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THE NEW SPACE RACE INITIATIVE

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Abstract:

This project is a follow up to the initial New Space Race study by Elko et al, (2004). The current report is a review of economic, political and technological implications of a space race to the Moon between the United States of America and the People's Republic of China. Our team considered the added implications of technological breakthroughs not considered in the prior report. The changing levels of American public support in the success rate of NASA and its plans to return to the Moon, is a second added feature. The impact of public knowledge on the level of public support is studied as well.

Introduction

In the twentieth century it was recognized that whoever controlled near space probably could control the world as well. As a result, the world watched as the United States and the Soviet Union raced to develop space programs that would grant them control over this new "high ground" region. With several successful manned Moon operations and the collapse of the Soviet Union, the United States has claimed space supremacy for the last few decades. However, Russians have spent more time in space and are the Earth's Space Station experts. Hence, the combining of the US and Russian efforts in the International Space Station was a significant technological as well as symbolic political moment.

However, given President Bush's announcement of the United States' plan to return to the moon and the Chinese National Space Administration's progress in developing a manned space program (in the hopes of constructing lunar bases), are we on the verge of another space race? If so, what would its socio-technical implications be? The idea of a China-USA match up is not as topsidedly in favor of the United States as one might think. The Chinese National Space Administration (CNSA) has access to all the Russian technology to use as a starting point. The Shenzhou capsule is a three-man craft, really an improved, enlarged, and upgraded version of the Soyuz. This is hardly starting our with suborbital Mercury mission flights. Further, NASA is not really

interested in the Moon, but has its eyes on being first to reach Mars. Hence, while the United States tries to build a spacecraft capable of supporting a six month (that is a one way trip) Mars mission, China just has to build a system for a 3 day trip to the Moon. Further, they will be using a system which has already been used to reach a space station, and was designed as part of the "moon race" systems, as a starting point. This is hardly a level playing field, in which the two agencies are starting from about the same place and planning to do the same thing.

The knowledge base to deal with questions about the implications of a second moon race has increased considerably since the first IQP report by Elko et al. was written on the subject three years ago. Many of what we consider to be the key issues have changed, but some are similar to the issues that Saunders and Elko et al. identified. This report will cover relevant questions and provide updates to those issues that are still important as we consider known changes in technology and policy in the years since the original study.

In order to provide steady connection to a Moon base and then a self sustaining mining colony on the Moon, current technology will need to become more efficient as well as develop in new directions. This report will cover the rate of technological advance, as well as the likelihood that there could be some technological breakthroughs that vastly change the face of space exploration and habitation in the near future. It is

important to note that many of the questions discussed herein will have vast economic and social effects on Earth and in the new communities in space, and it is our belief that these questions will be answered in the decades to come, by people currently in grades 7-12. Hence, we take a glimpse of the future by studying their perceptions, attitudes and beliefs now.

The major oversight of the prior study is, in our view, lack of attention to shifts in public opinion about space. They saw the space program as grounded in international politics and we see it as grounded in domestic culture and beliefs, an outgrowth of American (and Russian/Chinese) worldviews and self image. Others have made the point that NASA imagery draws heavily on "Age of Discovery" and pioneering themes. We would go further and note the technological optimism and belief that scientific advance and technological innovation bring prosperity and social progress that is characteristically American. Space, the final frontier, high risk, high gain imagery in which the individual can go from rags to riches by their own effort and creativity is important to Americans, and individuality is taken to extremes in their country.

The last 40 years, especially since 1970, the USA has been told that the growth era is over. Expansion, growth, and consumption, once the economic engine that fostered consumption based prosperity have run into the limits to growth, environmental ethics, the need to conserve and accept restrictions to avoid using more than our fair share of

Earth's limited resource base. Energy crisis, over population, environmental constraints are the watch words of the day. Technological control over nature is a mixed blessing and the "inconvenient truth" about global warming and its implications is in the news.

Some of those looking for a way out of a constrained future that is less glorious and prosperous than the past, are looking to space for resources, freedom, opportunity and the unconstrained application of technology growth. If technology is applied outside of the biosphere, where efforts to alter, control, and use nature seems more appropriate and less dangerously disruptive, it need not be constrained. Thus, it is more than just colonizing a new world that is involved in going to the Space Station, Moon, and Mars, and building the first step stones to the stars. It is an effort to create new territory for the species that evolved on Earth. They must go into space together, if at all, in an ecological balance-microbes, plants, and the human animal.

Success means off planet colonial expansion and a chance to pump new resources back into Mother Earth without raping its fragile ecosystems. The case NASA is making for the Moon is as a potential energy fuel source. We may not know how to build a fusion reactor yet, but in theory, Helium-3, a power source of the Sun, is the ultimate fuel for a fusion energy system. Since the solar wind is deflected by Earth's atmosphere, the closest source of Helium-3 deposits is the Moon. By contrast, Mars has nothing we need but is enough like the Earth to be settled, even "Homesteaded" as the group looking into

this at MIT refers to their project. So, resources from the Moon and asteroids, expansion into a new World on Mars, these are the glorious images NASA offers to an environmentally constrained, overpopulated world facing the end of the oil era.

Will the American Public will buy it and invest in a new Age of Discovery or want to hoard its resources to deal with short run problems closer to home? The social problems at home are urgent and seem to be multiplying. Some of these social and ecological problems seem to have been caused by technology. Can more technology solve them?

These are the questions of the age – repair and responsibly man space ship Earth, or invest in trying to create a Solar System scale economy starting with the Earth and Moon as complementary economic partners. Our goal was to find out what the perceptions and inclinations of current High School students are regarding the Moon specifically. They are going to be the crucial voters in 2015-2045, when the Moon base(s) and off World development efforts are in full swing.

One of the greatest successes for the United States government during the Apollo project was the mobilization of the public to support developing the technology for venturing into space. The willingness of the tax payers to support the Mercury, Gemini, and Apollo programs may have been due in part to anti-communist propaganda as well as international competition, but this high level of public support is what made the Apollo

missions a success as a scientific and technological initiative as well. This was not the decision of a dictator, though a charismatic and popular president was instrumental. We believe that there is a direct correlation between the amount of public support for NASA's direction and goals and the success and failure of the government agency, both politically and technologically.

There are three main issues under study in this research: (1) Do levels of support show any correlation with the level of knowledge about NASA and the Moon issues? Further, are the most knowledgeable the supporters or the skeptics? In the Apollo era, we suspect the most knowledgeable were the supporters and increasing public knowledge increased support. If that situation has changed the implications are large. If the space technology field after Challenger and Columbia is in the situation of Nuclear power after Three Mile Island and Chernobyl – i.e. the skeptics are the relatively knowledgeable opinion leaders – The space boosters are at a disadvantage. (2) What will the level of support for NASA's return to the moon be in 2015-2020 at the time when NASA is scheduled to return to the moon and build a base? (3) How will the level of support affect NASA's success in creating a lunar base and turning it into a colony? In short, could the American people ever be as interested in settling the Moon and Mars as they were in the first Apollo missions?

We intend to find out by survey methodology using a questionnaire designed for a current secondary school audience. The plan was to survey high school populations instead of college populations because they tend to be more representative of the American public. However, delays in gaining access to two Worcester Public Schools led us to collect college data at Worcester Polytechnic Institute as a "hedge" and to add the question of whether the High School and College population distributions of opinion differ. If so, by how much and in what direction? Using at least three different high schools in different areas of the US we planned to submit the questionnaire to about three science classes worth of students per High School. In the end we had to settle for two High Schools in Worcester and one in rural Pennsylvania.

One of our key variables is how informed the students are. In order to both manipulate and control this variable we requested access to both honors and general classes and then provided an information sheet to inform the students on the key issues of the new space race. Ideally, we wanted to resubmit the questionnaire to them one week later to see if their opinions have changed in response to this new "input". In practice, we were likely to get in once and get them to read the sheet before filling the same survey out again. However, in Pennsylvania there was a real half hour discussion of what was on the sheet. In the college sample the data are mostly just the first round data with no follow up and we just have to assume that Worcester Polytechnic Institute students know

more about space and NASA than the typical High School student did before our information session. We expect the information provided to change perception and opinions. However, theoretically the relationship between knowledge and opinion is complex and subject to selective perception, so support for our hypotheses is far from a certainty. However, since we are more interested in shifting population averages than individual opinion, and shifts in the balance of opinion at that level is more likely. One only has to get the uncommitted to take a position and raise doubts among the skeptics so that they move to a neutral position.

Selective perception is a more powerful phenomenon when opinions are grounded in fact and strongly held since they are controversial and have to be defended often, such as one's position on abortion or the War in Iraq, or even constructing nuclear power plants. It seems that opinion about going to the Moon is different, not mobilized, activated or even grounded at the moment. If people do not know much, have not thought about it and are not publicly committed one way or the other, (or associating with people that are), they are open to suggestion if a case can be made. NASA has not been working hard to make a case for the Moon, since it is focusing on Mars. However, a case for the Moon can be made and we want to see how current High School students, future voters will respond to it, should NASA ever take its case to the public via the media, or via presentations in High School science classes all over the nation.

CRITICAL REVIEW OF THE INITIAL REPORT

This report serves as a follow up to the first new space race initiatives report. In the first report, the students concluded that, barring any significant breakthroughs, that the United States would decide to return to the Moon, to build a base about 2018 and that international competition (most likely with China) would motivate this. Hence, International Space Station style cooperation was unlikely (Saunders, Elko, et al.). However, several years have passed since the initial report was written and this view now seems conservative and even erroneous. With the work and discoveries made in the time that has passed, it has become apparent that the added implications of a major technological breakthrough or of an increased level of public concern and awareness are too large and too significant to ignore. Security issues which were important in the first space race are also becoming involved as China practices using systems to destroy satellite and nuclear proliferation to "rogue" nations such as North Korea and Iran is in the news. This technology reached them from Pakistan, which in turn was aided by China after India developed an Atom Bomb. China has close relations with several nations antagonistic to the United States.

Furthermore, the initial team failed to consider the effects of public opinion in their analysis of NASA's return to the moon or the technological impact here on Earth. In America, the level of public support for particular issues determines the political

candidate elected into office and thus what policies will be developed and implemented. The level of support for the United States' plan to return to the Moon could make or break political careers and an impending space race is an opportunity for someone. How and when the public hears about what is at issue will matter a great deal. John F. Kennedy's bold announcement that we were going to the Moon turned the Bay of Pigs debacle and Missile Crisis in Cuba into a Moon Race with the Soviet Union. This resulted in a great, peaceful American victory after the United States started as the technological underdogs, given a string of Soviet "firsts" (first satellite, dog, human, spacewalk in orbit) by Korolev's brilliant team at Energia Labs, in the Soviet Union.

SOCIAL IMPLICATIONS

A return to the Moon will affect society in three different, though closely related areas: technology, politics, and the economy. The depth of the effects in these areas will depend heavily upon the level of support that the government receives from the public.

I. POLITICAL

Domestic

The environmentalists have presented the public with the idea that our society's excessive materialistic lifestyle has depleted the Earth's resources and that we, as a society, need to scale back in our everyday lives and practice an alternative lifestyle, using less resources. What space presents is a new frontier for exploration. During the Middle Ages, the courts of Europe sent explorers across the world in hopes of not only finding new land to conquer, but also new products. Silk, Jade, Spices, precious metals, and crops were found that helped to revolutionize everyday life and created new economic and political markets as well. Can this be achieved through space as well? Can space provide us with new resources that will produce a sustainable way to maintain our routine practices of living? Are there things rare and valuable on Earth that are relatively abundant in Space?

Legislation

During the Cold War, several countries and the United Nations developed legislation in hopes of preventing a future war over control of space. These laws and treaties do not allow for any country or corporate entity to claim a heavenly body. Not that Neil Armstrong stepped onto the Moon and proclaimed a leap "for mankind" not a claim for United States territory. However, with both the United States of America and the People's Republic of China heading for the Moon looking to utilize the resources that the moon provides, what is necessary to deter a new conflict especially given that a nation can legally withdraw from the treaty with one year's notice?

International Competition vs. Cooperation

Throughout the Space Race the world watched as the United States and The USSR pitted themselves against each other in an attempt to be the first to gain technological superiority with missile technology – and then use it to enter outer space, and thus prove who the international super power was. The United States of America was the leader in air power at the end of World War II and Russia had the best tanks, and lots of them. Soviet jets were as good as or better than those of the United States by the time of the Korean War. However, the United States had more and better Bombers. The Soviets responded by developing heavy lift missile delivery systems for their atomic bombs. The United States miniaturized its ICBM components and built lighter smaller

missile delivery systems. Most were put in hardened silos so as to survive a "first strike". The rest of them were put in submarines to make them hard to target. For the Kennedy administration, the best way to acknowledge the Soviet lead in rocket technology was to set a goal far enough out that it could catch up and surpass the Soviets by out spending them. Hence, the Moon landing was given dramatic emphasis by the United States which was trying to downplay prior Soviet "firsts" in satellites and first manned orbit and the likelihood that there would be more such firsts before its American/German rocket development team led by Von Braun could catch up to Korolev. The Soviets had more powerful rockets so the United States compensated with light, miniaturized satellites and capsules while Von Braun and his German rocket experts were working on the Saturn V "Moon" Rocket. Things looked even worse than they were to the public, since the United States government allowed the United States Navy "Vanguard" rocket team try to launch a satellite several times (unsuccessfully) before turning to the United States Army (German) team in Huntsville, Alabama to do so, which they did on the first try.

The end result of early humiliation and vindication and redemption for the United States was an overwhelming amount of national pride. For the Kennedy administration, the risk of nuclear war over Cuba was converted into a "space race" rivalry with only a few (volunteer) lives at risk. Almost 40 years ago, over 600 million people around the world watched as Neil Armstrong first stepped onto the Moon and saying "That's one

small step for Man, One giant leap for Mankind". For many this was not just a step into a new territory of the Universe, not just a representation of the United States crossing the finish line in the race for the Moon, but a representation of the victory of Capitalist Democracy over Technocratic Communism.

