Space Science: Developing Scientific Awareness amongst Middle to Senior School Students

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ABSTRACT

This paper will investigate a space science elective and how it relates, links and promotes real science, and authentic projects and initiatives. It will discuss the Space Science elective operating at St Joseph's School Northam, Western Australia at a Year 10 level and the activities and research conducted leading up to and including the space science field exercise that occurred in 2008. Space science is a full year long elective course offered to Year 10 students attending St. Joseph's School. The course explores the four main branches of science; biology, chemistry, geology and physics, through practical assessments and research, investigations and experiments that mirror authentic scientific initiatives, projects and endeavours. The culminating practical assessment was the field exercise at the end of the academic year. The 2008 space science field exercise was the culmination of the year's projects, and the combined efforts of the five members of the class to put their projects to the test. The Space Science course develops students' interest in science by allowing them to investigate for themselves science and its application to the wider world and through this can explore the diverse career opportunities within a Science framework.

KEYWORDS

Space Science, Hydroponics, Rover, Tethered Balloon, Spacesuit, Spaceward Bound Australia One, Model Aircraft, Field Exercise.

1. INTRODUCTION

The structure of the Space Science Course is mapped accordingly to the four school terms; first term designing mission patches; second term constructing model aircraft and researching their significance; and third and fourth term working on individual projects that culminate in a day long, field exercise just before the end of the academic year. This outline extends students, exposing them to science and all that this offers, making them far more aware of science and the direct role it plays in our everyday lives, and finally develops significant interest through practical tasks that link to the wider scientific community contrary to other science classes that often involve learning out of a textbook with irrelevant examples of science in everyday life. (10)

2. MISSION PATCH

In first term, students were asked to design a mission patch for the Spaceward Bound Australia One Expedition. However, designing the patch involved more than just being able to design aesthetically pleasing images on the computer. Designing a mission patch involved a lot of research into the plan, aims and goals of this Expedition. The mission of the Spaceward Bound Australia-One expedition was to train the next generation of space explorers, done by allowing students and teachers to participate in the exploration of areas that are scientifically interesting, of historical, aeronautical and astronautic importance, as well as areas of geological and astrobiological significance, within the areas of Woomera, Arkaroola Wilderness Sanctuary and Wilpena (Rawnsley Park) (16). Involving students and teachers into this process of investigation, it enables an understanding of these areas as analogues for human exploration of the Moon, and Mars. After identifying the purpose of Spaceward Bound, and then specifically the Australia One Expedition, students then needed to identify the significant points and relevant space information of the mission, and to then find significant symbols that linked to these.

Figure 1 - The Winning Patch; Designed by Adriana Spadaccini from St Joseph's School in Northam WA

The winning patch was designed by Adriana Spadaccini (As seen in Figure 1), a member of the St. Joseph’s School Space science class. Her completed patch included the Southern Cross constellation, to identify the role that Australia has in this expedition. It also included a depiction of Mars, representing that the expeditions are Earth Based, but are of the purpose to prepare technology, scientists and astronauts and for a future Mars mission. The patch includes also an orange Government Aircraft Factory (GAF) Jindavik pilotless aircraft. This aircraft, which features prominently in Missile Park at Woomera today, was seen as an important moment in Australian aviation and space history, from its first launch in 1952 being used in various capacities and being ordered by Sweden, the United Kingdom and the United States Armed Forces. The Jindavik was seen as the most versatile, reliable and economical subsonic target aircraft produced anywhere in the world. (18), therefore important for this patch and what it represents. Pictured adjacent to the Jindavik is a US Redstone rocket, with the Weapons Research Establishment Satellite (WRESAT) aboard. This is highly relevant to the Woomera area because, on 29th of November 1967, WRESAT was launched aboard the Redstone rocket, which was the only example remaining after the Sparta programme.

This made Australia the fourth, debatably the third (The French launched in 1965 from Algeria), country to launch a satellite from its own territory – this is symbolic of the emphasis placed on the historical side of Australia's link to aerospace, and the link to the Woomera Area throughout the expedition. In addition, in 2007, the American Institute of Aeronautics and Astronautics (AIAA), designated the Woomera Test Facility as a Historic Aerospace site, placing it in the same league as Kitty Hawk, North Carolina and Tranquility Base on the Moon. Spaceward Bound in Australia is the conjunction of MSA in association with NASA and therefore is the reason as to why both of the logos are positioned and feature prominently on the Patch.

