"SCIENCE CAMP", a research program aimed at motivating youths to study engineering and make interaction between engineering and lower grade education like junior high school and high school.

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Abstract *— Science Camp is a research program aimed at motivating young people to study science, mathematics and technology. The program was first carried through in 2002 when near 100 teenagers from junior high school and their teachers participated in a 14 days long scientific investigation project. The junior high school pupils were guided and taught by engineering students from the Østfold University College in Norway. Teachers from junior high school and professors from the University worked out this project together. The camp was financed by the National education Office and the Østfold County Council. Science Camp was a great success due to the focus on creating motivation by introducing young people to mysteries, and use scientific equipment to investigate them. The Science Camp doctrine is that mysteries motivate to gain insight and knowledge. For over 100 years, mysterious lights have been seen flying around in a small remote Norwegian valley named Hessdalen. The intensity of their appearance made a peak in the period of 1982-1985. Lights were seen daily in this period, and the Hessdalen light phenomena became a world known tourist attraction. No scientific investigation has been able to explain the behaviour and existence of the flying light balls. Science Camp used this world renown mystery to motivate and the NASA Inspire program and Astronomy to gain insight into science, mathematics and technology. In the NASA Inspire program, the participants develop and use ultra low frequency receivers, to study electromagnetic radiation from space and ionosphere. The participants in Science Camp were taught to build and use NASA Inspire receivers & antennas to study electromagnetic radiation from the Hessdalen phenomena. In addition they were also taught astronomy and how to use optical spectroscopy to determine the composition of chemical elements in the phenomena. The participants were also using several other sophisticated instruments like RADAR, Geiger counters and radio frequency spectrum analysers. The "fire power" of modern science was given into the hands of teenagers to give them possibility to force the Hessdalen phenomena to give away its secrets. Two research bases and scientific equipment was established in the mountains together with a control centre down in the valley. The research bases could only to be reached by foot after climbing the mountains, and all communication was done by radio transmitters. The participants managed to detect the flying light phenomena several times, and the interest from media was huge. Several TV programs about this project were made. The pupil's web page from 2002 is still operational, see: www.sciencecamp.no . During the project, this page had over 37000 hits in joust 24 hours, an unbelievable interest! This interest was based on science, technology and mathematics, used in the challenge for unmasking a mystery. Plans is now being undertaken to make Science Camp open for teenagers from other countries in 2004/2005. Science Camp International is based on cooperation between USA (NASA Inspire, Goddard), Italy (Institute for Radio Astronomy, Bologna) and Norway (Østfold University College, Hessdalen).*

Index Terms *— Science Camp, K12 , lower grade research program, interaction between university & high school.*

BACKGROUND

The number of students that want to study engineering in Norway has decreased alarmingly since 1990. The number of applicants has decreased up to 50% for some engineering disciplines, chemistry maybe one of the most unpopular studies in Norway. This is also a common trend in most parts of Europe. Mathematics' and physics is not popular to study among pupils in lower grades, these subjects are regarded as difficult and uninteresting. Since young people avoid mathematics and physics, they also remove the theoretical basis for studying Engineering and natural sciences at the universities. The number of qualified applicants has decreased, and quality of the students is also decreasing since knowledge in mathematics' and physics is poorer. Since Norwegian universities are paid for each student that take courses, budgets is reduced and the quality of the education is becoming dangerously low. The future is not bright for engineering education in Norway, and the debate of closing down regional university colleges has started in the newspapers. Young people today are very concerned about the environment, and about pollution from industry. In fact the word "industry" has a very bad meaning to many young

people because of pollution and environmental problems. In the 1980's engineering education was popular and the universities refused amounts of applicants, this giving good budgets and economy for investing in up to date laboratory equipment. The education was well known and popular among pupils in lower grades, and the professors teaching engineering courses was used to have highly motivated and bright students. In these "good old times" the professors forgot to inform and motivate teachers at the lower grades about engineering education, and slowly the education became more and more invisible for pupils and teachers at lower grades. Marketing of engineering education towards pupils in lower grades did almost not exist before 2000, and no one at the universities knew how to do it. Another problem was that it was not easy to get in touch with the different schools at lower grades, everyone was autonomous and lived were well in its little closed world. And if they got in touch, what was the motivation for doing it? A lot of traditional information programs were carried out, like professors and students that went out to lower grade classes and gave away dull information about engineering education. This was not very motivating for either pupils at lower grades, nor professors from the universities. The traditional information programs did not create motivation and inspiration for studying courses based on mathematics and physics, subjects regarded by pupils as difficult and boring.

