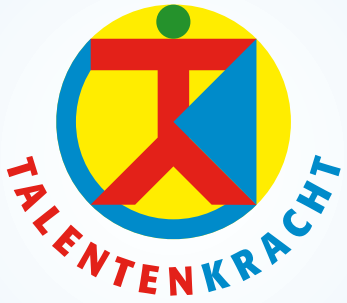

Curious Minds

an innovative interface between

scientific disciplines

and children's development

I have no special talents. I am only passionately curious.

Albert Einstein

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Curious Minds: an innovative interface

Everyone who looks closely at toddlers or kindergartners will notice astonishing talents. Young children appear to be very good at logical reasoning, recognizing patterns, finding their way around and at constructing. Yet, what strikes us most is how they "sparkle" in their amazement about the world around them. Young children question, theorize, experiment, reason and solve problems during their play. The Dutch Program Curious Minds (TalentenKracht) is aimed at finding ways to map, preserve and develop these talents, so as to prevent them from withering away. Curious Minds is supported by the Dutch Ministry of Education and the Program VTB of the Platform Bèta Techniek in the Netherlands.[1]

Young children's curiosity

According to logician Johan van Benthem, theoretical physicist Robbert Dijkgraaf, and mathematics educator Jan de Lange, as well as many parents and teachers, young children exhibit a wide range of remarkable talents and capabilities regarding the way in which they explain the world around them. They question and explore natural phenomena and the space they live in as they compare quantities, draw conclusions, reason about large and small or about how things seem to work or not. Children between the age of three to six years are very eager to learn and know more about scientific concepts and issues such as the moon, stars, planets, tides, volcanoes, dinosaurs, thunder and lightning, to name but a few. Why do planes fly, boats float and cars drive? How do you build a strong dyke or a proper bridge? Why does your shadow walk with you?

What is also remarkable and yet disturbing, is that many of these interests seem to disappear as soon as the children enter school: their *talent power*, so to speak, diminishes and (perhaps even because) school-learning seems to take over. It appears that many talents do not develop further and a lot of

[1] *The Platform Bèta Techniek has been commissioned by the government, education and business sectors to achieve a structural increase of students in scientific and technical education. VTB (Broadening Technology in Primary Education) is part of the Platform Bèta Techniek.*



spontaneousity, curiosity and creativity dissolves in the traditional instructional patterns of school and everyday life. Current educational practice seems to be more concerned with transferring knowledge of facts than with scientific and mathematical literacy, and often misses the goal of cultivating children's capacities. Are we "unlearning" children things that we expect them to learn again at a later stage?
It may come as no surprise that several publications support the concern that educational researchers have been failing to properly value the cognitive capacities of young children. A report from the National Research Council concluded that "(…) early childhood education, in both formal and informal settings, may not be helping all children maximize their cognitive capacities."[2] At a scientific level, little is known about talents in pre-school except in the areas that prepare for traditional school disciplines such as arithmetic, language and, in some countries, science.
These observations motivated Van Benthem, Dijkgraaf en De Lange to initiate the program Curious Minds.

- What people often say about children is: "They can't do this yet."
- We turn it around and say: "Look, they can already do this."
- And maybe it should be: "They can still do this now!"

Johan van Benthem and Robbert Dijkgraaf, initiators of Curious Minds, in an interview

In search of the "sparkling" coefficient

The researchers behind the Curious Minds program are keen to know more about what children between the age of three to six years know and do with talents in the STEM (science, technology, engineering and mathematics) disciplines. Yet, within these disciplines, no reference is made to curricular or

[2] *National Research Council (2005).* Mathematical and Scientific Development in Early Childhood. *Washington D.C.: National Academic Press, p.3.*



structural aspects of education. Curious Minds does not concentrate on static knowledge, but rather on the talents that involve processing such as problem solving, logical reasoning, making an argument, working with multiple representations, estimating chance, classifying, seriating, grasping space, and reflecting. These processes reach far beyond traditional school curricula, and it means that the domain for studying children's talents is almost unbounded as long as children's curiosity, reasoning and problem solving are present. The surprise, the excitement, the curiosity of young children must be taken seriously; it triggers many research questions such as what causes children to have such a high "sparkling coefficient", and how we can preserve the scientist in the child. Curious Minds aims to create awareness of, and open people's eyes to children's spontaneous expressions as exclamations of these processes and cognitive abilities.