Through the designing of the mission patches, the students within the Space Science class were able to gather and share information relevant to the history of space science, aerospace, and space all significant to Australia, with an application and a purpose, therefore making the learning interesting and more realistic.

3. MODEL AIRCRAFT BUILDING

This method of learning was again applied through the building model aircraft. Not only were engineering skills required, but also a research paper investigating the significance of the aircraft and the role the craft played in the history of aerospace and aviation. Each aircraft modelled had made a particular contribution to the aerospace world. The models selected, were, the Messerschmitt Me 262, the SR71 (also known as the Blackbird), the F-117 Nighthawk (otherwise known as the Stealth Fighter), and the Aérospatiale-BAC Concorde. Through individual research and a brief presentation, summarising the research paper, it was discovered that the Concorde, was the first supersonic passenger airliner with only 20 examples constructed, effectively only operated by 2 airlines, the Nighthawk was a US stealth ground attack aircraft that operated for 5 years under total secrecy, and was the first operational aircraft to be based upon low-radar return technology, the SR-71 Blackbird was an advanced long-range, Mach 3 strategic reconnaissance aircraft and the Messerschmitt (Me 262) which became the first operational jet-powered fighter aircraft in April 1944. (27). This project assisted in developing an understanding and an appreciation for aviation and its significance to current aerospace technology in a realistic manner that provided a clear purpose and easily attainable objectives.

4. SECOND SEMESTER PROJECTS

The second semester of Space Science required each student in the class to select a project from a short list and spend the following two terms conducting research on their chosen topic. The majority of the research being conducted was in the form of tests, trials and various experiments. Most of the data accumulated from this research was put to use at the conclusion of the semester on the space science field exercise. The projects chosen consisted of, designing a mission plan, engineering a rover, creating a spacesuit, and building a tethered balloon. A hydroponics system was also constructed, however, this project did not play a direct role on the day of the field exercise, rather it was a supplementary project, providing additional research, information and knowledge, on the topic of space science.

4.1 HYDROPONICS

Hydroponic systems are a relatively new and more efficient method of agriculture. They provide larger plants and a bigger yield, both of which can also be harnessed in areas that are non-arable. For these reasons hydroponics is being harnessed in the space science world as it can provide astronauts on long journeys with fresh food and a production source that is efficient. Hydroponics will also be a major part of the agriculture within future space settlements, specifically on Mars, providing a form of agriculture that will not rely on the nutrients found within the soil, and rather, will not restrict settlements to certain areas of the planet.

The aim of this hydroponics project was to yield a harvest from a variety of different plants in a hydroponic system and to thus discern which species would be the most suitable species to grow in a situation where harvest needs to be maximised, in the shortest amount of time. To achieve this aim it was necessary to decide upon which type of hydroponic system to use, by researching the advantages and disadvantages of each one, and weigh them up with the restrictions and limitations that a school environment provides.

From this prior research the decision was made to construct a flood and drain system. The system comprised of three levels (Refer to Figure 2); on the bottom level was a bucket containing the nutrient solution and a pump, known as the reservoir, which pumped the solution to the top most level, to where, it was dispersed through poly pipe due to gravity into four individual buckets on the middle most level, each bucket contained a different species of plant, asparagus, tomato, radish, and turnip seedlings, within these large black buckets, was a smaller green bucket, which held two Rockwool cotton cubes covered by an upturned plastic yoghurt container with small holes dotted in to it to disperse the solution. This allowed the solution to shower the seedlings, without damaging their vulnerable stems. The Rockwool cotton cubes absorbed the solution, and any excess could be drained away through the holes in the green bucket. The solution then travelled through a poly pipe to the bottom most level, back into the reservoir to travel the through the cycle again.

Figure 2 Brittany Hunter tending to her Hydroponic System

A flood and drain system works by flooding the plants with nutrient solution, which throughout this project was Dutchtreat, mixed at 5ml per 1L water, at regular intervals and then allowing the solution to drain away. This process was controlled by the pump, and due to limitations in apparatus, a timer for the pump could not be sought, thus, the entire system relied on the student to turn the pump on and off. In an ideal situation the pump would usually run for approximately 15 to 30 minutes twice to four times a day, however, it was extremely inconvenient for the student to be excused from class constantly to do so, therefore, the pump was run for approximately an hour each day of the school week, and on weekends and break periods the system was unable to be run due to an obvious denied access to school grounds by students and also by staff, creating problems with consistency in measurements and recording.