The Soviets covered their failure to reach the moon by building space stations and logging more time in space than the United States. Sergei Korolev considered a space station to be a prototype spacecraft minus the drive system. He wanted to study the long term impact of space on the human body and test various types of technology. When he died of a heart attack, the Soviet program suffered a massive accidental explosion. This was covered up and the Moon rocket development effort was scrapped and manned space missions were limited to Low Earth Orbit. Unmanned missions were successfully undertaken by the Soviets to retrieve regolith samples from the Moon. The Russians also tried to grow plants in their space stations. However, after years of economic hardship from investing everything into the Arms and Space Race, the Soviet Union finally suffered economic and political collapse on December 31, 1991.

Having ceased to be a Communist nation, it could now be a partner rather than a rival in developing access to Space. However, the Apollo/Soyuz mission had set the stage for cooperation even in the Soviet era. Soon American astronauts are visiting MIR. Russia decided not to build Mir II, and rather contributed the module already built to the

United States Space Station Freedom project which was renamed the International Space Station project.

So, as the United States enters into a new Space Race with Communist China, it begs the question, what will be the political outcome of this new international competition? Russia is a United States space partner, but selling technology and training to the Chinese. The Chinese wanted to be part of the International Space Station, but were rebuffed by the United States. Hence, they were not acknowledged as an equal (like Europe and Japan were) and have lost face, so they are determined to go it alone.

First, it is important to make clear that we are entering into a race to the moon with China though some would deny it and others consider it a mismatch. In January 2004, President Bush announced his approval of NASA's plan to return to the moon by 2020 in order of beginning production of a lunar base to be used as a stepping stone on its ultimate path to Mars. However, we were not the first to commit to building a Moon base. Chinese political leaders and scientists had already announced their plans for landing on the Moon. There was no certain date at the time, but since then dates as early as 2010 have been mentioned, though Saunders, Elko et al. predicted 2018 for China and the United States. Project 921, the Chinese manned orbital space flights, got all the attention initially. Most Americans did not take the Chinese Moon plan too seriously. China emphasizes independent innovation and avoids dependence on foreign technology

in strategic areas. Hence, most thought that it would take years to develop the appropriate technology to repeat the American Apollo program. Obviously the United States was expecting that the Chinese will not be capable of building a base before 2020 or they would have moved up the deadline for NASA's return. At that point in time, the United States did not consider China to be a threat in terms of their newfound desire for exploration. Recent events however, may have changed their perspective. For one thing, it is clear that China has access to all existing Russian space technology from spacecraft to cosmonaut training and used space suits. It is not be starting from scratch.

Then, in November 2006, the American public elected enough Democrats into congressional seats to result in a Democratic majority in Congress. This has many worried about having a political deadlock over spending on space given that it is a "Republican" president's initiative. Historically, the Nixon administration ended the Kennedy's space extravagance and focused on ending the Vietnam War, inherited from Johnson, while cutting back on the "Great Society" spending. The possibility of an economic redirection is even more likely to occur since the president's approval rating has dropped to a record low of 28%. This decline is primarily due to our deteriorating foreign relations and increasing national debt resulting from an extended war in Iraq that has now gone on longer than World War II, though with many fewer American casualties.

However uncertain as we are about the priorities and capabilities of our current legislature, we are about to enter into a Presidential election year. This puts everything up in the air as to the future priorities of our country. Will we elect a Republican or Democratic president? Pro or anti war? Will he or she mandate extensive budget cuts, social spending, environmental programs or stress the economy and technological leadership?

This last question is what leaves agencies such as NASA on pins and needles. With an increasing threat in Space from China, as seen from their January 11th test of a "satellite killer", it has become imperative that the United States maintain an active initiative for technological superiority if it wants to remain the technology leader in space technology. However, it does not help NASA if space becomes a military matter. The United State's other space agency, the Air Force's Space Command, would get all the new funding, and Space Command has traditionally stressed unmanned space technology.

If China were to successfully land on the Moon and begin building a lunar base before the United States, it would symbolize a large shift in global power that has an economic basis in fact. Ever since the United States' triumph over the USSR in the Arms Race of the 20th century, America has claimed technological superiority over most if not all countries around the world. This technological superiority was grounded in military, economic and space capability. The predominant factor of the United States' label as the

primary global super power is its technological edge not a huge labor and military manpower pool. For China to beat the US in this new space race would highlight China as having become more efficient, more innovative, and to have "arrived" as a technological leader and force to deal with in these other realms.

How would it affect the world order if the new technological super power were a Communist country? This would have social implications in terms of world leaderships in other realms. Though it is mostly a symbolic statement, China will have done what the United States could have done 20 years ago, but lacked the political will to do, once the Soviet Union was bested in the last race.

China maintains that its aims in space are:

"to explore outer space, and enhance understanding of the Earth and the cosmos; to utilize outer space for peaceful purposes, promote human civilization and social progress, and benefit the whole of mankind; to meet the demands of economic construction, scientific and technological development, national security and social progress; and to raise the scientific quality of the Chinese people, protect China's national interests and rights, and build up the comprehensive national strength" (White Paper).

In short, it is building and displaying a general technological infrastructure capability. This is a political statement as well.

With its most recent accomplishments including progress with launching vehicles, Telemetry, tracking and command, satellite remote-sensing, and manned spaceflight, China is on track to be a full scale space faring nation – equal to the United States. Further, the cost of a Chinese satellite launch is about a third of that charged by ESA's commercial spin-off ArianeSpace. American launch systems are even more expensive.

It is still unclear what China's intentions were with the unannounced test of the "satellite killer". Some believe China is attempting to force the Bush administration's hand in developing legislation against the weaponization of space. Others consider it the opening shot in a new arms race. Since the United States is militarily dependent on its space assets, and they are now under threat for the first time, it will have to find ways to defend them, and replace them rapidly while under fire. Clearly this is a Chinese warning not to mess with them, that they are better friends than enemies and they have systems to sell that countries on the outs with the United States (like Iran and North Korea) might want.

II. The Economy

There are many benefits associated with settling on the Moon or Mars. A trade system could make things available to Earth that would increase the average human's standard of living. However, they will not be equally distributed. When Spain was colonizing the new World that did not mean wealth for Austria-Hungary. France and Britain became competitors, but North America was not the prize that South America was at the time. Besides the possible world-wide benefits of low cost, high efficiency energy, one must also consider the technological byproducts. Many of the items we use every day were created while exploring other questions and one can assume that some new inventions would arise as result of our efforts to colonize a celestial body.

The country that is able to obtain resources from the moon and bring them back to Earth can potentially increase its useful land area without increasing its population, thus improving its Gross Domestic Product.

$$GDP=C+I+G+(X-M)$$

The US economy currently runs a trading deficit by importing more than it exports. This negatively impacts our GDP, but Moon resources from a lunar colony would not be imports – and could be exported. Increasing "X" could improve the United State's trade balance. If this is done while boosting the total GDP, the standard of living increases.

To compete in the space race a country must invest funds to develop new technology and create things needed by the “Off world” mining and production centers. Communist states with a command economy could get an edge if a long term loss is required before a positive trade balance is achieved with the “colony”. However, the cost of getting things to Earth from the Moon is much less than vice versa. So high value items going to the Moon and low value raw materials coming from the Moon to Earth would be a worthwhile trade system. For our energy needs on Earth there are a few sources being used. They consist of fossil fuels, nuclear energy, solar power, and hydropower plants.

The use of fossil fuels is exacerbating climate change and the use of oil will be coming to an end in this century of Earth history. Coal burning might go on for another century after that, but in terms of global warming it would be better if it did not. Fission nuclear power works but is socially unacceptable in many countries due to the risk of catastrophic meltdown and nuclear waste, much less the risk of diversion of fuel to weapons programs. Fusion reactor nuclear energy is much harder to do but theoretically would be much cleaner and safer. The hydropower plants and wind turbines are clean but do not contribute a high percentage of energy consumption compared to the other sources discussed. They certainly cannot be used on the Moon. For these reasons new sources

must be found to power the economy of the Earth and also the new (more energy intensive) civilization to be created on the Moon.

It is hard to determine the long-term and short-term price trends for fossil fuels. Stability cannot be assumed, especially for crude oil. Part of the reason for this is that estimates of the remaining reserves in the Middle Eastern are not very accurate. Indeed, it is believed that they are significantly inflated by regimes trying to delay the development of alternative energy systems. Another question mark is that the economic growth of China (as well as India) needs to be taken into account. While the growth rate is slowing, these economies are expanding. It appears that China is already causing a rise in the price for crude oil. China is going to continue to grow from raising its productive capacity, exports, and standard of living. If other developing countries do the same, the pressure on remaining oil supplies will increase, and the need to find new technologies will become more urgent. One thing that could be obtained from the Moon is a fusion reactor fuel. However, even if the goal was only to find a way to use that local resource on the Moon and to power the next generation of spacecraft, NASA would still want to develop the Helium-3 fusion reactor capability. Once it exists, you might as well power at least some of the fusion reactors on Earth the same way.

III. Technologically

New technological advances are making the moon very appealing. We know that the moon is comprised of many irons, ores and gasses, most of which are found on Earth, but some of which cannot be found on Earth. Perhaps the most intriguing gas available on the Moon but not on Earth is Helium-3. Helium-3, which is theoretically the best (high yield) fuel for nuclear fusion reactions, is relatively plentiful on the moon. Of course it has no value until we first achieve a commercial fusion reactor using easier to fuse Deuterium. Theoretically 25-30% efficiency can be achieved by a Deuterium reactor. This is estimated to be ten years away. Via incremental improvements in fusion temperature and magnet field compression a Helium-3/Deuterium reactor will become possible in about 40 years. This type of reactor can theoretically reach 65-70% levels of efficiency in producing electricity. Then in 60 years, the world will be nearly out of oil and have to turn to a new source of power probably coal or nuclear. By then oil will not be used for electric plants anyway, being reserved for transportation, but electric cars will have emerged and place further demands on the electric power grid to recharge car batteries, especially overnight for commuter cars.

Will technological advancements be on pace to mine Lunar Helium-3 and perfect the fusion reactions before the oil economy ends? It is possible. However, even if Earth turns to another fuel source, Helium-3 is the only local energy source with which to run

the lunar economy and fuel Fusion Drive spacecraft from sources in space. Sooner or later the Moon's Helium-3 fields will be mined for energy production.

Helium-3 molecules get to the moon by the "solar wind" because there is little atmosphere. They do not get to Earth. There is a nearly four-billion-year old rocky debris layer on the Moon's surface which is called the regolith. This layer collects helium-3, regular helium, and traces of hydrogen, carbon, and nitrogen. The samples from the early Apollo missions collected by Neil Armstrong and the other 11 Americans to walk the Moon after 1969 shows the helium-3 concentrations to be by weight at least thirteen parts per billion. This may not appear to be a significant amount of helium-3, perhaps not worth collecting, but the amount of energy that can come from it is larger than most if not all sources of energy per unit of mass. It is estimated that the cost of helium-3 would be near $40,000 per ounce; this is from using the probable energy equivalent of coal in 2010-2020 which is conservatively estimated at $2.50 per million BTU. This value is much greater than an ounce of gold, which is near $400 per ounce at this point in time.

At $40,000 per ounce, it will cost about $140 million for 100 kilograms of helium-3 but would be worth it in the end? This amount of helium-3 would be enough fuel to power a 1000-megawatt electric plant for a year when it is fused with deuterium (a hydrogen isotope). The amount of energy produced from this size electric power plant will be enough to serve the electric needs of a city around the size of Dallas for a full

year. To produce one hundred kilograms of Helium-3 mining an area of the moon equivalent to two square kilometers going only three meters deep would be necessary.

After the gases are collected out of the soil through heating and agitation, they must be separated. For this to happen there must be the development of the lunar mining, processing, and refining. It is currently estimated that the cost of the creating the base would be about $2.5 billion dollars of investment capital over five years. That is after the design work was done. The breakeven point with one hundred kilograms of helium-3 selling at $140 million would take about 5 years with about five miner-processors in place and in working order.

Of course, none of this will happen until Helium-3 can be fused. It currently is of interest primarily for research purposes, but it allows us a glimpse of what a future energy economy might look like if we do not burn coal 100 years from now, and what it will probably look like in 200 years even if we do burn coal as long as possible.

As mentioned earlier, Helium-3 may be fused with itself or be combined with deuterium. This reaction would produce a helium-4 ion (alpha radiation particle) and a high-energy proton. However there will be a side reaction of the deuterium with itself producing a neutron. This reaction can be minimized by finding the optimum amount of helium-3 needed to have this side reaction slowed. The neutrons will still need to be disposed of as low-level radioactive waste at the end of a thirty to forty year plant life.

One of the biggest advantages of the deuterium with the helium-3 reaction is that the positively charged proton can be directly converted into electricity using electrostatic deceleration methods. However, if helium-3 reacts with itself, it produces no side reaction and hence no radioactive waste to deal with at the end of the electric plant's life. In short, there is "clean" energy, especially compared to a nuclear fission plant.

The next challenge to be overcome in order for the helium-3 mining and production on the moon to be feasible is to have there be a greater payload capability and a lower cost for freight deliver to the moon and back. The biggest rockets ever used for launches to the moon were the Saturn V rockets. They weighed 6.2 million pounds and produced a thrust of 7.5 million pounds of thrust at liftoff. This could send a payload of 48-tons to the moon at a cost of $59,400 per kilogram. A new rocket is in development called the Saturn VI and will be capable of launching 50 to 100-ton payloads to the moon at a cost of $3000 dollars per kilogram, much less than the Saturn V rockets used to cost. With some of the improvement and profit from the helium-3 collection, the capital investment for transporting energy supplies would be around $15 billion. This is about the same infrastructure cost or that required for the construction of the Tran Alaska Pipeline in the 1970s or the 1980's Euro Tunnel.