Importantly, we emphasize here that this research concerns all children between the age of three to six years, and specifically not only those who rank in the top of their class.

Defining "talent"

Most research on talent has taken a retrospective perspective on defining talent as a highly developed ability that usually results from exerting great effort. In the case of young children, it often involves qualitative characteristics that relate to high learning potentials, environmental characteristics that relate to talent supporting surroundings, children's individual characteristics and even chance.

What makes the research in Curious Minds unique is that it defines "talent" from a prospective perspective. Taking the various characteristics of young children's talents together, then, the definition looks ahead into the direction of stimulating and supporting the expression and development of talent in the STEM disciplines. The research in Curious Minds does not concentrate on what things there are to know, but rather on understanding how children reason and on grasping the surprise and excitement that they tend to express during everyday activities.

As a result, Curious Minds contemplates several variables within the area of talents. Some variables include more general distinguishing marks such as curiosity, enthusiasm, concentration, willingness to explore, task persistence, reflection, processing information, and verbalizing. Other variables relate more specifically to the content of the STEM disciplines such as spatial awareness, comparing quantities, grasping space, logical reasoning, mechanical and constructive insight, counting structurally, and action and reaction processes.

Young children have what I call the "sparkling coefficient": they're curious, they are problem solvers and they think without barriers. It is a waste not to build on that.

Jan de Lange, initiator of Curious Minds

Curious Minds's key questions

The challenge for the Curious Minds program, then, is to determine how we can best observe young children's talents outside of scientific disciplines and in the children's daily playful life. Put concisely, the questions Curious Minds aims to address are:

1. What talents, possibilities, and qualities do children in the age range of three to six years have?
2. How can we optimally enhance the development of these qualities and talents?
3. How intertwined are these talents? Are these talents attributable to each of the aforementioned disciplines or are they broader and more connected?
4. How is this development of talents linked to language development?

Below, we summarize the unique characteristics of the Curious Minds program that should contribute to answering the program's key questions.

I'm right all the time, am I not?! That's because I'm a scientist!

Jaap (4 years and 10 months old), student of the Jan Campertschool in Driehuis

Curious Minds: scientific disciplines & children's development

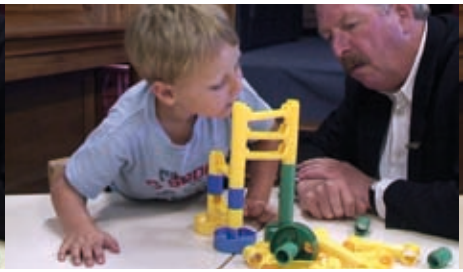
The Curious Minds research rests on two important pillars: scientific research and the involvement of children's social surroundings, with a special link to parents.

Interdisciplinary research

In order to create a sufficiently wide and solid research base, many different disciplines work together in Curious Minds. Experts in the STEM disciplines, brain and cognitive science, (developmental) psychology, (educational) neuroscience, language acquisition, and (neuro) pedagogy are represented in the program.

Program structure

The three initiators of Curious Minds are prof. dr. Johan van Benthem, prof. dr. Robbert Dijkgraaf and prof. dr. Jan de Lange (chairman). A Board of Advice and a Scientific Board are responsible for the scientific coordination and social embedding of the program. The members of these boards advise about the program as a whole and about the research of each of the research groups, the so called "satellites". The satellites form the backbone of Curious Minds. They carry out the practical research with the children. A steering committee supervises the program closely. This committee consists of a number of scientists from different disciplines and people from relevant institutions. Next to these more formal committees and groups, Curious Minds includes a broad network of people from the more practical field such as child care, primary education and professional organizations. This entails teachers, caretakers, children and, very importantly, parents.