Once the system had begun it was important to maintain the system through daily upkeep. This involved ensuring that the temperature of the solution remained between 18 to 24 degrees Celsius, and upheld a pH of 5.8 to 6.8. A maintained volume of nutrient solution in the reservoir needed to be kept in order to keep the levels of fluid high enough so that the pump could continue to function. The system also needed to be checked daily for any leaks, cracks, or other malfunctions. Failure of the system equated to failure of the project, and thus, the upkeep was a main focus throughout the project.

Once the system was set up and checked for any errors, it was crucial to track the growth of each species in the form of qualitative and quantitative measurements, through observation and to distinguish which species had the largest, and most edible element ratio in respect to their size. These daily results would provide the data to prove or disprove the hypothesis.

As the project furthered and neared the end of semester, the asparagus, tomatoes and radish all wilted before there was a chance to rectify their sudden stunt in growth. Only the turnip lasted, but because the end of the year was drawing to a close, the project was cut short and thus, not one species of plant saw fruition. This meant that the data collected was insufficient in order to prove or disprove the hypothesis. This led to all the results, notes, and research, including the write-ups; being held and passed on to the next space science class and specifically the next student that takes on and further develops this project. This availability of research and experiment procedures is common practice in scientific society, as many scientists want to imitate others experiments, in order to retrieve their own set of data or for their own research.

Although the project seemed as though it achieved minimal results, as it was unfinished and all but one of the plants died, it provided the student who took on this project, an insight into the scientific world, with skills of analytical nature, research, planning, engineering, but most importantly it gave the opportunity to work as an individual, without a textbook or a teacher there to guide or direct, to make individual decisions, and obtain results, to prove the students own hypothesis, from their own research, which came from their choice of project – hydroponics.

4.2 FIELD EXERCISE

The second semester also brought the field exercise. The field exercise was a day long task that was carried out on school campus in an empty block, approximately twenty by thirty metres. There were previous arrangements to carry out the exercise at Burlong Farm, which is a farm property 8 km west of the township of Northam and used extensively for other science activities such as rocket launches and astronomy field nights and other school related activities such as cadet activities and orienteering, but due to extremely poor weather conditions on the first occasion and a lack of transport on other proposed dates throughout the term, those arrangements could not proceed, this alternate venue was then confirmed. The projects to be prepared for this day were the remote rover, the spacesuit, the tethered balloon, and a mission scenario for the entire day.

The teacher of the Space Science class Mr. Mark Gargano, acted as the speaker at fortnightly meetings preceding the field exercise, to keep all the projects, and the students, coordinated with each other.

These meetings connected to genuine best practice, similar to that of NASA briefings, which helped support the authenticity of the field exercise.

4.3 MISSION PLAN

The field exercise, was in the format of an off world mission, in that the four members of the Space Science class were a realistic mars surveyor team, with one of the students being appointed Mission Commander. The role of Mission Commander involved developing a step by step, realistic mission plan for the Field Exercise. The completed mission plan, worked as follows;

4.4 TETHERED BALLOON

The first phase of the mission was a photographic reconnaissance. In realistic missions this is almost always the first phase of the mission, and requires low altitude satellites or balloons, or unmanned aerial vehicle technologies to provide a photographic reconnaissance of the area that will be further surveyed, to attain a brief outline to the environment, and to highlight areas of further interest. In the St. Joseph's School field exercise this phase of the mission involved the tethered balloon. Unfortunately the tethered balloon project was unable to be constructed due to many complications, difficulties in construction and with modifying existing components and time constraints that exist within a school-based elective. The projected aim for the student constructing the tethered balloon was to design and construct a low altitude tethered balloon installed with a camera, to provide live footage back to mission control, and to complete an aerial reconnaissance of a designated area during the field exercise. To achieve this aim, the student needed to test variables, which included the number of balloons, the number of tethers, the way in which to attach the camera and the simplest way to control the balloon. However, because the tethered balloon was not constructed these tests were not undertaken, and therefore are no results.