Number of applicants for studying engineering has decreased dramatically in Norway due to:

- **Pupils avoid mathematics and physics:** These subjects are regarded as difficult and uninteresting.
- **Environment protection:** Young people are not interested in working in industry with its pollution problems.
- **Invisible universities:** Interaction between universities and lower grade education did almost not exist before 2000.
- **Interaction without inspiration:** When interaction occurred, it was joust dull information exchange.

Something had to be done to make pupils regard at least physics as interesting and challenging. In 1998 Dean Terje Karlsen at Østfold University College, department of engineering and natural sciences, started to develop interaction projects for junior high schools in the county. These interaction programs was small physics and engineering projects guided by engineering students and professors, which teachers at junior high school could choose to use in their classes. These projects started the first interaction between university and lower grade education where motivation through collaboration of solving engineering problems was created. Focus was changed from information about engineering education, towards making collaboration projects for generating motivation and inspiration for studying engineering and natural sciences. Projects should target to motivate both teacher and pupils in lower grades, through collaboration. When collaboration projects were developed, focus was increased on the motivation aspect, and not so much on the learning effect. The projects should create motivation and inspiration to go on with studying physics and mathematics, not necessary deliver the knowledge itself. This created the MAMI principle, which was the pedagogical basis for Science Camp.

Evolution of interaction between university and lower grade education

- **Phase 1: Information programs:** Plain and dull one way information in classroom, given from engineering students and professors towards pupils in lower grades.
- **Phase 2: Collaboration projects:** Small collaboration projects guided by engineering students and professors, where junior high school pupils solve engineering and physics problems in teams.
- **Phase 3: MAMI projects:** Collaboration projects where focus is on creating motivation for further studying of engineering and natural sciences, not necessary to deliver knowledge

THE MAMI CONCEPT

Traditional textbooks in engineering and natural sciences, usually starts out with a formula to explain the problem, and other formulas to deliver insight and knowledge about the subject. I suppose that this is done to scare the student, and to show colleagues of the author how brilliant he is in mathematics……What could possibly motivate the student to go on whit the next pages? Fear of passing the examination I suppose! Inspiration and motivation about a mysterious problem disguised in an abstract mathematical formula is hard to create. After reading biographies about fa mous researchers from Newton to Einstein, it struck me that their research was motivated more from the mystery that they wanted to explain, than writing papers and solving equations. Modern scientists started to remind me more of the nights of the round ta ble and their chase for the Holy Grail, the grate mystery. Their motivation and inspiration was based on a mystery, and their whish to solveous it, not their desire to solve mathematical problems. The mathematical equations can not emerge before the myste ry is solved.

Since famous scientists are motivated by mysteries, why not motivate pupils and students by using mysteries as basis for motivation? Mystery is the key to knowledge. The mystery creates astonishment that enables the human process of wondering, and this again creates motivation and insight. This process creates a situation where students and pupils drive the learning process themselves, by their lust to solve the mystery. This is the MAMI concept for learning and project development.

The MAMI concept of learning:

- **M = Mystery:** Create a real mystery that astonishes and starts the process of wondering.
- **A = Astonishment:** Positive astonishment gives basis for wondering and motivation.
- **M = Motivation:** Creates a need for knowledge to solve the mystery.
- **I = Insight :** Need for knowledge creates insight.

If done right, the MAMI process can give a long term motivation for gaining knowledge and insight. It is like starting a treasure hunt, a game that children is very fond of, and sometimes remembers all through their lifetime. The quest for the Holy Grail is still going on today, a mystery that was created for 1000 years ago…….The problem is to find mysteries that will motivate young people to study mathematics, physics, engineering and natural sciences, and keep the interest over long time. This was done in Science Camp.

Motivation type	Degree of motivation
One way information	Low
Collaboration projects	Medium / High
MAMI projects	Very High

TABLE 1
MOTIVATION DEGREE REGARDS TO MOTIVATION TYPE

SCIENCE CAMP, SOLVING A MYSTERY

Science Camp is a research program aimed at motivating young people to study science, mathematics and technology by introducing them to an unsolved mystery in the nature. This kind of program has taken inspiration from traditional summer school programs and different kind of "Camp's" around the world, like the NASA "Sally Ride Space Camp", see picture 1. Table 2 lists some examples of Camp's and related motivation projects targeted towards young people.