This interdisciplinarity is not only necessary for building a broad base of evidence and for establishing a theoretical framework, but also for fuelling fundamental discussions about differing methodologies. The universities of Amsterdam, Maastricht and Utrecht started the research in early 2006. From 2008 onwards, six of the thirteen universities in the Netherlands will be involved in the research. These universities are spread around the country with locations in Amsterdam, Groningen, Leiden, Maastricht, Nijmegen and Utrecht.

Curious Minds research groups

Developmental Psychology – University of Amsterdam

In Curious Minds the University of Amsterdam mainly studies logic and reasoning. For one project they use formal, traditional testing material and for a second project they use games. These projects focus on the development of reasoning. Moreover, the researchers of this satellite work together with science center NEMO in Amsterdam on smaller Curious Minds projects.

Developmental Psychology – Groningen University

The researchers in Groningen aim to make the criteria for defining and identifying "talent" more observable by making use of theoretical and statistical methods. They also want to be able to formulate advice based on learning materials and interactions between adults and children, and about what characterizes learning environments that can best foster early talents.

Neuropedagogy, Department of Clinical Child and Adolescent Studies – Leiden University

The aim of the research in Leiden is to identify relevant neurocognitive factors that might help predict children's developmental paths. The researchers want to gain insight into the influence of factors such as social functioning, the children's environments, and the influence of social cognitive abilities on children's cognitive development and success at school.

Brain & Neurosciences – Maastricht University

The project at Maastricht University is working towards mapping the factors that seem to define talent development in STEM. Further, the researchers are creating educational, pedagogic and neuropsychologic interventions to optimize the development of individual talents and to bring to the fore individual patterns in development.

Freudenthal Institute for Science and Mathematics Education – Utrecht University

The research that is being carried out in Utrecht focuses on mapping the excitement and reasoning skills of young children as they work on activities that concern mathematics, science and technology. Since the starting point is always the child, reference to school activities is avoided. The researchers try to stimulate the child's activity by asking the proper questions. Each interview is taped on video.

Behavioral Science – Nijmegen University

Nijmegen brings the language-factor into Curious Minds. The researchers investigate what the role of language is in the acquisition of mathematics skills in the field of numeracy, spatial orientation and logical reasoning. In the latter context, young children's notions of truth and certainty will be investigated as well.

> There is evidence that children, from the youngest age, are capable of building upon their natural and insatiable curiosity to develop logical and rational thought.
>
> *Pierre Léna – Emeritus Professor at the Université Denis-Diderot in Paris in his Erasmus Lecture 2005*



Each of the satellites contribute to the overall research questions by starting from their own field of expertise. As scientific findings are exchanged during regular intergroup meetings, the added outcome is that the different scientists truly learn from each other.

Curious Minds research questions

Three main goals for the Curious Minds research have been formulated to reach between 2008 and 2010:

1) Mapping the talents of children between the age of three to six years, defining talent in a broad sense and including "new" talents.
2) Researching the role and effect of interventions on talents and the discovery of talent development.
3) Monitoring talent development for a longer period of time, and identifying factors that may be influencing this development.

1) Mapping the talents

One of the main questions that is being addressed in Curious Minds is: what are the observable characteristics of talented behavior in the scientific areas? Can we make a "map" of disciplines in which children show these talents?
To bring the talents of young children to the fore, the researchers are designing and using talent eliciting tasks. These tasks include games, puzzles, talks, toys and tools, exhibits in a science center, and simple psychological tasks. The procedure is such that the children engage in a discussion with an interviewer who, through carefully worded interventions, tries to give the child a chance to really get involved in the task or activity and to show what he or she understands and is able to accomplish. The activities that the children perform alone or together – while being encouraged by a researcher, parent or another adult – are taped on video. These videos are a source for analyzing and eventually mapping the topic areas in which children exhibit their talents. In effect, children's possible competencies concerning, for instance, their willingness to "explore", must be mapped in order to ultimately be able to optimize and foster them.