This project is similar to the current Australian Space Research Institute (ASRI) HABx (2) project which is part of a sequence of balloon flights, that are most likely to take place in Woomera, that are developing High Altitude Ballooning technology. This aim will be achieved by ASRI by developing a launch, tracking, control and retrieval capability for a wide range of high altitude balloons, which are to include radio transceivers and computers that can be used to record and broadcast live data. While this project concerns high altitude balloons, it is still similar to the tethered balloon in the means of developing technology to broadcast live footage, but also similar in that of tracking and control. This connection to authentic projects strengthens to reality of the Field Exercise, and in turn provides the students with a realistic goal and a wider and more achievable aim and goal for their project.

The tethered balloon project, being incomplete, meant the team surveyed the area instead, by taking 15 photos pre-determined via a hand drawn map based grid-reference system to be uploaded to a computer as to sketch a map from. From this the team was able to plan the next phase of mission, by identifying specific areas of further interest, and where the first robot ground team should be sent.

4.5 ROVER

The next phase of the mission required the capabilities of a robot, the rover. The aim of the rover project was to design and construct a rover that was able to be remotely controlled, to cover a medium range of off road terrain that could obtain live feed to send back to mission control. The purpose of the rover in a real life application is to survey the areas deemed as interesting from aerial reconnaissance at a closer, more detailed level, before an Extra-Vehicular Activity is undertaken.

The rover used was designed jointly by two students in the Space Science class. The rover was based on the structure of a remote control tractor, which through re-designing and adding specific selected parts for both function and aesthetics was altered enough to be sufficient in fulfilling their aim. The rover was altered by adding a camera to transmit live footage to a receiver. It was also installed with a battery pack that had two rechargeable batteries, one for use, and one for replacement. The rover was also given artificial solar panels to add to its realistic look.

Prior to the field exercise field tests were carried out to ensure that the rover would be able to handle its role on the day of the field exercise. These tests included the length of battery life, the distance the rover could transmit from, and the ability of the rover in terms of terrain.

The rover on our field exercise was controlled remotely by mission control back at base to where they obtained live feed from the camera attached to the rover. The instructions from mission control where given to the field operator by two way radio to investigate further the areas that were interesting.

Real life applications of the rover can be seen in the research being conducted by Crew Number 71 at the Mars Desert Research Station. One of the projects completed by crew 71 while at MDRS, was testing how the Husar 2D Autonomous Rover (5) help humans on an expedition. The rover was used, to send data from its webcam and thermometer via a Wi-Fi connection to the Mission base. The rover designed by our students, is simpler but demonstrates a similar aim but simpler design to this rover.

During the mission, the rover became stuck, after reversing into a hole, and the team of students were required to make some decisions about solving this problem on-the-spot, to successfully complete the mission. The team came to a quick democratic decision to send out a retrieval team to bring the rover back to base deciding to send out a two manned retrieval team, with the objectives to firstly, collect the rover and secondly, investigate one of the areas outlined as scientifically interesting by collecting samples, this way maintaining the mission objectives. As this phase of the mission was unplanned, it called for quick thinking, co-operation, and collaboration of the team, but as well as this, it incorporated the failures that are a part of real scientific projects in the wider world. Thus enhanced the day's experiences, by demonstrating other skills that are required and can be obtained from practical work such as this.

4.6 SPACESUIT

To continue the reality and authenticity of the field exercise the students were required to wear spacesuits when going out into the field. This became a project for one of the students in the Space Science class. The aim of the spacesuit project was to create an earth-like environment for the astronaut or student, when on a simulated EVA during the field exercise. Unfortunately the student involved with this project also found that the depth and scale of the project was far too great for a six month program of only 100 minutes per week and thus, the suit used, and tested, was an analogue early version suit, borrowed from the Mars Society Australia.

The Mars Society Australia analogue suit consisted of, overalls which provided as the outer layer of the suit, which had many pockets, to substitute as the tool belt. Flexible gloves provided as the inner layer of protection, and larger gloves with grip provided as the outer layer of protection. A backpack was used to house the battery. Extra mass was added to the backpack to simulate the weight that an astronaut would be required to carry during a real EVA in space. Finally plastic tubes were connected to a fan within the backpack, which simulated delivering oxygen to the plastic bowl arrangement, which substituted for an actual helmet.

The student carried out various tests on the suitability of the suit from a qualitative personal point of view, the major summary of these results were that the helmet needed to be attached in some manner to the suit itself. However, in the school environment, this arrangement would be inconvenient to do so. Despite this limitation the suit itself allowed for a range of comfortable major movements required of a person. However as the mass added to the backpack increased, it brought reduced movement and comfort of the entire suit.