PICTURE 1
POSTER FROM NASA SPACE CAMP PROGRAM AND SPACE CAMP FACILITIES IN TURKEY

Country	Project	Organisation	Web address
USA	Space-Camp	NASA	http://www.spacecamp.com/.
Belgium	Space-Camp	ESA	http://www.ping.be/eurospace/englishv.html
Norway	Space-Camp	NAROM	http://www.unge-forskere.no/space-camp/
Norway	SETI	ESA/UiO	http://www.norskfysikk.no/liu/index.html
USA	INSPIRE	NASA	http://image.gsfc.nasa.gov/poetry/inspire/

TABLE 2
EXAMPLES ON RELATED SCIENCE CAMP'S AND PROJECTS AROUND THE WORLD

The program was first carried through in 2002 when near 100 teenagers from junior high school and their teachers participated in a 14 days long scientific investigation project of the famous Hessdalen phenomena. The Hessdalen phenomena are an unexplained luminous phenomenon that appears in the air over a remote Norwegian valley called Hessdalen. The first 14 days long "camp" in the Hessdalen valley vas carried out inn September 2002, and repeated in 2003 and 2004. This "camp" in Hessdalen had the form of a scientific summer school for youths, and was the primary event in the whole project. The youths had to travel 600km by bus, from their home in southern part of Norway, to a remote and isolated small valley up in the mountains near the famous mining town Røros. The valley has only 150 inhabitants, and the main occupation for several hundred years has been mining and farming. From 7-14 days the pupils and their teachers had to live in the mountainside at approximately 1000m of altitude, half of this time at mountaintops where there was established base camps. These base camps were equipped whit scientific instruments, computers, radio communication, tents and sun cell power supply. All of this equipment had to be carried up to the mountain tops on the shoulders of the participants and by the use of horse. Headquarter was established down in the valley and controlled observations, security and radio communication 24h. All reports and data was transmitted to headquarter and published on internet, www.scienceamp.no. The whole period in the valley was carried through like a military operation, with 24h surveillance established by a rotating guard system. While someone slept, others manned the base camps and headquarter. Together with professors and students from the university, teachers from the junior high school worked together and lived on the mountaintops with the pupils. This operation was not possible to do without involving teachers and pupils at the junior high school in advance. The whole project started out 6 months in advance when pupils, their parents and teachers was informed and trained for this operation. Pupils and teachers visited the university and were trained to use the different kind of instrumentation that was put up on the base camps in the valley. Pupils and teachers was trained by students and professors from the engineering department at the university. Teachers from the junior high school and professors from the university visited the valley 8 weeks in advance of the "camp" and worked out detailed plans for the 14 day long operation in the valley. The teachers at junior high school also used the project in ordinary subjects at the school to exemplify mathematics, physics and other related topics. After the "camp" in Hessdalen, data had to be processed, reports had to be written and the result and experiences was to be presented for a public audience and the press. All of this was done by the pupils, under the guidance from university staff and their teachers. The project ended in January 2003, almost a year after the first step of the project process started. The different phases of the Science Camp project is shown in table 3, and the two base camps in Hessdalen is shown in picture 2.

PHASE NR	ACTION	DURATION
1	Pre project phase, information & motivation	8 weeks
2	Theory, instrument training & project work for pupils	16 weeks
3	Field and base camp inspection by teachers	1 week
4	Establish base camps and HQ in Hessdalen	1 week
5	Scientific field investigation, the "camp"	2 weeks
6	Post processing and data analysis	12 weeks
7	Presentation of experiences from project & data	2 weeks

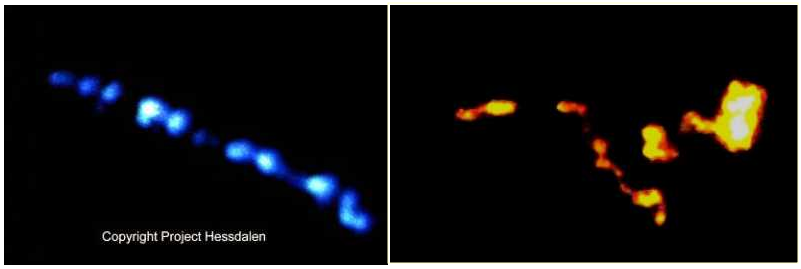
TABLE 3
THE DIFFERENT PHASES OF THE SCIENCE CAMP PROJECT

PICTURE 2
BASE CAMP "FINSÅ" AND "ROGNE" IN THE MOUNTAINS OF HESSDALEN VALLEY

The whole process of carrying through Science Camp took almost one year, with preparations and post project work. This period can be done shorter, but the stay in the valley with the scientific investigation, should not be shorter than one week. . The camp was financed by the National education Office and the Østfold County Council, and by voluntary work done by teachers, professors and students.