The most expensive element of the total cost of retrieving helium-3 from the Moon is the cost of launches to the moon. The size of the payload of a Moon freight

rocket is to be double the load carried by the Saturn V rockets. A target cost of near $3000 per kilogram is realistic only if a new class of heavy lift rockets becomes available. The spacecraft and operational costs estimated for the new generation of the Saturn rockets bring this goal barely within range. The spacecrafts of the Apollo missions weighed 30,900 kilograms for the command module and service pack and the lunar module weighed 17,250 kilograms. The cost of the Apollo launches in 2005 US dollars would be about $3 billion per launch. This cost includes the cost of manufacturing, the preparation and operation of the spacecraft. As stated earlier the marginal cost of the shuttle cargo system was $59,400 per kilogram. The target cost is $3000 per kilogram which means there has to be a cost decrease of close to a factor of twenty. The following is a list of requirements to reduce cost by 90-95%.

The first would be an increase in the payload per flight as stated previously. The target payload would double, to be near 100,000 kilograms compared to the Saturn V's 50,000 kilograms during the Apollo missions of the 1970s. The new Saturn-based rocket will already have the specifications that need to be met and the design and operational approaches that have worked in the past carried over from the Saturn V rockets. The last time the Saturn V rockets were used was forty years ago and there have been improvements in technology since that time to make the rockets more efficient and perform better. The mining of the helium-3 on the moon will also lead to long-term

assembly line type contracts between vehicle producing and using organizations. Assembly line production with economics of scale will then cause the cost of the missions to the Moon to be less expensive than they were when the rockets were built individually or in small batches.

A different booster system, “Shuttle Derived Vehicle” (SDV) will be developed to substitute as a non-reusable payload module for the Space Shuttle itself serving the Space Station. It will however retain the three shuttle main engines and the two solid rocket boosters of the Shuttle. The payload for the booster would be 40 to 45 metric tons which is around ninety percent of that of the Saturn V rockets. As shown by the accident of the Challenger, solid rocket boosters do not allow the recovery of any payload when there is a failure of the rockets as they cannot be shut down. Also, the high pressure hydrogen-oxygen fueled shuttle engines are more expensive and complex compared to the low-pressure kerosene- oxygen Saturn F-1 engines. However, since they are familiar and cheap to develop they might be suitable for unmanned freight missions to the Moon as well as servicing the space station.

Breakthrough Technologies

In order to safely and efficiently continue the exploration of space, major breakthroughs will have to occur in some key areas within the industry. A recent Delphi study, created and implemented by students at WPI(Gillis and Wu, 2006) (Flaherty et al., 2007), asked members of the NASA Institute for Advanced Concepts (NIAC) to rate 21 potential breakthroughs that might prove significant in the future space program in terms of likelihood. Likely breakthroughs in the areas of propulsion, space vehicles, materials, and shielding technology were identified. When considering possible technological breakthroughs, it is important to rate these technologies on two factors: 1) will it create a reduction in cost for space travel, and 2) will it help to create a new capability for space travel or transport? Under these conditions, technologies taking the forefront include those leading to development of the capabilities for single stage orbit, the refueling of liquid oxygen in space, and another delivery system in which transportation by rocket is not necessary. The possible breakthrough technologies that will expedite the development of these processes include LEO gas collector, solar sails and others.

Fusion Reactor

The first breakthrough technology is that of fusion reactors. This technology was heavily sought out by Soviets and Americans during the Cold War. In particular, the Soviets felt that if it were possible to successfully produce such a technology, not only

would it resolve all of their economic difficulties, but it would result in the Soviets having technological superiority even though the United States had won the race to the Moon. Although neither side successfully developed a prototype, scientists have continued researching the possibilities. According to the NIAC survey, scientists believe the technology would be highly significant to the innovation and this would result in an increased demand for space travel. This is centered on fusion reactors made from Helium-3; however, Deuterium is currently being used in most prototypes.

One of the largest "road blacks" for traveling into space is the cost of transport. Not only is the price per pound for lifting an object into space high, but the structures being lifted generally weigh several thousand tons. Also, it is estimated that this technology will not be developed until at least 50 years from now. The next three technologies involve proposed methods for alleviating some of the transportation costs.

Solar Sails

The concept of solar sails involves propelling a body by the force received by a film of some specified material from the pressure created by light. Although this method of transport requires no propellant, scientists worry that it will not be capable of producing enough thrust to transport large payloads or structures. According to a NIAC respondent, there are three different types of Solar Sails being considered. The first is a metal or carbon film and has a high likelihood of being produced in the coming years;

however, this version does not generate a significant amount of thrust. The second type of solar sails has an expected time period of 30-40 years from now before it will be capable of production, but it is capable of reaching higher velocities. Lastly, it has been proposed to create a solar sail that utilizes laser or microwave technology. In theory, this version would produce more thrust than any other; however, the technology required is no where near being developed (Flaherty, et al. 2007).

ReSSTO

The Reusable Single Stage to Orbit (ReSSTO) is considered the most likely of all the breakthrough technologies to be developed in the near future. It is considered to be the next evolution in spacecrafts. We started with huge, multi-stage Saturn V rockets carrying us to the Moon and are now using a reusable craft, the Shuttle, to enter Earth Orbit. Several aerospace companies, in cooperation with NASA, are working on a hybrid of the two technologies, as is necessary since there have been several technology breakthroughs since the 1960s. Scientists feel that most of the technology is already in existence, but that the economic requirement to develop a workable system may be too high. In addition, a method for refueling once in Earth orbit would be necessary for travel outside the Earth's sphere of influence.

LEOCAC

The final breakthrough technology relevant to the innovation of space travel is the Low Earth Orbit Oxygen Harvester (LEOOH). This technology, proposed by Paul Klinkman and a group of WPI students, involves a harvester orbiting Earth at an approximate altitude of 400km. The harvester would continuously orbit the earth and would essentially "scoop" oxygen from the upper atmosphere called the exosphere at this level. While this technology would completely revolutionize the space industry, it is still in the elementary development stages. Even fully developed it will probably not be able to meet the full demand for liquid oxygen in space. Liquid oxygen is about 80% of the weight of fuel for rockets. It would need to be combined with something else, probably Hydrogen.

Public Opinion and Approval

During the 1950s, increasing concern over the Soviet Union's expansionary political ambitions helped motivate the American public to support an aggressive space program. Starting out behind the Soviet Union, the United States caught up with and surpassed the Soviets in seven years. With more than 600 million people watching Apollo 11, the initial lunar landing, the government had almost complete public support for its space program. In all, twelve Americans in six teams would land on the Moon, but public support waned as it became clear that there was no real plan for what to do there, having arrived. Other political issues seemed more pressing.

The Soviets denied there had been a race and were stressing the construction of Space Stations. The United States turned to the idea of a reusable spacecraft, the Shuttle, and the dream of cheap access to space; however, the Shuttle design project was under funded, especially the rocket booster part of the system. That dream turned into a nightmare as the shuttle never became cheap, safe and reliable. However, it did enable the construction of a space station-a very much more expensive one than the Russian MIR however. The costs ultimately discredited the whole idea of having a space station as an orbiting laboratory. However, the problem was having one so big that it had to be assembled in space. When a Saturn V boosted Skylab into space in one piece, the

mission was cost effective. When a second Saturn V was needed to reboost it, Skylab was prematurely abandoned in favor of the Apollo-Soyuz mission.

Now China is becoming more aggressive in its quest to land on the moon and it is increasingly viewed as a political statement. The plan is to out do the United States by going, staying, and building a base. At the same time there are nuclear threats from North Korea and Iran, which China has relations with and tends to protect. Are we entering into a period of parallel politics akin to that of the Cold war "communist bloc"? If so, could the American government today achieve a level of support for space activity similar to that it saw during the Apollo program? Having a symbolic techno-muscle flexing contest with an emerging economic and political power that is a rival (and has a communist government and anti-American allies) is better than a war.

One of the main arguments against the likelihood of a new space race between the United States and China is the lack of public enthusiasm for one, at least in the United States. Even as President Bush promises to go back to the Moon, and on to Mars, the 109th U.S. Congress continues to deny the National Aeronautics and Space Administration (NASA) the necessary level of funding to complete these tasks. The United States got to the Moon in about 7-8 years during the 1960s. NASA wants until 2018 to get back there and start to build a base. In order to do so it will have to largely abandon the International Space Station which is not yet completed. That will probably

be turned over to the Russians and Japanese to operate. The Chinese, having not participated with the International Space Station, may well build their own small space station the way the Soviets did. This will probably be a station that can be orbited in one shot as a whole unit for about $1 billion, not constructed in space for the $20 billion and counting.

What if the public's opinion on space was changed? Could an uninformed populace be inspired to back space exploration if they understood that the possible economic and social impacts and were worth the cost and effort? Could the American people ever be as interested in settling on the moon as they were in landing there as part of the Apollo missions? We intend to find out indirectly by studying the future voting public now.

SURVEY

Overview of the Study Design

A survey instrument will be used to estimate the amount of public support for NASA 15-20 years from now when America is scheduled return to the moon, and build a semi-permanent base. The study using the questionnaire will have a quasi experimental design. The instrument will be administered twice, with information provided between the two administrations. Both the T1 survey results and the change data are of interest in estimating public support.

Sample

In order to determine this future level of public support, the survey will be administered to today's high school students who will, at that time, be an important part of the active voting population. High School students were chosen as the study population because a high school population is typically more representative of the American public than the student body found on a college campus. The study was designed for a population of about 240 High School students from three High Schools. In the end there were three but two in Worcester and only one in Pennsylvania was elsewhere. We had hoped for Texas, Pennsylvania, and Massachusetts.

Doing a study on the WPI campus was considered, but it was decided the student body was not representative enough and to fill the gaps, i.e. that community college, state

college, liberal arts, and business college students would be necessary to go with the WPI respondents. That design would still not include those people not college bound that went to trade schools. So, it was better to study them in High School before they dispersed. However, as the study fell subject to a waiting period for the Worcester Public Schools to collect data, the group decided to collect WPI data anyway to see how bad the skew would have been and to compare future “public” to future “technologist” opinion.

Experimental Design and Procedure

First, the students are presented with an initial survey (see Appendix A1). This survey serves to determine the current views of an uninformed populous. Space exploration is not getting much media coverage so the High School students will probably not have heard a case for going back to the Moon, but they may have heard one for going to Mars. Some students, particularly those more interested in space technologies and/or politics, will have a greater knowledge of NASA's history and space technologies. Thus college students at WPI are likely to be more knowledgeable taking their first survey than the High School students and so the high school and college student opinion distributions will be compared (if possible) to see what the effect of this knowledge/expertise variable is on opinion. However, both (High School and college students) will have only general impressions while filling out the first opinion and perception survey.

After the initial survey, the students are then presented with an information sheet (see Appendix A2). The information sheet contains facts about NASA's budgetary history including amounts spent on the International Space Station, the Apollo projects and the projected costs for returning to the moon. The information sheet also contains information about NASA's motivations for its post-Apollo course of action. With so much focus on the Columbia disaster, we felt it relevant to also include information

outlining some of NASA's successes, and some of its conspicuous failures. This was in hopes of keeping the survey population's knowledge as balanced and objective as possible. The goal was to allow students to form their own opinions once they were briefed on the issues. An attempt was made not to propagandize in making a case for the Moon but just to dispel misconceptions and provide some information.

The information sheet also serves to give the survey population a general knowledge of NASA and its plan to return to the moon. This is to approximate the level of information that a population of adult voting age might get from a few newspaper articles if the media was covering the issue and they were following the relevant series of articles. Alternatively, we wanted to access the impact of a half hour long public information session.

The majority of the voting population in America is presented with basic information through the media and can now follow up by doing independent research on the Internet. On any given issue, one person may choose to ignore the information they are presented with because they find the issue to be irrelevant to their personal interests or in opposition to their current views. This can be equated to those students that will choose to disregard the information presented, or never turn in a second round survey.

The information session for the Pennsylvania High School students was thorough we were not able to do the same with the Worcester, Massachusetts High School students

but the information sheet provided some stable comparability to the studies at the three sites. In the Pennsylvania case, the students were walked through the information sheet and a discussion was started covering Helium-3 and international cooperation vs. competition. This is to help engage the students in a form of public debate. Public discussion also serves to approximate having to defend their views, analogous to taking part in public debates during an election. This action serves to make the High School population a better approximation of its future self as an adult voting population.

Finally, a second survey (see Appendix A3) was administered to the students. This survey was used to determine the amount of change in public support for NASA's plan to return to the moon and allows one to estimate the distribution of opinion that would find in an informed populous. Here we need to determine the difference between uninformed and uneducated. The term uneducated is used by us to approximate that part of the public that does not have enough background knowledge of the issue at hand to be able to form a grounded opinion, and thus, will have to "follow the leader". By this we mean that they will have to select an opinion leader that they trust or find credible and agree with them. While every citizen over the age of 18 has the legal right to vote, the "Fathers" of our country felt that each voter should be literate in order to be able to educate themselves and select leaders or offer informed consent. Thus, they were

committed to general or universal public education to provide a reasonably informed voter for a democratic society.

The next part was to assure a free press that could not be censored and prevented from informing the public about what was going on, especially what their elected leaders were doing and planning to do. In today's society, the literary requirement is fulfilled by the legislation mandating compulsory attendance and/or completion of a high school education typically for about four years. Vocational training is not stressed at most public high schools, so its purpose is to produce a literate citizenry. Part of that public purpose is to produce a technologically literate and information literate citizenry employable in a Technological society. Hence, not only English and Social Studies, but Math and science, are required subjects.

Survey Construction

Our survey instrument design team (Katie, BJ, and Derek) wanted to determine different areas of perception and support or opposition to a moon base(i.e. economic, political, and scientific/technological). Thus, the survey had to be brief and had to take into account background knowledge levels for both the informed and uninformed rounds of data gathering opinion. As noted, the plan was to create superficially "informed" opinion artificially. Would information change opinion?