Though when viewing these results, it is important to remember that a small 15 year old girl was testing the suit and two things were noted. First, she was still growing so tests conducted at the beginning of the semester compared to the end of the semester may have been influenced by differences in size that engineers designing suits for adult astronauts would not need to consider. Also that she would not have the strength of most of the current astronauts in the world, both male and female, who are older and as a part of the training process are expected to complete extensive physical training and conditioning over many years. There were also tests performed on the gloves of the suit, with the results showing that fine motor skills and significant dexterity of the hands are greatly reduced when wearing the gloves.

These findings were investigated further and were found to coincide with the current studies into Gloves of EVA suits (25) These studies show that Gas Pressurised Suit Gloves, similar to the gloves of the Mars Society Australia analogue spacesuit, take up to 6 times longer to perform tasks than with the bare hand. Other research shows that there is a dire need for improved spacesuit technology, as the current gas pressurised EVA suits are a severe hindrance to astronaut function and capability. This is why MSA has been developing analogue MarsSkin technology, which is a Mechanical Counter Pressure suit, or MCP. MCP technology works on the basis of physically compressing the body with tight fitting garments. The student on this spacesuit project was fortunate enough to borrow one of MSA's analogue MarsSkin's (15), and was fortunate enough to be able to wear this, underneath the overalls, to act as an inner layer of protection. The development of this technology will allow astronauts, a greater range of motion, more dexterity, and a more light-weight suit when compared to its EVA counterparts.

With the use of the spacesuit, the retrieval team could achieve both of their outlined objectives successfully within the given time limit. This time limit imitates limited oxygen that real astronauts would experience and have to work with while on authentic EVA's.

The next phase of the mission, was planned, and involved a second EVA again harnessing the spacesuit. The second EVA, for safety reasons decided upon by the whole team, a different two manned team were sent out into the field to collect samples from another two areas outlined as interesting from both the rover and aerial reconnaissance. This phase was completed successfully, again within the time limit of the 'limited oxygen', all samples were collected and all interesting areas were visited.

Again mirroring authentic scientific practice, the samples collected from the field were brought back to the laboratory to be analysed. This analysis was carried out in a fashion of looking at the sample under the microscope at the crystalline structure and for microbial growth, pH testing with Universal Indicator (UI) and with digital actual digital probes, carbonate testing, and putting a sample of each area into pre-made sterilised agar plates to potentially identify long-term what was microscopically was present and to identify the types of rock present within the field. This analysis led the students in the class to pose questions about the samples and to investigate further why and how the students got the samples they did. The results from the samples allowed the students, a greater understanding of the environment in which they executed the field exercise. This process incorporated the geological science within the Space Science course, as well as incorporating analytical skills and observational skills.

4.7 REVIEW OF THE FIELD EXERCISE

When the mission commander reviewed the field exercise at a later date, they found that the exercise ran relatively smoothly. The team of two females, and two males, was highly desirable in the field exercise situation, as current teams for space missions, are comprised of approximately four people. Although the research into the ratio of gender is still current, the mission commander found that a two female and two male team was an ideal combination. The equal ratio of female to males assisted in the decision making, as the opinions and attitudes of one gender were balanced by the other. However, the smooth running of the field exercise was due majorly to the thorough preparation on behalf of the entire team.

The student found that as the leader of the team it was necessary to combine and adapt different leadership styles to different situations. Often requiring an assertive, quick decision and problem solving, dictatorship style of leadership, but at others a knowledgeable, respectful, democratic leadership style was required. Communication difficulties with the controller of the rover comprised the only complications throughout the day. The student found that when communicating instructions to the controller it was necessary to take a calm tone with a very clear voice, and to make instructions simple and step-by-step, and when things went wrong to not get irritated, but to clearly explain the problems, and be respectful of the other person. The student’s role as mission commander was enhanced by their previous experience they had as a mission commander at VSSEC on the ‘mission to mars’ (22). Previous experience of the difficulties and complications involved with these types of exercises, allowed the mission commander to be a better leader, because of the greater experience.