HESSDALEN VALLEY, AN UNSOLVED MYSTERY OF FLYING LIGHT BALLS

The Science Camp doctrine is that mysteries motivate to gain insight and knowledge, and the project team had to find a mystery so intriguing that it would motivate young people to speculate over physics and mathematics. The NASA and ESA Space Camps have huge resources, and pupils are highly motivated by the mysteries of the universe and the space crafts. Norway is a small country with no facilities like "Kennedy space centre" and no space shuttle program. No mystery is found in Norwegian fishing vessels and oil platforms in the north sea, like in the NASA space program. But in a small Norwegian valley, research has been carried out for over 20 years trying to solve a mystery about flying light balls, se picture 3.



PICTURE 3
THE HESSDALEN PHENOMENA PHOTOGRAPHED WHILE MOVING AND BLINKING

For over 100 years, mysterious lights have been seen flying around in the small remote Norwegian valley named Hessdalen. The intensity of their appearance made a peak in the period of 1982-1985. Lights were seen daily in this period, and the Hessdalen light phenomena became a world known tourist attraction. No scientific investigation has been able to explain the behavior and existence of the flying light balls. In 1998 a combined Norwegian and Italian research team installed a permanent observatory inside the valley. This team consisted of researchers from The Østfold University College and Institute for Radio Astronomy at the University of Bologna in Italy. This installation has since 1998 done automatic surveillance of the valley, and the data, films and pictures is found on: www.hessdalen.org. This web side and hundreds of newspaper articles and TV programs has made this phenomenon known all over the world. The web page has normally over 10.000 hits each day! Every year, pupils from all over the world requests permission to use the Hessdalen phenomena for thesis work. The research station, nicknamed "Blue Box", is filled up with equipment for optical and radio frequency spectrum analysis. Current instrumentation in "Blue Box" is shown in table 4.

Instrument	Supplier
Fluxgate magnetometer	Norway
ELFO extremely low frequency observer (0,1-20KHz)	Italy
Sentinel 1 spectrometer (1.42GHz)	Italy
INSPIRE Nasa ULF receiver (100-22000Hz) E-field	Italy
Raytheon EHF Radar & IRA UHF radar	Norway/Italy
Color + B&W CCD Stereo Automatic video rec. system	Norway
VHF & UHF spectrum analyzer	Italy

TABLE 4
EQUIPMENT INSTALLED IN THE HESSDALEN OBSERVATORY, CALLED THE "BLUE BOX"

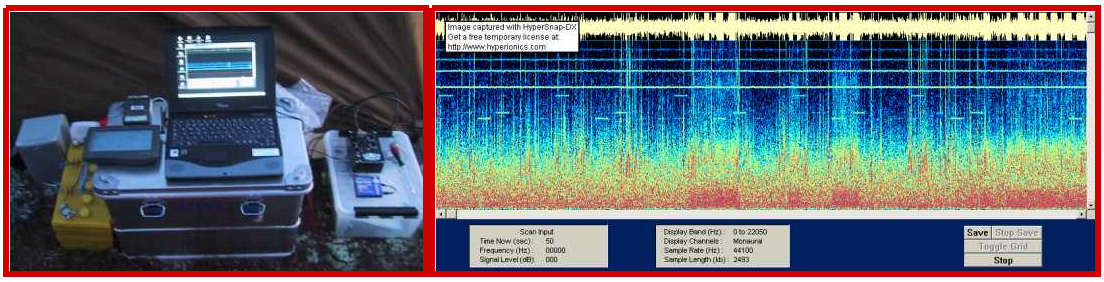
Despite 24h automatic surveillance from the Hessdalen observatory, and several scientific research campaigns, no answer can be given about why this glowing light ball appears in the valley, what the power source is and what it is made of. Theories is still unconfirmed, se table 5.