Changing the climate of opinion in a population individuals does not require one to reverse strongly held opinions. Instead, it could be like the effect of Three Mile Island on support for nuclear power plant construction in the United States, for a sample of 1000 Massachusetts residents pre and post Three Mile Island (Wilkes et al., 1985). Basically, those slightly opposed became strongly opposed; those with no opinion became slightly opposed, those slightly in favor decided they were conflicted and shifted in both directions. The strongly in favor were largely unaffected, at least on balance they did not reverse opinion. Though some were less strongly in favor, others responded by increasing their support for nuclear power. Yet, overall the effect was a 20% shift from majority support to majority opposition to building nuclear power plants in the United States.

For the majority of the space survey questions, except for eight, nine, and ten, there are six choices for answers. They consist of strongly agree, agree, slightly agree and the same three for the disagree side of the choices. There is no neutral position in this survey, the reason being that we want the study participants to take a position, even if it is soft and tentative, if they can see any difference at all. We are looking for the immediate affect of just a little knowledge, the level that could be reached in a single one day speaker showing up for an assembly in a typical High School. This would be within

NASA's capability as would funding some informational documentaries to be shown in science classes all over the country. The questions that were developed are as follows:

1. The United States should attempt to place a permanent base on the Moon.

This question is used in hopes of getting an initial response to NASA's return to the Moon. We want to know if, with the current economic, political, and social conditions of the United States and/or the international community, the public will support NASA's plan. This question was also placed first, because several following questions may imply scenarios not previously considered by the participants and may sway their existing positions.

2. The United States will not be technologically able to colonize the Moon for at least 25 years.

NASA has proposed returning to the Moon no sooner than 2020 primarily due to the need for time to develop new technologies including a new launch vehicle. This question serves to determine if society believes that NASA will meet its goal or not. In the midst of the Cold War, America sat on pins and needles watching to see if NASA would meet Kennedy's challenge of placing a man on the moon within ten years without prior technologies other than ballistic missiles.

Although NASA has an advantage this time of having more experience with traveling to and from space, its new objective is to begin developing a lunar base for which it has no direct experience. NASA has lost credibility due to its three fatal failures and problems with the Hubble and Martian Landers. We want to determine if the general population believes that NASA will meet its goal? This question serves two important purposes. First, to show whether or not the public believes it is possible to develop the necessary technologies and secondly, if the public still has confidence in NASA's ability to set and meet a challenging goal beyond its current capabilities. After the Challenger and Columbia disasters, a Gallup poll showed that the majority of the American public felt that NASA should halt further actions until it had redefined its objectives. Has confidence in NASA been restored by its publicly announced plans? The current public view is less important than that of the future public.

3. Another country will be ready to build a permanent town of 500 people on the Moon before the United States.

Although NASA's plan is to use the Moon as a stepping stone on its path to Mars, other countries around the world have a slightly different view. China has released plans for a permanent lunar base, and now India is looking to develop a lunar program. This question serves two purposes. First, does the American public have confidence in

NASA's ability to successfully produce the technologies required to achieve the goals it has set and secondly, to determine how capable the American public perceives the other countries in this budding space race to be. Further, once the public learns about the stakes involving control and access to the Moon, will it respond favorably to NASA's not planning to stay on the Moon, but rather set off for Mars, leaving the Moon to other Space Agencies?

4. I am very patriotic.

With this question, we hope to determine if the respondents' views are based on nationalism. Is the patriotic part of the American public most optimistic, perhaps because it wants to see America remain technologically superior? We can use this as a control variable and look at the range of scores on other items for the very Patriotic and Less Patriotic groups respectively.

5. The Moon is a source of useful natural resources for Earth.

The Moon contains various elements that could prove to be useful to the Earth in the future. Although there has not been a great deal of media coverage about NASA's plan to return to the Moon, does the American public believe there exists an economic as

well as a technological justification the United States to set up a base on the Moon? So far, all NASA has said is that it wants to go to the Moon to practice for Mars.

6. The Moon is a strategic military location.

This question is used to get the sense if there is more than just one reason to go to the Moon. This will give another reason to persist on landing on the Moon if the public sees it as the military "high ground". From one stand point it is easy to get from the Moon to anywhere on the Earth, on the other hand it will take time to get there. Defense is always important to people in the United States as well as other countries, and the idea that observation sites or a strategic missile launch from the Moon is a threat may concern them. These actually matter little in the context of spy satellites and MIRVed missiles.

7. It is more likely that the U.S., Russia, China, Japan and Europe will cooperate rather than compete in an effort to build an Earth colony on the Moon.

This is the last question having the agree/disagree format. As stated before other countries are talking about going to the Moon. The issue here is what will be the reasons to merge the international effort, as happened with the Space Station. One feasible reason is the budget for NASA might not be enough for a return if done by the United States alone. Of course, a major funding increase could change that, which leads to

question ten. Is it possible for the United States to share with other countries given that NASA has not shown interest in permanently occupying the Moon – and wants to get on to Mars? An international Moon base might be a possibility, just as there is an international base near the South Pole in Antarctica. All the current space agencies except that of China participate on the International Space Station, and have developed experience working together with NASA and each other.

8. Which statement do you agree with most?

The first question deviating from the agree/disagree format is question eight dealing with the return to the Moon. From the information sheet, there is a value for the estimated cost for a return to the Moon. This with the price of building and making a Moon base functional will be the total cost be justified by the return and will there be a profit? This leads to the three possible choices. The three choices consist of a Moon base would never pay for itself, break even and be profitable after fifteen years. Fifteen years was chosen as the basis for the time period of financial return for a specific reason. By using a period of fifteen years, we will be able to determine if the respondents believe they will see this return within their lifetime, and if it will be a proven success or not by 2035, when they are close to their parents' current age – early to mid fifties.

9. Out of a 100 person astronaut corps, what is the highest number of lost astronauts worth the sacrifice to build a permanent moon base?

From this, we will be able to determine a percentage of deaths believed to be acceptable in the eyes of the American public. With an increasing number of casualties due to war in Iraq that many have deemed unnecessary, how will the American public view any deaths that may arise as part of scientific discovery rather than military action? The death of the Challenger seven shut NASA and the Shuttle down for three years.

10. What are your feelings about the adequacy of NASA's current funding level?

The choices include that NASA needs more funding, less funding or has the proper amount of funding. Currently, the cost of one shuttle flight is 1.3 billion dollars and the NASA budget is 16.8 billion dollars. One of the most successful missions for NASA was the Apollo Mission and that was priced at $14,644,000,000. This question serves to determine not if NASA has adequate funding, but whether or not the American public believes that NASA should receive the increase in funding necessary for a successful and timely return to the Moon, on top of maintaining current operations.

ANALYSIS

Method of analysis

The responses of WPI students and high school students were compiled into a database as two separate data sets. These two data sets were then compared and contrasted to observe different behaviors among the respondents. Key means and variances were computed to aid in the process of comparison. The entire data set of both WPI and high school students was then analyzed to test other hypotheses.

Hypothesis

There are two sets of hypotheses to be tested by this survey. The first set is more general while the other is question specific.

General Hypotheses

Students, on average, will become more receptive to the idea that there is likely to be a new space race after reading the informational materials. By providing students with materials to quickly ramp up their knowledge of space and the history US space program and current NASA policies (as well as new and upcoming technologies), they will be likely to positively change their minds about the desirability of a return to the Moon. This hypothesis can only be partly tested in this analysis, but changes in perception due to new information is one thing that we want to know about.

WPI students will be more likely to expect a new space race than high school students. Since the WPI community is a relatively "technologically savvy" population, more of them will be "following" developments in space technology and policy. They

will use that greater knowledge base when filling out the survey the first time. The average level of knowledge difference will lead to answers that contrast with high school populations because high school populations will have a lower proportion of technically inclined students who follow space. Those who follow space will support at least a return to the Moon and possibly a Mars mission. This will help us test the theory (well the assumption) that high school populations are more representative of the public at large than a college community like that of WPI. If the distribution of responses is not different either the college population is not more knowledgeable or there is little to no relationship between knowledge and opinion in this field.

Specific Question Hypotheses

We hypothesize that students will, on average, agree that the United States should attempt to build a lunar base. Perhaps it is arrogance or manifest destiny, but Americans believe the US is the technology leader in space and will want to prove it by being first to build a permanent structure on the moon. When they learn that other nations are thinking about it too, they will be even more in favor of the idea.

Students will not know if the United States will be ready to colonize the moon within 25 years. They will have their gut instincts but few will have strongly held beliefs about this. After the information sheet and discussion students will firm up their positions and agree or disagree more strongly than before, but will still vary in opinion.

They may or may not change their opinion. We do hypothesize that the distribution of opinions will become more strongly held. The distribution will "polarize" toward the extremes as knowledge is added, due to selective perception.

Students will not want to believe that another country will be prepared to place a 500 person colony on the Moon before the United States if we tried to do so. The question is, will we, (or should we) try? – If they believe it could pay for itself they will support trying. If the NASA budget does not have to increase to do so, they will want to try as well. However, we doubt that the support is there for an all out effort at great cost to make a symbolic point, in like in the last space race. It will have to be justified by economic return or national security concerns. Again, students will have a feeling that the United States it so technologically superior that this could never happen unless we decided to let it happen.

However, after the information sheet is discussed and questions are asked the students will see that there is well financed Chinese competition with a national pride point to make. Then they will shift toward agreeing with the statement that we could be beaten due to lack of resolve. Whether that will lead to a call to increase the NASA budget remains to be seen.

Most students will consider themselves patriotic and those most patriotic will most want to see us compete and win. It is not expected that one will see much change in

levels of patriotism after the space discussions and information sessions. Any changes that are seen might be attributed to competition in space bringing out patriotism in students, but we don't expect to see change on this variable.

Students will become aware that the Moon is a source of potentially useful resources even for use on Earth. Slightly agree or disagree should be the main answer before discussion, but afterwards students will tend to accept this statement as true. The information sheet and discussion hits this point many times and the students will probably not question it.

Students probably do not know if the Moon is a strategic military location but some will liken it to holding the high ground and much easier to occupy initially than to capture in the face of armed resistance. Answers for this question will be varied, and not much will change after the discussion. Some students will insist that the Moon is an important stronghold for future military operations while others will not be able to conceive a scenario where a militarized Moon would be beneficial until there are trade routes to defend.

We predict that the students will expect the United States to compete with foreign nations rather than cooperate in building a permanent lunar base. Although these high school students were not alive for the first space race they know that there was a competition with the Soviet Union and why should this time be any different? After

hearing that NASA would share expenses with other countries, probably Japan, students may rethink this answer and start to agree that cooperation is a possibility.

Initially, students will see a lunar base as a technological feat, and probably like Apollo, expensive with little hope of paying for itself. After gaining knowledge about some of the natural resources on the Moon and some of the new low-cost technologies being developed, some students will decide that a lunar base could become profitable after a period of loss, and end up a wash.

Most students will not tolerate much loss of human life in the exploration of the Moon and space, but after Apollo1, Challenger, and Columbia they will expect some loss. On average a low number, perhaps 5-10 out of 100 will be considered an acceptable loss in Moon exploration. This average number will grow after the information session to 9-18 out of 100. A greater increase can not be expected because loss of human life will still often be considered too high a cost to risk on an adventure, but the information between administrations will serve to give justification for why the return to the Moon.

We predict that most students will believe that NASA is at least adequately funded for a return to the Moon. Heck, it's been done; we still have the technology to get there, right? Wrong! But only the WPI students are likely to know that prior to the information session. Students will likely know that NASA has a very large budget, but may not know the actual amount or how small a percentage of the federal budget it is.

They will be surprised at how high the cost of the Space Station is compared to the Apollo program. A lot of time is spent on this subject in the information session and the dollars will speak for themselves. Students who believe that the US is in a new space race will also think NASA is under funded and those who do not will find NASA adequately funded or over funded, for what it has delivered recently and want more for the same budget.

Results

The survey was administered to 69 students at Hughesville High School in rural Pennsylvania, 74 students at both Doherty High School and North High School in Worcester, Massachusetts, and 88 students at Worcester Polytechnic Institute. For the two Worcester high schools, each student took both the pre-informational and post-informational survey, and their answers to each were kept together. However, we were not able to match up corresponding pre- and post-informational data for the Pennsylvania students, and not all the WPI students responded to the post survey, therefore we do not have sufficient data to measure the effect the information sessions had on a respondent's opinion on an individual basis for the whole data set. We can still compare the frequency distributions before and after to get some idea as to how opinions changed due to the presentation of new data, and compare on a person-to-person basis for the Worcester HS data set.

In order to better display the correlation between variables, we consolidated the data into fewer response categories. Starting with the raw frequency distributions for the entire pre-informational data set, the data was recombined into 3 groupings of approximately the same size. For example, for the second question, the first and second response (strongly agree and agree) have a combined frequency of 34.4%, the third response (slightly agree) has a frequency of 26.6%, and the fourth through sixth (disagreement at all levels) combine for the remaining 39%.