5. CONCLUSION

The Space Science elective is a subject that encompasses the four traditional branches of science; physics, chemistry, biology and geology into real life applications. Space science develops students by allowing them to investigate real science that links to authentic projects in the wider world. Space Science is captivating and successful as a Year 10 school subject because it’s real. The class offered at St. Joseph’s wasn’t reading out of a textbook and listening to teachers lectures like other science classes. Space science was hands on, and allowed students to see for themselves the applications of science in the world and develops a strong understanding for the subject. Space science offers a purposeful concept of science by connecting each project to genuine, current research and studies, which gives students the feel that what they are doing is real and the work they were putting in meant something more than a grade. This is significantly important because “mastery of scientific content is only half of our curricular intentions, the other half is that “students *always* learn scientific concepts *in a context, with a purpose*” (10).

To scientifically develop the current generation of students, and the students of the future we need to develop scientific literacy, which according to the Status and Quality of teaching and learning of science in Australian schools, “Scientific literacy of students is the main purpose of school science education. Scientifically literate persons will be able to contribute to both the social and economic well being of Australia.” Scientific literacy can be developed within the space science elective offered at St. Joseph’s School in Northam because “The teaching and learning of science is centred on inquiry. Students investigate, construct and test ideas and explanations about the natural world.” (10)

The first decadal plan for Australian Space Science States; “Space is a unique source of inspiration, with the potential to draw young and not so young Australians into science, engineering, mathematics, and other studies that develop their talents into skills and capabilities increasingly needed by the nation.” Australia needs space science, every Australian relies on the spin offs of space each and everyday without even realising it. On an international level, Australia needs to develop its space science sector, to maintain is strong global status, and influence amongst the world. With the possibility of Australia winning the rights to the Square Kilometre Array, (3) interested and qualified, engineers, astronomers, and other scientists will be essential for the SKA to go ahead and to be internationally and nationally successful. To upkeep the current scientific systems within Australia such as the nationally recognised Bureau of meteorology and the facilities at Tidbinbilla, interested and qualified scientists of this current generation will be essential for any form of development within these sectors and for greater development of Australia.

On a national level space science will provide technologies that will undoubtedly improve the quality of life of many Australians. This is exampled in hydroponics. As well as the space science application, hydroponics also holds a lot of value in 21st century society, because due to more population, there’s less room for agriculture but a greater demand for food, with these restrictions hydroponics will allow for a more secure form of agriculture than those currently in place. Rovers, and robotic technology, will also provide a major use in security, surveillance and safety monitoring.

On and individual scale space science develops skills that are useful to real life applications and other learning areas. Students in the class recalled gaining and furthering their skills in “leadership, communication, problem solving and interdisciplinary skills; all skills that can be applied to other areas of my life, not only specific to science and space science.”

So “At this time the greatest priority, is to improve the quality of school science in the compulsory years of secondary schooling so that all students can experience a science education that will make a difference in their lives, and attract our best young minds into science research and careers to make Australian industry internationally competitive.” (10)

And to this; Space Science is the key. To ensure development amongst the nation of Australia, and more importantly nations of the world, middle to senior school students need to be exposed to classes similar to that of the space science elective offered at St Joseph's School in Northam to develop scientific awareness to keep the great nations of the world, just that, great.

References

1. Alexander, T. Parker, D. 2002, *The Best of Growing Edge,* Volume 1, New Moon Publishing. Inc., Corvallis, Oregon.

2. Australian Space Research Institute (ASRI) 2009, Australian Space Research Institute, Australia, viewed 20th of May 2009, <*http://www.asri.org.au/web/HAB*>.

3. Australian Square Kilometre Array Project (AuSKA), viewed 8th of June 2009, <*http://www.ska.gov.au/Pages/default.aspx*>

4. Beatty, Thomas 2002, National Aeronautics and Space Administration, Washington, DC, viewed 8^{9h} of July 2009, <*http://www.nas.nasa.gov/About/Education/SpaceSettlement/teacher/lessons/contributed/thomas/hydroponics/hydroponics.html*>

5. Boros-Olah M., Hargitai H., Hirsch T., Kereszuti A., Muhi A., Tepliczky I., (2009) '*HungaroMARS2008: Analog Research in the Education of Planetary Science*.' 40th Lunar and Planetary Science Conference.