The videos do not only serve the researchers, but have also proved to be well-suited for professionalization purposes. Early 2008 there is material for more than 300 video clips with more than 100 children. Some of these clips are published on the Curious Minds website (www.talentenkracht.nl). What makes the video clips unique is that they involve broad, non-curricular activities and open interventions and conversations. Many of the fragments show how curious, fascinated, inventive and "sparkling" the children are. It is striking how hypnotized and evidence-minded the children operate. They want to take over the "experiment" and repeat it to see if what they are observing and finding is correct. The faces of the children, their gestures, their exclamations and their actions during the activities are very inspiring. This is why the clips continue to call for follow-up research questions and activities. Also, the clips are very popular among parents and researchers, because they open people's eyes for the unexpected and seemingly hidden talents of young children.

Wesley (five years and three months old) and the researcher talk about an air syringe. "Yeah, that is really fun!", Wesley reacts. "It is used to give someone a shot." One of the syringes is pulled out and both squirts are connected with a tube. Wesley is holding the one that is still pushed in, the researcher is holding the other one. "What will happen if I push this syringe in?", the interviewer asks. Wesley looks and follows the tube to his syringe with his finger. He thinks, sighs and finally says: "Then … shhhh… the air will come to mine." "So what will happen to yours?" "It will squirt it back." "And then what?" "It will go to yours."
The researcher pushes the syringe. After a short while, Wesley sees it: "Hey, mine is going backwards!" "How can that be? I was pushing mine in, not yours." Wesley: "I don't know exactly…" "Can you do it too?" Slowly Wesley pushes his syringe in, while watching the other. Triumphantly he calls out: "Yeah!"
Both syringes are pushed in one after the other. Again Wesley is asked how this is possible. "Because this one breathes towards that one." "So where is the breath now?" Wesley is pointing to the one syringe with the pulled-in piston: "Over here!"

By working together, the researchers expect to create an inventory of clustered qualities that are believed to characterize children's talents. This contributes to the research reliability and helps gain insight into what kinds of interventions would be suitable to support children in the development of their talents.

2) The role of interventions

Besides studying the actual talents that children show as they try to explain things in the world around them and as they attempt to solve problems that they encounter, there is another interesting factor in the research. Namely the mapping of observable characteristics of the partner (whether another child or adult) who is involved in the interaction. Hence, the Curious Minds researchers aim to make observable criteria for talent more explicit, and to formulate advice that is based on learning materials and on interactions between adults and children, about activities and environments that can best foster such early talents.

This aspect is an important focal point for each of all the researchers in Curious Minds. The researchers are, for instance, concerned with different types of interventions in different scientific areas, studying how these interventions impact learning outcomes. They are, for example, looking at the role of interventions in the children's playgrounds as well as at how explorative talents change with a change in the children's environment. Observations have also started on the influence of parents when they take their children to science centers.

One of the ways to include the role of interventions in the talent-map is by analyzing the videos using various behavior observation software packets. As such, the researchers are contributing to the development of a protocol for analyzing talented problem solving behavior. Furthermore, they are formulating advice for how teachers and adults may interact with the children to best foster children's talents, and they are highlighting pointers for intervention in case of frustrated or blocked talents.

3) Developing insight into how to build on the identified "talents"

Talent is not only a short-term manifestation of success when a child is performing a concrete activity, but it also involves a long term period of preservation and further development of problem solving abilities. Is it true that children seem to lose or change talents while they are growing up? Can we demonstrate this in a research setting? And is this related to one domain of talent or can we detect switches to another domain?