Tables 1-19: Frequency Distributions for Pre-information Data and Regrouped Data

Q1 US Build Moonbase?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	51	16.7	16.8	16.8
	agree	104	34.1	34.3	51.2
	slightly agree	82	26.9	27.1	78.2
	slightly disagree	29	9.5	9.6	87.8
	disagree	26	8.5	8.6	96.4
	Strongly disagree	11	3.6	3.6	100.0
	Total	303	99.3	100.0	
Missing	System	2	.7		
Total		305	100.0		

Q1 US Build Moonbase? (regrouped)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree & Agree	155	50.8	51.2	51.2
	Slightly Agree	82	26.9	27.1	78.2
	Disagree-All Levels	66	21.6	21.8	100.0
	Total	303	99.3	100.0	
Missing	System	2	.7		
Total		305	100.0		

Q2 Colony 25 years away or more

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	30	9.8	9.8	9.8
	agree	75	24.6	24.6	34.4
	slightly agree	81	26.6	26.6	61.0
	slightly disagree	68	22.3	22.3	83.3
	disagree	39	12.8	12.8	96.1
	Strongly disagree	12	3.9	3.9	100.0
	Total	305	100.0	100.0	

Q2 Colony 25 years away or more (regrouped)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree & Agree	105	34.4	34.4	34.4
	Slightly Agree	81	26.6	26.6	61.0
	Disagree-All Levels	119	39.0	39.0	100.0
	Total	305	100.0	100.0	

Q3 Other Countries will have first base

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	6	2.0	2.0	2.0
	agree	24	7.9	7.9	9.9
	slightly agree	50	16.4	16.4	26.3
	slightly disagree	72	23.6	23.7	50.0
	disagree	106	34.8	34.9	84.9
	Strongly disagree	46	15.1	15.1	100.0
	Total	304	99.7	100.0	
Missing	System	1	.3		
	Total	305	100.0		

Q3 Other Countries will have first base (regrouped)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree-All Levels	80	26.2	26.3	26.3
	Slightly Disagree	72	23.6	23.7	50.0
	Disagree & Strongly Disagree	152	49.8	50.0	100.0
	Total	304	99.7	100.0	
Missing	System	1	.3		
	Total	305	100.0		

Q4 I am very Patriotic

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	32	10.5	10.6	10.6
	agree	89	29.2	29.5	40.1
	slightly agree	97	31.8	32.1	72.2
	slightly disagree	40	13.1	13.2	85.4
	disagree	32	10.5	10.6	96.0
	Strongly disagree	12	3.9	4.0	100.0
	Total	302	99.0	100.0	
Missing	System	3	1.0		
	Total	305	100.0		

Q4 I am very Patriotic (regrouped)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree & Agree	121	39.7	40.1	40.1
	Slightly Agree	97	31.8	32.1	72.2
	Disagree-All Levels	84	27.5	27.8	100.0
	Total	302	99.0	100.0	
Missing	System	3	1.0		
	Total	305	100.0		

Q5 Moon Source of Useful Resources

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	22	7.2	7.4	7.4
	agree	46	15.1	15.4	22.7
	slightly agree	85	27.9	28.4	51.2
	slightly disagree	71	23.3	23.7	74.9
	disagree	56	18.4	18.7	93.6
	Strongly disagree	19	6.2	6.4	100.0
	Total	299	98.0	100.0	
Missing	System	6	2.0		
Total		305	100.0		

Q5 Moon Source of Useful Resources (regrouped)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree & Agree	68	22.3	22.7	22.7
	Slightly Agree	85	27.9	28.4	51.2
	Disagree-All Levels	146	47.9	48.8	100.0
	Total	299	98.0	100.0	
Missing	System	6	2.0		
Total		305	100.0		

Q6 Moon is Strategic Site

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	38	12.5	12.5	12.5
	agree	39	12.8	12.9	25.4
	slightly agree	65	21.3	21.5	46.9
	slightly disagree	51	16.7	16.8	63.7
	disagree	80	26.2	26.4	90.1
	Strongly disagree	30	9.8	9.9	100.0
	Total	303	99.3	100.0	
Missing	System	2	.7		
Total		305	100.0		

Q6 Moon is Strategic Site (regrouped)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree & Agree	77	25.2	25.4	25.4
	Slightly Agree & Slightly Disagree	116	38.0	38.3	63.7
	Disagree & Strongly Disagree	110	36.1	36.3	100.0
	Total	303	99.3	100.0	
Missing	System	2	.7		
Total		305	100.0		

Q7 Space faring Nations likely to Cooperate

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	24	7.9	7.9	7.9
	agree	75	24.6	24.8	32.7
	slightly agree	70	23.0	23.1	55.8
	slightly disagree	60	19.7	19.8	75.6
	disagree	48	15.7	15.8	91.4
	Strongly disagree	26	8.5	8.6	100.0
	Total	303	99.3	100.0	
Missing	System	2	.7		
Total		305	100.0		

Q7 Space faring Nations likely to Cooperate (regrouped)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree & Agree	99	32.5	32.7	32.7
	Slightly Agree & Slightly Disagree	130	42.6	42.9	75.6
	Disagree & Strongly Disagree	74	24.3	24.4	100.0
	Total	303	99.3	100.0	
Missing	System	2	.7		
Total		305	100.0		

Q8 Will Moon Base Pay for Itself?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never pay for self	147	48.2	48.5	48.5
	Breakeven	63	20.7	20.8	69.3
	Profitable after 15 years	93	30.5	30.7	100.0
	Total	303	99.3	100.0	
Missing	System	2	.7		
Total		305	100.0		

Q9 Acceptable Loss per 100 Astronauts

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	128	42.0	43.7	43.7
	1-20	99	32.5	33.8	77.5
	21-40	17	5.6	5.8	83.3
	41-60	20	6.6	6.8	90.1
	61-80	7	2.3	2.4	92.5
	81-100	22	7.2	7.5	100.0
	Total	293	96.1	100.0	
Missing	System	12	3.9		
Total		305	100.0		

Q9 Acceptable Loss per 100 Astronauts (regrouped)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 Astronauts	99	32.5	60.0	60.0
	20 or less Astronauts	17	5.6	10.3	70.3
	Greater than 20 Astronauts	49	16.1	29.7	100.0
	Total	165	54.1	100.0	
Missing	System	140	45.9		
Total		305	100.0		

Q10 Adequacy of the NASA Budget

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Need much more money	50	16.4	16.7	16.7
	Need Some more Money	103	33.8	34.4	51.2
	properly funded	111	36.4	37.1	88.3
	overfunded	27	8.9	9.0	97.3
	Extremely overfunded	8	2.6	2.7	100.0
	Total	299	98.0	100.0	
Missing	System	6	2.0		
	Total	305	100.0		

Q10 Adequacy of the NASA Budget (regrouped)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	They need much more money	50	16.4	16.7	16.7
	They need some more money	103	33.8	34.4	51.2
	They are properly or over funded	146	47.9	48.8	100.0
	Total	299	98.0	100.0	
Missing	System	6	2.0		
	Total	305	100.0		

It should be noted that not all the college students who took the pre-information survey took the post survey, and this shift in our sample size could have had created unexpected changes in our results. About one-sixth of the respondents to the first survey did not respond to the second survey, all of which were college students. The first two paragraphs refer to our general hypotheses, and are based on the analysis we did for all the question-specific hypotheses that follow.

Discussion

Students, on average, will become more receptive to the idea that there is likely to be a new space race after reading the informational materials. Our data did show that the average response was more likely to expect there to be a new space race after the information was presented. This is seen in the general increase of frequencies for all "agree" responses to questions 3, 6. However, it is slightly contradicted by the shift in responses for question 7. In the Post survey, students were more apt to believe that the space fairing nations would cooperate rather than compete with one another.

WPI students will be more likely to expect a new space race than high school students. We found that WPI students did not expect a new space race any more than high school students. Furthermore, the WPI students were more pessimistic about the potential benefits of space exploration. Since WPI students, in general, have a larger knowledge base for cost and risk analysis with these types of technologies, we believe that this added to their pessimism. Secondly, most high school students do not have much experience with financial responsibility and/or much knowledge of government funding policies. This may have contributed to the difference between high school and WPI distribution of responses. High School students do not have follow scholarship funding or government loan policies the way college students do. They are also probably more interested in the long-term economic opportunities to be created by the opening of the "New Frontier," given their age and the long lead times involved.

Students will, on average, agree that the United States should attempt to build a lunar base. A majority of students did think the US should build a base on the moon, and the proportion grew even larger after the information session. For the first survey, the

majority of students' responses were in the slightly disagree to slightly agree range with almost identical frequencies. After having been presented with the information, some of the respondents felt that adequate information had been presented to change their vote to a more solid "agree" response. Overall, responses tended to stay in the middle, with a slight tendency towards skepticism Also, after the presentation, the data shows a slight tendency for high school students to be more supportive of a US base on the moon developed.

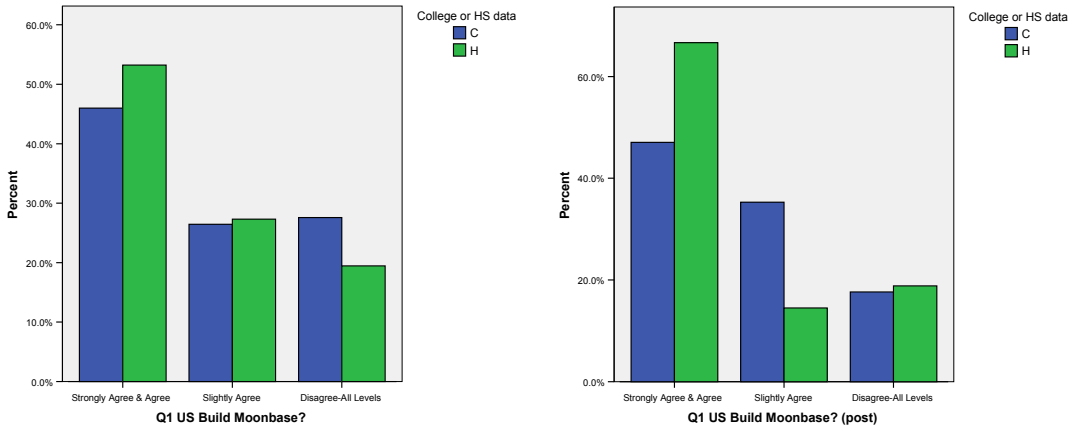


Figure 1: Question 1 vs. College or High School (pre and post)

Students will not know if the United States will be ready to colonize the moon within 25 years. After the information was given, opinions did firm up, but opinions were still divided.

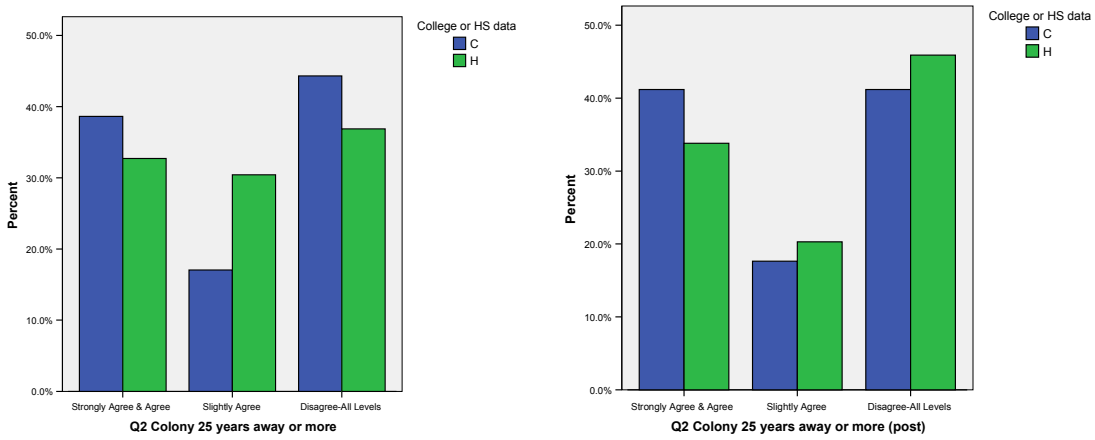


Figure 2: Question 2 vs. College or High School (pre and post)

Students will not want to believe that another country will be prepared to place a 500 person colony on the Moon before the United States if we tried to do so. The vast majority of students did not think another country could beat the US to the moon. Following the information session, people were more receptive to this possibility, but a majority still believed that this space race is the United States' to win.

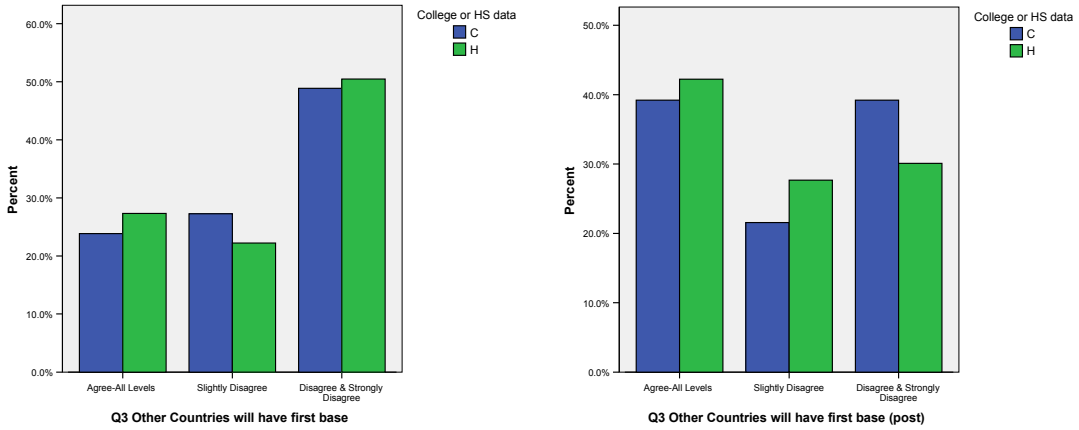


Figure 3: Question 3 vs. College or High School (pre and post)

Most students will consider themselves patriotic and those most patriotic will want to see us compete and win. Nearly three-quarters of those surveyed considered themselves patriotic. High school students tended to think themselves more patriotic than

did the college students. However, there was no significant difference in opinion between patriotic and non-patriotic respondents for over half the other questions. There were moderate correlations, with coefficients of between .2 and .3, for questions 1, 3, 5, and 6. For example, of those who were strongly in support of building a base on the moon (about 50% of respondents), 48% were patriotic, 20% were slightly patriotic, and 25% were not patriotic. In contrast, out of those opposed to building a base on the moon (about 22% of respondents), 22% were patriotic, 37% were slightly patriotic, and 41% were not patriotic (see Appendix F).