6. California Science Centre 2008, California Science Centre, Los Angeles, California, viewed 8th of July 2009, <*http://www.californiasciencecenter.org/Exhibits/AirAndSpace/AirAndAircraft/BellX1/BellX1.php*>

7. Clarke, Jonathan D. A., Willson, David, 'Exploration Radii at the Arkaroola Mars-Oz Site: Implications for Mars', Mars Analog Research, Volume 111, pg 129 – 146, viewed 20th of June 2009, Science and Technology Series, American Astronautical Society, AAS 06-259

8. Conrad, Linda 2007, National Aeronautics and Space Administration (NASA), Washington, DC, viewed 8th of July 2009, <*http://quest.nasa.gov/projects/spacewardbound/alums/gargano/2008july.html*>

9. Curry, Marty 2006, National Aeronautics and Space Administration (NASA), Washington, DC, viewed 8th of July 2009, <*http://www.dfrc.nasa.gov/gallery/photo/X1/HTML/index.html*>

10. Gargano, M. (2007), 'Space Science and Education: Sparking, Signing and Securing The Space Generation', Mars Society Australia, 2007 Australian Mars Exploration Conference

11. Goodrum, D., Hackling, M., Rennie, L. (2000) *'The Status and Quality of Teaching and Learning of Science in Australian Schools'*. A research report, Department of Education, Training and Youth Affairs, Canberra, Australia.

12. Greentrees Hydroponics 2009, Greentrees Hydroponics, Vista, California, viewed 9th of July 2009, <*http://www.hydroponics.net/learn/hydroponic_gardening_for_beginners.asp*>

13. Hydroponic Systems, Growing and Gardening 2007, Hydroponic Systems, Growing and Gardening, Australia, viewed 10th of July 2009, <*http://www.australianhydroponics.com.au/types/hydroponics-flood-and-drain-pot-system-23/*>

14. Jet Propulsion Laboratory, California Institute of Technology 29th of May 2009, National Aeronautics Space Administration (NASA), Pasadena, California, viewed 1st of June 2009, <*http://marsrovers.jpl.nasa.gov/home/index.html*>

15. Lagarde, Jean 2008, The Mars Society, Lakewood, Colorado, viewed 8th of July 2009, <*http://www.marssociety.org/portal/Members/jlagarde/spaceward-bound-au/*>

16. Laing, J., *'Jarntimarra 1 Scouting Expedition, Steps towards Mars through the Australian outback, Media Kit'*, Mars Society Australia, viewed 28th of October 2009.

17. Mars Society Australia 2008, Mars Society Australia, Clifton Hill, South Australia, viewed 8th of July 2009, <*http://www.marssociety.org.au/*>

18. Model Airplane Factory 2009, Model Airplane Factory, Scottsdale, Arizona, viewed 8th of July 2009, <*http://www.modelairplanefactory.com/index.php?main_page=product_info&products_id=613*>

19. Morton, P., *'Fire across the Desert'*, 1997, Australian Government Publishing Service, Canberra, ACT, pp. 361-373.

20. Rigby, Mark. T. 2001, Rigby, Mark T., Woomera, South Australia, viewed 8th of July 2009, <*http://homepage.powerup.com.au/~woomera/wresat.htm*>

21. The Hydroponic Warehouse 2002, The Hydroponic Warehouse, Brisbane, Australia, viewed 8th of July 2009, <*http://www.aquagardening.com.au/what/default.htm*>

22. The Steering Committee 2008, '*First Decadal Plan for Australian Space Science: Building a National Presence in Space'* ,The Australian Academy of Science, National Committee for Space Science (NCSS), Draft Release.

23. Victorian Space Science Education Centre (VSSEC) 2009, Victorian Space Science Education Centre (VSSEC), Strathmore, Victoria, viewed 5th of June 2009, <*http://www.vssec.vic.edu.au/programs/sp_mars.asp*>

24. Viotti, Michael 2009, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California viewed 13th of July 2009, <*http://marsprogram.jpl.nasa.gov/msl/mission/overview/index.html*>

25. Vitamins Diary 2009, Vitamins Diary, viewed 11th of July 2009, <*http://www.vitaminsdiary.com/nutrients/hydroponic.htm*>

26. Waldie, J. M. A., Cutler, N. A., '*The Flexibility of Mechanical Counter Pressure Spacesuit Gloves*', Mars Analog Research, Volume 111, pg 161 – 174, viewed 20th of June 2009, Science and Technology Series, American Astronautical Society, AAS 06-261

27. Wikipedia 2009, Messerschmitt Me 262, viewed 11th of July 2009 <*http://en.wikipedia.org/wiki/Messerschmitt_Me_262*>