To grasp the development of talent, it is relevant to monitor children's development for a longer period of time using activities that relate to the different clusters of talent. The talent-map can also play a role in this aspect

of the research. The question is whether specific characteristics in the interaction, in the use of materials or in the way in which children tend to explore, can be detected. As such, a longitudinal study will evaluate the stability of cognitive and social functioning and the predictive value of these measures on academic achievement. In this respect, the dialogue with parents and professionals can also be helpful.

Giving parents "eyes"

In laying the foundations for the Curious Minds program, the researchers made it clear that the program should closely and continuously be intertwined with the dissemination and implementation of the outcomes. This highlights parents, teachers and children as the main group of people to which this program is directed.

Parents have excellent opportunities to facilitate "continuous curiosity" of their children. The right questions at the right moment often stimulate children to develop further in the activities that they are involved in. Stimulating curiosity at home and at day care centers are prerequisites for optimal development of young children. Curious Minds tries to identify which activities and what questions can help parents and professionals to do justice to the young curious minds.

Parents will be involved in two ways. On the one hand, Curious Minds should give parents and teachers "eyes" to see the talents of their children in regular daily activities and to help them to enrich these activities. More understanding is needed to develop interventions that encourage such supportive instruction. On the other hand, Curious Minds hopes to be able to make use of the experience of parents, teachers and other caretakers. Being in everyday contact with children, parents can be a vital source of information. A broad base is laid out for further research through bringing all this theoretical and practical knowledge and experiences together.



It was an eye-opener for me: in Curious Minds you do things in a way that we never do. I'm sometimes astonished by what the children are capable of!

Jacobina Taal, teacher of Effatha in Zoetermeer for auditive disabled children

Attention to children with special needs

The Effatha Guyot Groep in Zoetermeer, a school for children with hearing difficulties, has closely been involved with Curious Minds from an early stage in the program. The first experiences with doing activities with hearing impaired children were very promising. Effatha even asked the researchers to organize extra activities built around the research to be able to directly implement the findings in the classroom.
From 2008 to 2010, the research in special education will be extended towards visually disabled children. Moreover, some of the satellites will be studying children with cognitive developmental problems and learning deficits such as hyperactivity and ADHD (Attention Deficit Hyperactivity Disorder), and ADD (Attention Deficit Disorder), PDD-NoS (Pervasive Developing Deficits). Research on children with such disorders will be interpreted against studies with children who are considered to be developing normally.

One of my favorite anecdotes is about Leonard Bernstein, the prolific musical genius. He was confronted with the world of music at the relative late age of ten years, when an aunt gave the family a piano. When his father was asked why he had not introduced his son to music at an earlier age, he answered that he didn't known that his son would grow up to become Leonard Bernstein.

Robbert Dijkgraaf, initiator of Curious Minds

Curious Minds: perspectives on results for 2010

The Curious Minds program has several goals set to reach from 2008 up to 2010. There are many ideas for implementation which are also developing during the whole process of research and dissemination. By the end of 2010, Curious Minds aims to have achieved the following:

- Network of relevant people and parties: Besides the academics that are carrying out the research in Curious Minds, the network of other universities, disciplines, professionals and parents also has to be expanded to support the goals of the program. This includes contacts with international experts. The knowledge of all these people and parties has to be brought together to support children's talents and abilities.
- Talent-map showing clusters of talent: A map of the activities and related interview questions, clustered in domains of subjects. These domains entail logical reasoning, mathematics, science and technology. The talent-map can serve as a base for further research and for the development of tools and materials, as well as guidance for parents and stakeholders. The design of such a map will become clear as the research progresses.
- Insight into the effect of interventions: Talent is expressed in a certain way of observing, acting on, and reasoning about a concrete situation or task (e.g. games, puzzles, questions). Thus, talent is a process that is to be observed in the interaction between the child, another person and the task. Given that the task is sufficiently talent eliciting, this interaction can be open and supportive at the same time. An important aspect of the Curious Minds research, then, is the role and effect of interventions on children's development. Outcomes of this research will be shared, for example, during meetings, in (scientific) publications, through public broadcasting, and through publishing handbooks for parents.
- Insight into talent development: Curious Minds aims to monitor children for a longer period of time to see how their talents can be kept alive and why and how they may change, grow or wither away. Conclusions about this aspect of the research and what it may mean to parents and other stakeholders will be reported to relevant parties.