Figure 20: Correlation and Significance Coefficients from Patriotism Cross-tabs

	Pre-Gamma Correlation	Pre-Chi-Square Significance	Post-Gamma Correlation	Post-Chi-Square Significance
Q1 Build moon base?	.27	.00	.25	.00
Q2 25 years away?	.01	.98	.06	.14
Q3 Other country first?	.28	.00	.06	.90
Q5 Moon resources?	.23	.08	.16	.52
Q6 Moon strategic?	.23	.00	.27	.00
Q7 International Cooperation?	.09	.08	.02	.44
Q8 Base self-financing?	.03	.83	.19	.07
Q9 Astronaut loss	.00	.97	.14	.37
Q10 NASA budget	.03	.49	.25	.02

After the presentation, the correlation between patriotism and other countries beating the US and between patriotism and the moon being a source of natural resources diminished. However, new correlations, with .2 to .3 coefficients, occurred in patriotism versus a moon base will pay for itself and patriotism versus the adequacy of NASA's budget.

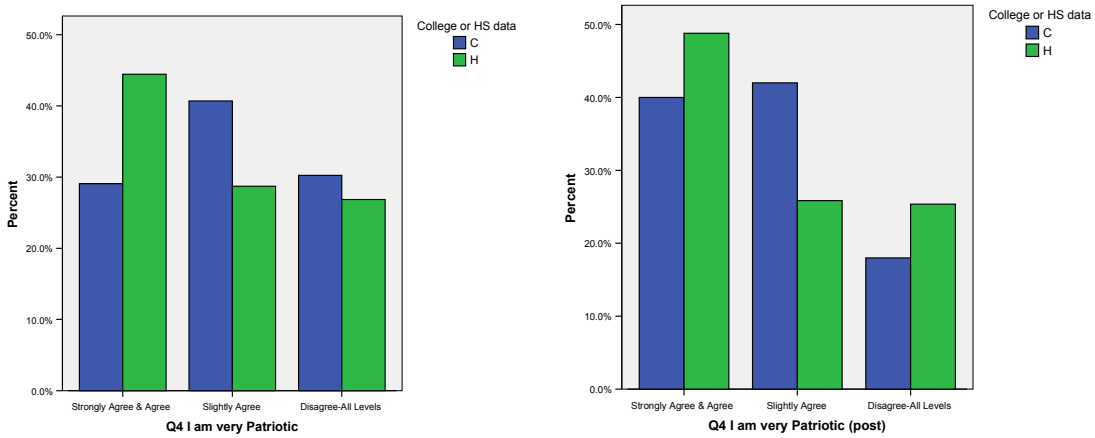


Figure 4: Question 4 vs. College or High School (pre and post)

Students will become aware that the Moon is a source of potentially useful resources even for use on Earth. The students were unsure of the Moon's worth beforehand, and after the information session, there was a significant swing, with many students accepting the possibility that lunar resources would be a future bounty worth having access to. High school students were more likely to believe the moon was a source of natural resources, and this divide in opinion widened after our information session.

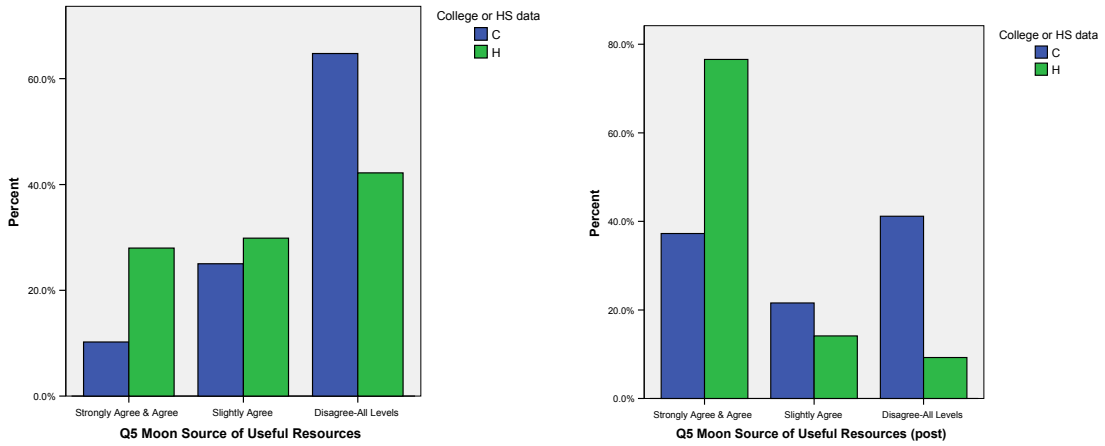


Figure 5: Question 5 vs. College or High School (pre and post)

Students probably do not know if the Moon is a strategic military location but some will liken it to holding the high ground and much easier to occupy than to seize in the face of defenders. Responses tended to fall in the middle, rather than either extreme. High school students were moderately more likely to believe that the moon was a strategic site before the presentation, but this relationship disappeared afterwards, as college students who disagreed were swayed, possibly by the prospect of new trade routes that must be defended.

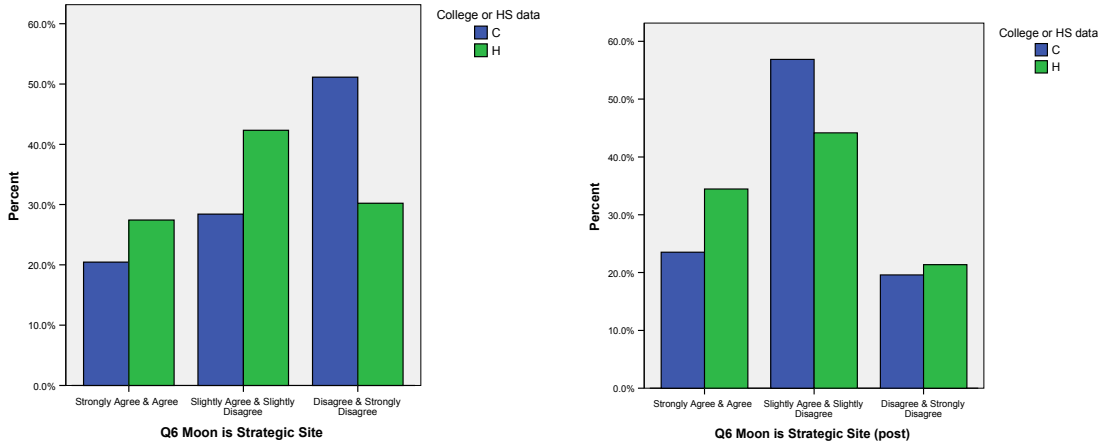


Figure 6: Question 6 vs. College or High School (pre and post)

The students will expect the United States to compete with foreign nations rather than cooperate in building a permanent lunar base. People were not as confident in their opinions as expected- responses were split about 50-50, and concentrated in the middle. The distribution of responses was not changed significantly by the presentation of new information.

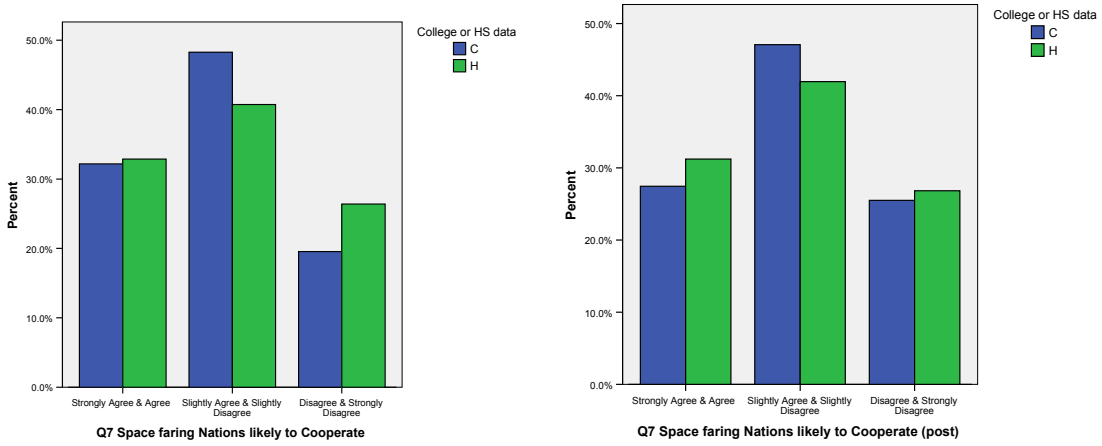


Figure 7: Question 7 vs. College or High School (pre and post)

Students will see a lunar base as a technological feat, and probably like Apollo, expensive with little hope of paying for itself. Students did not expect a lunar base to make any money. After the information session, students were more likely to expect some economic good to come out of a lunar base. Both groups saw a five-to-ten percent shift away from a base never paying for itself, with college students more likely to say it will break even and high school students saying it will be profitable after 15 years.

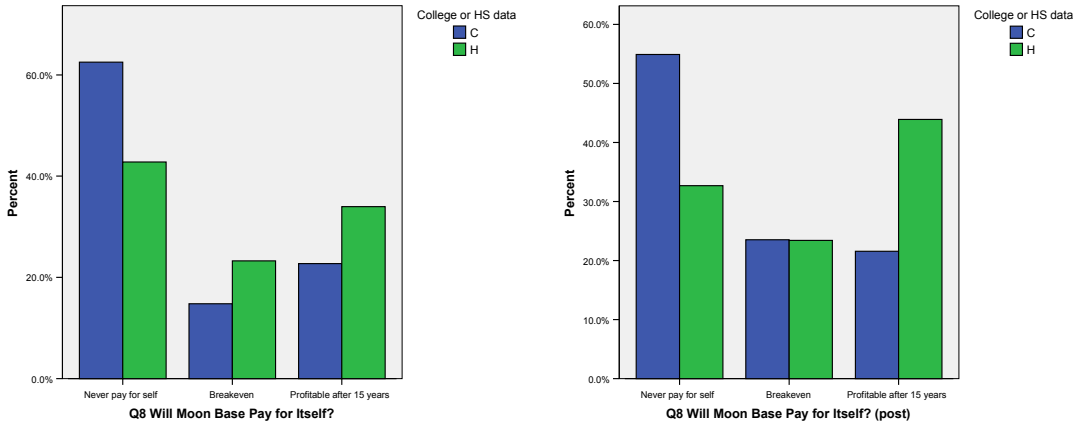


Figure 8: Question 8 vs. College or High School (pre and post)

Most students will not tolerate much loss of human life in the exploration of the Moon and space, but after Apollo1, Challenger, and Columbia they will expect some loss. Acceptance of deaths was very low, as expected- nearly half of the students would not accept any losses, and 75% said less than 10. These numbers increased slightly after the presentation. There was a clear tendency for high school students to accept higher losses, but this tendency weakened after the presentation, due to college students becoming more likely to accept greater losses.

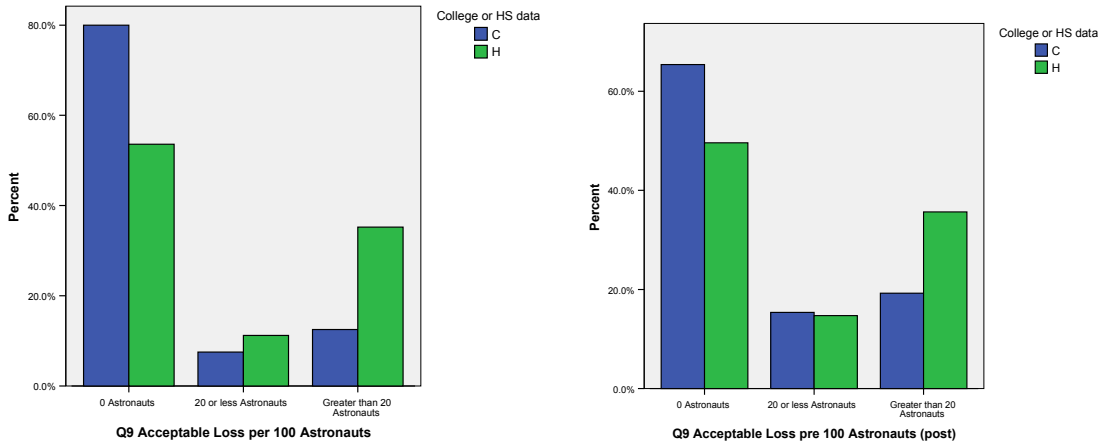


Figure 9: Question 9 vs. College or High School (pre and post)

Students will believe that NASA is at least adequately funded for their future space explorations. The students were willing to give NASA more than we expected-

half believed they needed more money, and that number increased to two-thirds after our presentation.

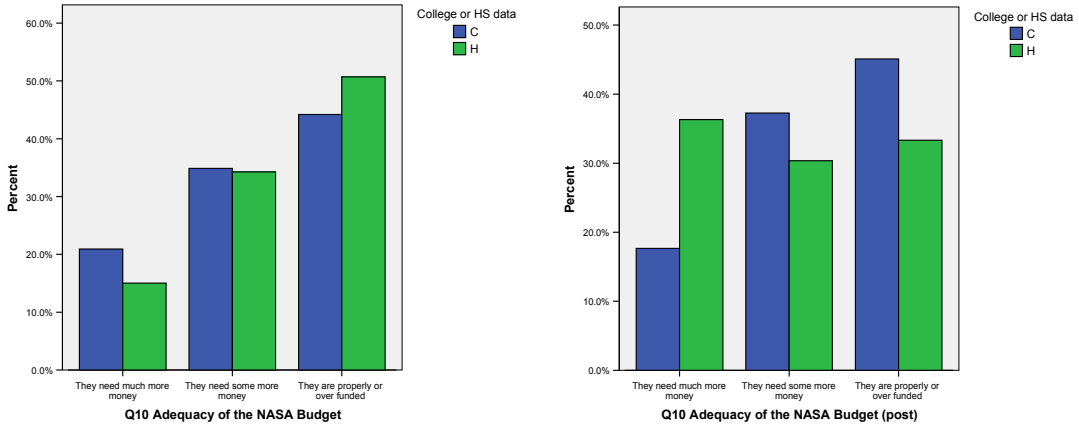


Figure 10: Question 10 vs. College or High School (pre and post)

Pre- vs. Post-information Analysis

For the Worcester high school data, the pre-information responses were cross-tabulated with the post-information responses to determine how individual opinions changed.

