years	100%	75%	100%	100%
Male & Female	6 to 7 years	100%	76%	100%	100%
Male	8 to 12 years	88%	79%	29%	63%
Female	8 to 12 years	70%	53%	31%	49%
Male & Female	8 to 12 years	82%	70%	30%	58%
Male	12 to 16 years	50%	41%	39%	38%
Female	12 to 16 years	23%	29%	22%	18%
Male & Female	12 to 16 years	32%	36%	31%	28%

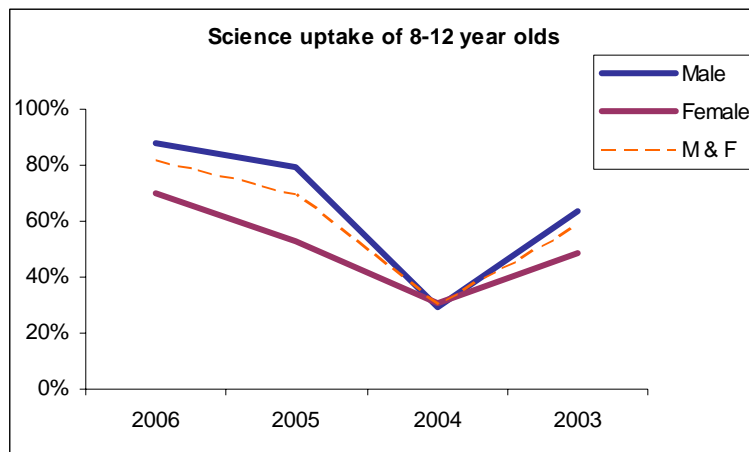


Fig. 1 – The participation in science in 8-12 year old students

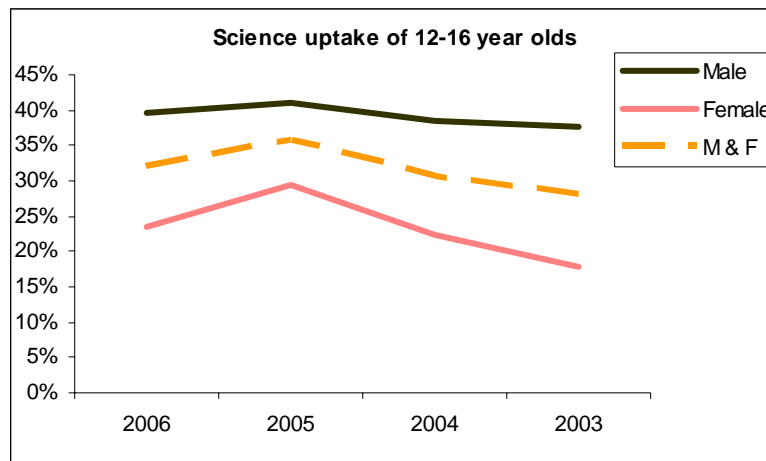


Fig. 2 – The participation in science in 12-16 year old students

Science Instructors

Instructors selected to teach science at CTY Ireland are generally university lecturers, postgraduate students or schoolteachers, with quite a specific area of expertise. While previous teaching experience is valuable, it is not imperative. A willingness to teach and some previous work with students in this age bracket are felt to be of far greater importance. Each instructor works very closely with the Centre at the time of course development, where all course material, practical activities and discussion topics are critically considered. CTY Ireland's philosophy is to respect the needs and abilities of each individual student and therefore instruction should be sensitive, responsive and flexible to each student's distinctive learning requirements.

CTY Ireland expects its instructors to be capable and confident in dealing with students of exceptional ability, as they differ from students in mainstream schools in many ways. While all students attending courses at CTY Ireland have achieved excellent scores in standardised tests, instructors must be able to handle the variations in talent, ability and motivation, as well as differences in level of attentiveness and prior knowledge of the subject. That said instructors should demand high standards from all students, while allowing for individual differences where necessary. The following guidelines are issued to all instructors on how best to conduct themselves and their classes. This list has been compiled as a result of many discussions with both CTY/Johns Hopkins staff and previous CTY Ireland instructors (CTYI, 2006).

- **Knowledge of the subject**

The instructor is a subject specialist, knows the material and can handle it with confidence. Further, the instructor is able to inspire a love of the subject in the student.