- Talent eliciting tasks and useful materials: The materials used in the research are parts of toys (e.g. marble circuit, LEGO, a box of bricks, mirrors), daily and domestic materials (e.g. egg cutter, experiment box, bath duck), exhibits at science centers and topics for conversation (e.g. colors, sun and moon, the weather). The aim is to continuously elaborate on and refine these activities with respect to children's developmental needs. Perhaps existing toys or materials that support the Curious Minds ideology can be given a Curious Minds-label and an accompanying guide for parents.
- Output for and input from parents and professionals: In the first two years of the program (2006 and 2007), many lectures where given to many different types of audiences: parents, teachers, people from day care centers, scientists and even companies. This was to inform people about what Curious Minds is doing and why. In the years 2008-2010 Curious Minds also wants to involve parents more closely. For example, by asking them to send in tapes of their own children. In anticipation of this, contacts are made with public broadcastings, science centers and publishers in the Netherlands.
- Activities for deaf and blind children: The satellite Utrecht will extend the research in special education from deaf to visually disabled children.
- Scientific discussion on research methods: The background of each of the research satellites differs remarkably. This makes discussions about methodology between the satellites very interesting and inspiring to all. Hence, the interaction plays a very important role in the Curious Minds program. This may lead to close cooperation and joint publications.
- Long-term project: The people behind Curious Minds are looking forward to initiating a long term project with a duration of at least 10 to 15 years.



Curiosity leads to development of talent

Anyone who has ever taken care of children knows that their questions can drive you crazy. Children have curious minds. They ask all sorts of questions. About dinosaurs (why aren't they around anymore?), about spiders (why do they have eight legs?), about crayons (how do they make those?) or about the moon (where does it go during the day?).

Children are not just curious inquirers, they are also creative inquirers. Somewhere, for instance, I read about a little boy who wanted to go to sleep and asked his father: 'Daddy, can you please turn on the dark?'

Although almost everyone will have hands-on experience with such curious minds, hardly any scientific research has been carried out into the ways in which small children think. And that brings me to the topic you will be addressing today: how exactly do three to five-year old children think? And do some children already possess a certain aptitude, for instance for thinking logically?

In order to find answers to these questions, in September 2005 we initiated the multi-disciplinary research program 'Curious Minds'. Curious Minds does not focus exclusively on research, however. The people behind the program also advocate the preservation of creativity and curiosity. For if these qualities gradually die off – as they do in many people – it becomes impossible for a particular aptitude to develop. One could say: talent ripens where curiosity thrives.

That is why I believe that we should be open to curiosity and creativity. The complex issues facing our world demand young people who can contribute in unorthodox and creative ways to possible solutions. However, apart from social issues, such an attitude has many advantages. Life is simply more enjoyable if you have learned to think outside the box. If you have learned to stay curious.

It is, therefore useful to study how young children explain phenomena. How they establish connections and how they reason. And afterwards, to consider how a potential talent might be brought into blossom. And how parents, teachers and grandparents may be made aware of the ways in which they can contribute to that process.

Fortunately, there will always be grown-ups with curious minds too. Today, they have united around the symposium bearing the same name, in a unique diversity of academic disciplines. All of them are as curious about the thinking of toddlers and pre-schoolers as I am.

Maria van der Hoeven
Minister of Education, Culture and Science (2002-2007)

(preface from the program booklet of the scientific conference Curious Minds, organized by Curious Minds, 6th of March 2006)