Q1 US Build Moonbase? * Q1 US Build Moonbase? (post)

			Q1 US Build Moonbase? (post)			Total
			Strongly Agree & Agree	Slightly Agree	Disagree-All Levels	
Q1 US Build Moonbase?	Strongly Agree & Agree	Count	57	8	2	67
		% within Q1 US Build Moonbase?	85.1%	11.9%	3.0%	100.0%
	Slightly Agree	Count	18	15	9	42
		% within Q1 US Build Moonbase?	42.9%	35.7%	21.4%	100.0%
	Disagree-All Levels	Count	3	3	23	29
		% within Q1 US Build Moonbase?	10.3%	10.3%	79.3%	100.0%
Total		Count	78	26	34	138
		% within Q1 US Build Moonbase?	56.5%	18.8%	24.6%	100.0%

Correlation Coefficient: .84

For the first question, most of the movement in opinion was from slightly agree to strongly agree. The majority of people's opinions did not change, but became stronger. Post opinions were highly predictable based on pre opinion- nearly 70% of the variance in the post data could be explained by the pre data.

Q2 Colony 25 years away or more * Q2 Colony 25 years away or more (post)

			Q2 Colony 25 years away or more (post)			Total
			Strongly Agree & Agree	Slightly Agree	Disagree-All Levels	
Q2 Colony 25 years away or more	Strongly Agree & Agree	Count	27	5	15	47
		% within Q2 Colony 25 years away or more	57.4%	10.6%	31.9%	100.0%
	Slightly Agree	Count	17	15	9	41
		% within Q2 Colony 25 years away or more	41.5%	36.6%	22.0%	100.0%
	Disagree-All Levels	Count	6	3	41	50
		% within Q2 Colony 25 years away or more	12.0%	6.0%	82.0%	100.0%
Total		Count	50	23	65	138
		% within Q2 Colony 25 years away or more	36.2%	16.7%	47.1%	100.0%

Correlation Coefficient: .59

A large number of people who agreed slightly moved to strongly agree/agree, but a significant portion of those who strongly agreed/agreed moved to disagree. Only 36% of the variance could be explained by pre data- the information caused a large change in the distribution.

Q3 Other Countries will have first base * Q3 Other Countries will have first base (post)

			Q3 Other Countries will have first base (post)			
			Agree-All Levels	Slightly Disagree	Disagree & Strongly Disagree	Total
Q3 Other Countries will have first base	Agree-All Levels	Count	29	4	3	36
		% within Q3 Other Countries will have first base	80.6%	11.1%	8.3%	100.0%
	Slightly Disagree	Count	7	15	5	27
		% within Q3 Other Countries will have first base	25.9%	55.6%	18.5%	100.0%
	Disagree & Strongly Disagree	Count	17	13	44	74
		% within Q3 Other Countries will have first base	23.0%	17.6%	59.5%	100.0%
Total		Count	53	32	52	137
		% within Q3 Other Countries will have first base	38.7%	23.4%	38.0%	100.0%

Correlation Coefficient: .68

There was significant movement towards more positive responses, and almost no one became more convinced that the US would be first. Almost 50% of the variance is explained by pre data.

Q4 I am very Patriotic * Q4 I am very Patriotic (post)

			Q4 I am very Patriotic (post)			Total
			Strongly Agree & Agree	Slightly Agree	Disagree-All Levels	
Q4 I am very Patriotic	Strongly Agree & Agree	Count	43	4	2	49
		% within Q4 I am very Patriotic	87.8%	8.2%	4.1%	100.0%
	Slightly Agree	Count	5	32	3	40
		% within Q4 I am very Patriotic	12.5%	80.0%	7.5%	100.0%
	Disagree-All Levels	Count	4	2	41	47
		% within Q4 I am very Patriotic	8.5%	4.3%	87.2%	100.0%
Total		Count	52	38	46	136
		% within Q4 I am very Patriotic	38.2%	27.9%	33.8%	100.0%

Correlation Coefficient: .90

As expected, very few people responded differently before and after, because the information had no influence on people's patriotism. With 81% of the post variance explained by the pre data, the pre and post patriotism data is nearly identical.

Q5 Moon Source of Useful Resources * Q5 Moon Source of Useful Resources (post)

			Q5 Moon Source of Useful Resources (post)			Total
			Strongly Agree & Agree	Slightly Agree	Disagree-All Levels	
Q5 Moon Source of Useful Resources	Strongly Agree & Agree	Count	33	2	2	37
		% within Q5 Moon Source of Useful Resources	89.2%	5.4%	5.4%	100.0%
	Slightly Agree	Count	20	12	1	33
		% within Q5 Moon Source of Useful Resources	60.6%	36.4%	3.0%	100.0%
	Disagree-All Levels	Count	33	12	16	61
		% within Q5 Moon Source of Useful Resources	54.1%	19.7%	26.2%	100.0%
Total		Count	86	26	19	131
		% within Q5 Moon Source of Useful Resources	65.6%	19.8%	14.5%	100.0%

Correlation Coefficient: .51

This question saw the biggest shift, with the majority of people who disagreed switched to agree, while almost no one who agreed moved to disagree. Only 25% of the post opinions are explained by pre data, so the information had a massive impact on opinions for this item.

Q6 Moon is Strategic Site * Q6 Moon is Strategic Site (post)

			Q6 Moon is Strategic Site (post)			Total
			Strongly Agree & Agree	Slightly Agree & Slightly Disagree	Disagree & Strongly Disagree	
Q6 Moon is Strategic Site	Strongly Agree & Agree	Count	25	3	3	31
		% within Q6 Moon is Strategic Site	80.6%	9.7%	9.7%	100.0%
	Slightly Agree & Slightly Disagree	Count	11	42	8	61
		% within Q6 Moon is Strategic Site	18.0%	68.9%	13.1%	100.0%
	Disagree & Strongly Disagree	Count	3	12	28	43
		% within Q6 Moon is Strategic Site	7.0%	27.9%	65.1%	100.0%
Total		Count	39	57	39	135
		% within Q6 Moon is Strategic Site	28.9%	42.2%	28.9%	100.0%

Correlation Coefficient: .78

There was very little movement, mostly from the middle to either extreme. About 60% of the post data is explained by the pre data.

Q7 Space faring Nations likely to Cooperate * Q7 Space faring Nations likely to Cooperate (post)

			Q7 Space faring Nations likely to Cooperate (post)			Total
			Strongly Agree & Agree	Slightly Agree & Slightly Disagree	Disagree & Strongly Disagree	
Q7 Space faring Nations likely to Cooperate	Strongly Agree & Agree	Count	33	8	3	44
		% within Q7 Space faring Nations likely to Cooperate	75.0%	18.2%	6.8%	100.0%
	Slightly Agree & Slightly Disagree	Count	10	34	13	57
		% within Q7 Space faring Nations likely to Cooperate	17.5%	59.6%	22.8%	100.0%
	Disagree & Strongly Disagree	Count	2	12	21	35
		% within Q7 Space faring Nations likely to Cooperate	5.7%	34.3%	60.0%	100.0%
Total		Count	45	54	37	136
		% within Q7 Space faring Nations likely to Cooperate	33.1%	39.7%	27.2%	100.0%

Correlation Coefficient: .77

Again, the only significant movement was out of the middle and into stronger opinions, with pre position accounting for about 60% of the post position.

Q8 Will Moon Base Pay for Itself? * Q8 Will Moon Base Pay for Itself? (post)

			Q8 Will Moon Base Pay for Itself? (post)			Total
			Never pay for self	Breakeven	Profitable after 15 years	
Q8 Will Moon Base Pay for Itself?	Never pay for self	Count	40	7	13	60
		% within Q8 Will Moon Base Pay for Itself?	66.7%	11.7%	21.7%	100.0%
	Breakeven	Count	6	23	3	32
		% within Q8 Will Moon Base Pay for Itself?	18.8%	71.9%	9.4%	100.0%
	Profitable after 15 years	Count	9	6	28	43
		% within Q8 Will Moon Base Pay for Itself?	20.9%	14.0%	65.1%	100.0%
Total		Count	55	36	44	135
		% within Q8 Will Moon Base Pay for Itself?	40.7%	26.7%	32.6%	100.0%

Correlation Coefficient: .58

People shifted back and forth, and there was no clear-cut trend in direction. The information session clearly shook up opinions, with only 35% of post opinions explained by pre opinions. About the same percentage of people changed from not believing a base could pay for itself to believing it might be able to and from believing it could to not.

Q9 Acceptable Loss per 100 Astronauts * Q9 Acceptable Loss pre 100 Astronauts (post)

			Q9 Acceptable Loss pre 100 Astronauts (post)			Total
			0 Astronauts	20 or less Astronauts	Greater than 20 Astronauts	
Q9 Acceptable Loss per 100 Astronauts	0 Astronauts	Count	22	3	5	30
		% within Q9 Acceptable Loss per 100 Astronauts	73.3%	10.0%	16.7%	100.0%
	20 or less Astronauts	Count	0	7	1	8
		% within Q9 Acceptable Loss per 100 Astronauts	.0%	87.5%	12.5%	100.0%
	Greater than 20 Astronauts	Count	3	0	31	34
		% within Q9 Acceptable Loss per 100 Astronauts	8.8%	.0%	91.2%	100.0%
Total		Count	25	10	37	72
		% within Q9 Acceptable Loss per 100 Astronauts	34.7%	13.9%	51.4%	100.0%

Correlation Coefficient: .870

67% of post opinions were explained by pre opinions. There were very few shifts in opinion, most of which entailed people who were not willing to accept any losses changing to accepting some losses. In general, the data does not support the hypothesis that increased support for a base or more knowledge about what is at stake would increase tolerance for losses.

Q10 Adequacy of the NASA Budget * Q10 Adequacy of the NASA Budget (post)

			Q10 Adequacy of the NASA Budget (post)			Total
			They need much more money	They need some more money	They are properly or over funded	
Q10 Adequacy of the NASA Budget	They need much more money	Count	13	3	4	20
		% within Q10 Adequacy of the NASA Budget	65.0%	15.0%	20.0%	100.0%
	They need some more money	Count	15	20	5	40
		% within Q10 Adequacy of the NASA Budget	37.5%	50.0%	12.5%	100.0%
	They are properly or over funded	Count	6	14	53	73
		% within Q10 Adequacy of the NASA Budget	8.2%	19.2%	72.6%	100.0%
Total		Count	34	37	62	133
		% within Q10 Adequacy of the NASA Budget	25.6%	27.8%	46.6%	100.0%

Correlation Coefficient: .75

A significant portion of respondents shifted towards NASA needing more money, while few shifted towards NASA being over funded. Just over half of the variance in the post data is explained by the pre data. Other things besides perception of the moon's value are clearly involved, but perception had more of an impact here than on whether a moon base should be built.

Other Analysis

We were also interested in the relationship between the positions taken on the various survey items. Initially, and on theoretical grounds, we identified questions 1 (should the US build a base on the moon?), 5 (the moon is a source of useful natural resources), and 8 (will a US moon base be a profitable venture?) as our independent variables, and questions 9 (Out of 100, what is the highest number of astronauts worth sacrificing to build a moon base?) and 10 (What are your feelings about NASA's funding level) as dependent variables. In retrospect, this was not a good theory, but we'll share the results before explaining our new theory.

Q1 US Build Moonbase? * Q9 Acceptable Loss per 100 Astronauts

			Q9 Acceptable Loss per 100 Astronauts			Total
			0 Astronauts	20 or less Astronauts	Greater than 20 Astronauts	
Q1 US Build Moonbase?	Strongly Agree & Agree	Count	57	13	25	95
		% within Q1 US Build Moonbase?	60.0%	13.7%	26.3%	100.0%
	Slightly Agree	Count	23	3	13	39
		% within Q1 US Build Moonbase?	59.0%	7.7%	33.3%	100.0%
	Disagree-All Levels	Count	17	1	11	29
		% within Q1 US Build Moonbase?	58.6%	3.4%	37.9%	100.0%
Total		Count	97	17	49	163
		% within Q1 US Build Moonbase?	59.5%	10.4%	30.1%	100.0%

Chi-Square Test: .435 Correlation Coefficient: .076 There is not a statistically significant relationship at the .05 level- wanting to build a moon base is not likely to make one more tolerant of loss of astronaut's lives.

Q1 US Build Moonbase? (post) * Q9 Acceptable Loss pre 100 Astronauts (post)

			Q9 Acceptable Loss pre 100 Astronauts (post)			Total
			0 Astronauts	20 or less Astronauts	Greater than 20 Astronauts	
Q1 US Build Moonbase? (post)	Strongly Agree & Agree	Count	62	19	34	115
		% within Q1 US Build Moonbase? (post)	53.9%	16.5%	29.6%	100.0%
	Slightly Agree	Count	13	0	5	18
		% within Q1 US Build Moonbase? (post)	72.2%	.0%	27.8%	100.0%
	Disagree-All Levels	Count	6	4	11	21
		% within Q1 US Build Moonbase? (post)	28.6%	19.0%	52.4%	100.0%
Total		Count	81	23	50	154
		% within Q1 US Build Moonbase? (post)	52.6%	14.9%	32.5%	100.0%

Chi-Square Test: .05 Correlation Coefficient: .19

A small but significant correlation developed with the addition of new knowledge. After the information session, 4% of the variance is explained by this factor.