- **Mental flexibility**
The instructor possesses the ability to stretch beyond the narrow confines of the subject being taught and is able to tolerate ambiguity as the class explores the meaning and substance of the discipline.
- **Knows what excellence is and can demand it**
The instructor sets high standards for work and is able to live up to them as well as convey them effectively to students.
- **Able to say “I don’t know”**
The instructor is secure enough to be able to admit to the class when he or she does not know the answer and does not feel it is necessary to bluff or evade the question.
- **Interesting and interested**
The instructor has a variety of pursuits and is open to a world of ideas beyond the confines of his or her subject
- **Able to learn from the classroom and able to listen**
The instructor sees the students as competent and fully contributing participants in the class, and assumes that the students will be able to provide new insights into the subject.
- **Willing to try many methods and be observant of the learning styles among students.**
Not all students learn in the same way. The instructor must be able to adapt to the students and draw upon a variety of approaches and teaching strategies in order to convey the subject.
- **Likes to teach and likes young people!**

Pedagogical Approaches in Science

One of the most attractive features of the science courses at CTY Ireland is the practical, hands-on way in which they are taught. There is a strong emphasis on delivering science in a way that is visual, tactile and where applicable, audible. While science laboratory facilities are not always available, instructors are encouraged to conduct experiments and science related activities inside and outside of the regular classroom. The Bugs and Stuff class was host to more than a few aquariums containing geckos, stick insects, centipedes and millipedes, as well as lizards and tarantulas. Detailed experiments in Chemistry too are easily conducted in the lab or classroom, with students experimenting on diapers in search of giant water-absorbing polymers, in chromatography, using materials ranging from kitchen towels, filter paper and chalk, and in phosphorescence and luminescence using a custom made UV lamp and a range of familiar items. Many of the experiments, which require complex materials on the Young Student Programme are shown as demonstrations for obvious safety reasons, while the simpler experiments that use more everyday materials are conducted by the children themselves. This approach permits students to replicate the

simple experiments at home, where they have access to such materials. The notion of having students “bring science home” is fundamental to the CTYI methodology.

The second aspect of the methodology is that it is steeped in the constructivist methodology. Instructors are encouraged to utilise this approach of discovery learning when delivering course content. Time for scientific discussion and debate is factored into all lessons. In this way students are more at home learning science using the scientific method of enquiry, rather than learning by rote, as is often the case in school science.

Research and Evaluation

Research carried out with CTYI instructors who have also taught in mainstream schools yielded some interesting observations. The instructors were asked to identify characteristics that they found amongst the high ability students attending science courses at CTYI and whether they saw similar characteristics in school students from regular schools (Szabos, 2006). They observe high ability students to be characteristically different to their age peers in the following ways:

- *They are interested learners*
CTYI students have quite specific interests. From a young age they are more inclined to choose the subject they are to study at CTYI themselves, and are thereby driven by interest and curiosity.
- *They learn easily*
High ability students cope with abstract ideas with greater ease. They require less repetition and typically understand new material on first hearing.
- *“Knows” the answers*
These students have greater reserves of prior knowledge, having read more widely and retained more information than their peers.
- *Are inclined to Question the answer*
They don’t readily accept what their teacher tells them. With a greater retention and a deeper understanding, high ability students are more likely to see the aspects of a theory that don’t add up much faster than their fellow school students.
- *Very often don’t appear to be working, but still manage to get good test scores*
High ability students rarely need the same amount of time as their peers to complete their work. With a faster comprehension and retention of information the mismatch between perceived work rate and test scores is what very often sets them apart from their classmates.
- *Are less inclined to enjoy the company of same age peers*

Characteristically gifted and talented students show a preference for individuals with a similar intellectual level. Very often this means students in older classes at school, or similarly aged students at CTYI.

These characteristics might be applicable across all subject areas, with none specific to science.

Teacher Perspectives

The instructors that participated in this study also described the learning characteristics of high ability students at CTYI. They found them to be very eager, highly interested and quite persistent learners. With good memories, the students were seen to absorb information very quickly. The following are quotations from the instructors.

“They seem to just absorb the information and if they don’t understand the topic they will ask questions until they do.”

“Like sponges, they retain information very well and rarely need anything repeated.”

“Enthusiastic students who love to learn so therefore learning is self-motivated, and close to insatiable – they want to find out more all the time.”

On the other hand they commented that regular school students;

“(they) don’t ask so many questions and are more satisfied by being told the answer.”

“They sometimes have more difficulty understanding the material, but they may be less likely to ask questions to improve their understanding.”

“They learn because they have to – different motive; more teacher-motivated than self-motivated.”

Conclusion

The attitude toward science of high ability students at CTYI would appear to peak for both boys and girls when on the 8-12 year old programme. The courses at CTYI increase to serve this peak, but there is a fall off when students make the transition to secondary school (and progress to the Older Student Programme) at 12-13 years of age. A similar trend was also reported in research carried out on the general population (Task Force on Physical Sciences, 2002).

Teaching science to high ability students is no different to teaching students any other subject. While intellectually they are ahead of their peers, specifically the

subject is of no consequence. Their attitude, approach and retention in science are as applicable to any of the humanities subjects.

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