Theory	Speaker	Country
Ball lightning process/fractal structure	Prof. Boris Smirnow	Russia
Self restricted EM field	Dr. Gert H. Arnhof	Austria
EM standing waves & Tectonic stress	Dr. E.T. Protasevitch	Russia
Rotating plasma	Prof. Y.S Zou	China
Vorton driven ionizes gass	Dr. David Fryberger	USA

TABLE 5
INTERESTING THEORIES TRYING TO EXPLAIN THE HESSDALEN PHENOMENA

INSTRUMENTATION & PHYSICS, USED IN THE SCIENCE CAMP PROGRAM

Science Camp uses the Hessdalen mystery to motivate, the NASA Inspire program and Astronomy physics to gain insight into science, mathematics and technology. In the NASA Inspire program, the participants develop and use ultra low frequency receivers, to study electromagnetic radiation from space and ionosphere. Se picture 4. The participants in Science Camp were taught to build and use NASA Inspire receivers & antennas to study electromagnetic radiation from the Hessdalen phenomena. In addition they were also taught astronomy and how to use optical spectroscopy to determine the composition of chemical elements in the phenomena. Se picture 5.



PICTURE 4
NASA INSPIRE ULF RECEIVER AND GRAM SPECTROMETER & SPECTRE OBTAINED IN HESSDALEN DURING SCIENCE CAMP

PICTURE 5
NEWTON TELESCOPE AND OPTICAL SPECTRUM OBTAINED IN HESSDALEN DURING SCIENCE CAMP.

The participants were also using several other sophisticated instruments like RADAR, Geiger counters and radio frequency spectrum analyzers. The “fire power” of modern science was given into the hands of teenagers to give them possibility to force the Hessdalen phenomena to give away its secrets. The pupils were also given the opportunity to use all of the instrumentation in the blue box. Theory and physics was necessary to explain the operation of the different instruments, and insight was given into electromagnetism, radiation and the structure of light. Since the Hessdalen phenomena is supposed to radiate electromagnetic waves at high frequencies, and also touch ground, samples from possible landing sites was taken and subjected to chemical analyses. The use of geometry and mathematics was trained by using GPS, range finders and telescopes for taking out bearing and altitude angle. Night vision and infrared binoculars was also used during nighttime to detect and navigate. Radio communication was taught and trained by use of UFH transreceivers. Each base camp at the two mountain tops used two computers and other equipment that was in need for power. Sun cell panels, batteries and power supply equipment was installed and used. Batteries was charged during nighttime and used, discharged, during nighttime. This was a very good example for teaching electricity theory. Tree different astronomical telescopes were used, Newtonian, Makustow casegrain computer controlled and traditional focal 1200mm telescope. The view of the Milky Way was fantastic at the mountain tops and astronomy was easily taught during these nighttimes of observation. Traditional 35mm cameras was used with lenses and different films, like high speed and infrared film. Two cameras was equipped with optical gratings to obtain the optical spectra and determine the Frauenhofer lines, and thereby find the chemical composition of the phenomena. Weather stations were used on both base camps, and air pressure, humidity, air speed etc was obtained every hour and meteorology was trained.

CONCLUTION

100 pupils from the junior high school at Marker and Hafslund and their teachers participated in science camp 2002. In 2003 30 pupils coming out from high school and starting up as students at the Østfold University college participated. This was to find out if the older pupils were more suited for attending Science Camp, what was suspected in advance. This did not happen! The older pupils around 18-20 years were more difficult to motivate and teach, regards to the younger ones at 14 ears from junior high school. It was supposed that more knowledge and higher age would make the participants more able to attract knowledge and to motivate, this was not the case. The older ones were afraid to show lack of knowledge, and played uninterested in an attempt to cover up. The younger ones in junior high school were interested and playful, and had no limitations regards to ask questions. Back in the town the junior high school pupils regarded the camp in Hessdalen as one of the most interesting things they had done in their life, and they wanted to go back to the mountains. Their interest was easy to trigger and they was easy to teach. The elder ones started first to ask questions six months after the camp was over, when they felt they had enough knowledge to ask! Based on these experiences, whole classes from junior high school is most suited for this type of camp. Pupils who attended the camp in 2002 is still asking me of the possibility to attend a new camp. The most surprising evidence of success was that the web page *www.sciencecamp.no* on the second day of the operation in Hessdalen had over 37000 hits! This project has also given inspiration for professors at the university to work together with teachers at the lower grades like junior high school. The project will be carried on in 2004/2005.

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