Q1 US Build Moonbase? * Q10 Adequacy of the NASA Budget

			Q10 Adequacy of the NASA Budget			Total
			They need much more money	They need some more money	They are properly or over funded	
Q1 US Build Moonbase?	Strongly Agree & Agree	Count	30	62	59	151
		% within Q1 US Build Moonbase?	19.9%	41.1%	39.1%	100.0%
	Slightly Agree	Count	9	28	44	81
		% within Q1 US Build Moonbase?	11.1%	34.6%	54.3%	100.0%
	Disagree-All Levels	Count	11	12	42	65
		% within Q1 US Build Moonbase?	16.9%	18.5%	64.6%	100.0%
Total		Count	50	102	145	297
		% within Q1 US Build Moonbase?	16.8%	34.3%	48.8%	100.0%

Chi-Square Test: .00 Correlation Coefficient: .28

Those who believe the US should put a base on the moon are moderately more likely to believe NASA needs more money. About 8% of the variance in budget opinion is explained by this factor.

Q1 US Build Moonbase? (post) * Q10 Adequacy of the NASA Budget (post)

			Q10 Adequacy of the NASA Budget (post)			Total
			They need much more money	They need some more money	They are properly or over funded	
Q1 US Build Moonbase? (post)	Strongly Agree & Agree	Count	64	57	37	158
		% within Q1 US Build Moonbase? (post)	40.5%	36.1%	23.4%	100.0 %
		% within Q10 Adequacy of the NASA Budget (post)	79.0%	71.3%	41.1%	62.9%
	Slightly Agree	Count	8	15	24	47
		% within Q1 US Build Moonbase? (post)	17.0%	31.9%	51.1%	100.0 %
		% within Q10 Adequacy of the NASA Budget (post)	9.9%	18.8%	26.7%	18.7%
	Disagree-All Levels	Count	9	8	29	46
		% within Q1 US Build Moonbase? (post)	19.6%	17.4%	63.0%	100.0 %
		% within Q10 Adequacy of the NASA Budget (post)	11.1%	10.0%	32.2%	18.3%
Total		Count	81	80	90	251
		% within Q1 US Build Moonbase? (post)	32.3%	31.9%	35.9%	100.0 %
		% within Q10 Adequacy of the NASA Budget (post)	100.0%	100.0%	100.0%	100.0 %

Chi-Square Test: .000 Correlation Coefficient: .48

The correlation was strengthened by the informational presentation. Now 24% of the variance is explained- opinion on NASA's budget is three times more connected with wanting to build a moon base.

Q5 Moon Source of Useful Resources * Q9 Acceptable Loss per 100 Astronauts

			Q9 Acceptable Loss per 100 Astronauts			Total
			0 Astronauts	20 or less Astronauts	Greater than 20 Astronauts	
Q5 Moon Source of Useful Resources	Strongly Agree & Agree	Count	23	8	18	49
		% within Q5 Moon Source of Useful Resources	46.9%	16.3%	36.7%	100.0%
	Slightly Agree	Count	29	5	7	41
		% within Q5 Moon Source of Useful Resources	70.7%	12.2%	17.1%	100.0%
	Disagree-All Levels	Count	45	4	22	71
		% within Q5 Moon Source of Useful Resources	63.4%	5.6%	31.0%	100.0%
Total		Count	97	17	47	161
		% within Q5 Moon Source of Useful Resources	60.2%	10.6%	29.2%	100.0%

Chi-Square Test: .07 Correlation Coefficient: -.15 There is a very slight likelihood that those who believe the moon is a source of useful resources are willing to risk more lost lives, but not quite at a .05 significance level. Only 2.25% of the variance in accepted losses is explained by perception of the moon's natural resources.

Q5 Moon Source of Useful Resources (post) * Q9 Acceptable Loss pre 100 Astronauts (post)

			Q9 Acceptable Loss pre 100 Astronauts (post)			Total
			0 Astronauts	20 or less Astronauts	Greater than 20 Astronauts	
Q5 Moon Source of Useful Resources (post)	Strongly Agree & Agree	Count	62	16	37	115
		% within Q5 Moon Source of Useful Resources (post)	53.9%	13.9%	32.2%	100.0%
		% within Q9 Acceptable Loss pre 100 Astronauts (post)	76.5%	69.6%	74.0%	74.7%
	Slightly Agree	Count	12	5	2	19
		% within Q5 Moon Source of Useful Resources (post)	63.2%	26.3%	10.5%	100.0%
		% within Q9 Acceptable Loss pre 100 Astronauts (post)	14.8%	21.7%	4.0%	12.3%
	Disagree-All Levels	Count	7	2	11	20
		% within Q5 Moon Source of Useful Resources (post)	35.0%	10.0%	55.0%	100.0%
		% within Q9 Acceptable Loss pre 100 Astronauts (post)	8.6%	8.7%	22.0%	13.0%
Total		Count	81	23	50	154
		% within Q5 Moon Source of Useful Resources (post)	52.6%	14.9%	32.5%	100.0%
		% within Q9 Acceptable Loss pre 100 Astronauts (post)	100.0%	100.0%	100.0%	100.0%

Chi-Square Test: .05 Correlation Coefficient: .11

There is still a weak relationship, with only 1% of the variance explained at this point.

Q5 Moon Source of Useful Resources * Q10 Adequacy of the NASA Budget

			Q10 Adequacy of the NASA Budget			Total
			They need much more money	They need some more money	They are properly or over funded	
Q5 Moon Source of Useful Resources	Strongly Agree & Agree	Count	17	22	27	66
		% within Q5 Moon Source of Useful Resources	25.8%	33.3%	40.9%	100.0%
	Slightly Agree	Count	10	38	36	84
		% within Q5 Moon Source of Useful Resources	11.9%	45.2%	42.9%	100.0%
	Disagree-All Levels	Count	23	40	80	143
		% within Q5 Moon Source of Useful Resources	16.1%	28.0%	55.9%	100.0%
Total		Count	50	100	143	293
		% within Q5 Moon Source of Useful Resources	17.1%	34.1%	48.8%	100.0%

Chi-Square Test: .02 Correlation Coefficient: .19 People who believe the moon is a good source of natural resources are slightly more likely to think NASA needs more money. This is a significant relationship, but only about 4% of the variance in opinion on NASA's budget is explained by perception of the moon's natural resources.

Q5 Moon Source of Useful Resources (post) * Q10 Adequacy of the NASA Budget (post)

			Q10 Adequacy of the NASA Budget (post)			Total
			They need much more money	They need some more money	They are properly or over funded	
Q5 Moon Source of Useful Resources (post)	Strongly Agree & Agree	Count	67	57	46	170
		% within Q5 Moon Source of Useful Resources (post)	39.4%	33.5%	27.1%	100.0%
		% within Q10 Adequacy of the NASA Budget (post)	84.8%	71.3%	51.1%	68.3%
	Slightly Agree	Count	5	11	24	40
		% within Q5 Moon Source of Useful Resources (post)	12.5%	27.5%	60.0%	100.0%
		% within Q10 Adequacy of the NASA Budget (post)	6.3%	13.8%	26.7%	16.1%
	Disagree-All Levels	Count	7	12	20	39
		% within Q5 Moon Source of Useful Resources (post)	17.9%	30.8%	51.3%	100.0%
		% within Q10 Adequacy of the NASA Budget (post)	8.9%	15.0%	22.2%	15.7%
Total		Count	79	80	90	249
		% within Q5 Moon Source of Useful Resources (post)	31.7%	32.1%	36.1%	100.0%
		% within Q10 Adequacy of the NASA Budget (post)	100.0%	100.0%	100.0%	100.0%

Chi-Square Test: .00 Correlation Coefficient: .45

The correlation became much stronger after the information session. Now there is a clear connection, with 20% of the variance explained by perception of the moon- a five fold increase in predictive power.

Q8 Will Moon Base Pay for Itself? * Q9 Acceptable Loss per 100 Astronauts

			Q9 Acceptable Loss per 100 Astronauts			Total
			0 Astronauts	20 or less Astronauts	Greater than 20 Astronauts	
Q8 Will Moon Base Pay for Itself?	Never pay for self	Count	45	6	21	72
		% within Q8 Will Moon Base Pay for Itself?	62.5%	8.3%	29.2%	100.0%
	Breakeven	Count	23	4	12	39
		% within Q8 Will Moon Base Pay for Itself?	59.0%	10.3%	30.8%	100.0%
	Profitable after 15 years	Count	31	7	16	54
		% within Q8 Will Moon Base Pay for Itself?	57.4%	13.0%	29.6%	100.0%
Total		Count	99	17	49	165
		% within Q8 Will Moon Base Pay for Itself?	60.0%	10.3%	29.7%	100.0%

Chi-Square Test: .94 Correlation Coefficient: .05 There is apparently no relationship between opinions on the profitability of a US moon base and acceptable losses.

Q8 Will Moon Base Pay for Itself? (post) * Q9 Acceptable Loss pre 100 Astronauts (post)

			Q9 Acceptable Loss pre 100 Astronauts (post)			Total
			0 Astronauts	20 or less Astronauts	Greater than 20 Astronauts	
Q8 Will Moon Base Pay for Itself? (post)	Never pay for self	Count	25	9	15	49
		% within Q8 Will Moon Base Pay for Itself? (post)	51.0%	18.4%	30.6%	100.0%
		% within Q9 Acceptable Loss pre 100 Astronauts (post)	30.9%	39.1%	30.0%	31.8%
	Breakeven	Count	19	4	14	37
		% within Q8 Will Moon Base Pay for Itself? (post)	51.4%	10.8%	37.8%	100.0%
		% within Q9 Acceptable Loss pre 100 Astronauts (post)	23.5%	17.4%	28.0%	24.0%
	Profitable after 15 years	Count	37	10	21	68
		% within Q8 Will Moon Base Pay for Itself? (post)	54.4%	14.7%	30.9%	100.0%
		% within Q9 Acceptable Loss pre 100 Astronauts (post)	45.7%	43.5%	42.0%	44.2%
Total		Count	81	23	50	154
		% within Q8 Will Moon Base Pay for Itself? (post)	52.6%	14.9%	32.5%	100.0%
		% within Q9 Acceptable Loss pre 100 Astronauts (post)	100.0%	100.0%	100.0%	100.0%

Chi-Square Test: .84 Correlation Coefficient: -.03

No relationship appeared after the new information was presented.

Q8 Will Moon Base Pay for Itself? * Q10 Adequacy of the NASA Budget

			Q10 Adequacy of the NASA Budget			Total
			They need much more money	They need some more money	They are properly or over funded	
Q8 Will Moon Base Pay for Itself?	Never pay for self	Count	30	43	72	145
		% within Q8 Will Moon Base Pay for Itself?	20.7%	29.7%	49.7%	100.0%
	Breakeven	Count	5	24	33	62
		% within Q8 Will Moon Base Pay for Itself?	8.1%	38.7%	53.2%	100.0%
	Profitable after 15 years	Count	15	36	40	91
		% within Q8 Will Moon Base Pay for Itself?	16.5%	39.6%	44.0%	100.0%
Total		Count	50	103	145	298
		% within Q8 Will Moon Base Pay for Itself?	16.8%	34.6%	48.7%	100.0%

Chi-Square Test: .15 Correlation Coefficient: -.01 There is no apparent relationship between opinion on the profitability of a US moon base and the sufficiency of NASA's budget.

Q8 Will Moon Base Pay for Itself? (post) * Q10 Adequacy of the NASA Budget (post)

			Q10 Adequacy of the NASA Budget (post)			Total
			They need much more money	They need some more money	They are properly or over funded	
Q8 Will Moon Base Pay for Itself? (post)	Never pay for self	Count	28	25	40	93
		% within Q8 Will Moon Base Pay for Itself? (post)	30.1%	26.9%	43.0%	100.0%
		% within Q10 Adequacy of the NASA Budget (post)	34.1%	31.3%	44.4%	36.9%
	Breakeven	Count	14	22	23	59
		% within Q8 Will Moon Base Pay for Itself? (post)	23.7%	37.3%	39.0%	100.0%
		% within Q10 Adequacy of the NASA Budget (post)	17.1%	27.5%	25.6%	23.4%
	Profitable after 15 years	Count	40	33	27	100
		% within Q8 Will Moon Base Pay for Itself? (post)	40.0%	33.0%	27.0%	100.0%
		% within Q10 Adequacy of the NASA Budget (post)	48.8%	41.3%	30.0%	39.7%
Total		Count	82	80	90	252
		% within Q8 Will Moon Base Pay for Itself? (post)	32.5%	31.7%	35.7%	100.0%
		% within Q10 Adequacy of the NASA Budget (post)	100.0%	100.0%	100.0%	100.0%

Chi-Square Test: .08 Correlation Coefficient: -.19

After the information session, 4% of the variance could be explained, but not at a .05 significance level.

After doing this analysis, we realized we had mixed up our dependent and independent variables. What we in fact should be interested in as dependent variables were the "policy" variables: should the US build a base on the moon and is NASA's budget sufficient. Thus, our most significant independent variable is people's perception of the moon, specifically, if there are valuable natural resources there, since this is what the information we introduced was focused on. The first step in our new analysis was a cross-tabulation of support for a US moon base against NASA's budget, done separately for those who believed the moon a good source of natural resources, those who weren't sure, and those who did not, for the pre-information data. We found that for those who thought the moon was a source of natural resources and those who weren't sure, there was no strong relationship, but for those who believed it was not, those who believed the US should build a base on the moon were more likely to believe NASA needs more money.

Figure 21: Correlation and Significance Coefficients from Q1 (Should the US build a moon base) vs. Q10 (Is NASA getting enough money)

	Correlation Coefficient	Chi-Square Significance Test
Moon is a good source of natural resources	.16	.37
Don't know	.28	.39
Moon is not a good source of natural resources	.32	.02

We then created a new variable to measure how people's perception of the amount of natural resources on the moon changed based on the information session.

Frequency Distribution for Lunar Perception Change

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	pre and post-resource-rich	53	17.4	17.4	17.4
	pre doubts- post resource-rich	54	17.7	17.7	35.1
	pre not resource-rich-post resource-rich	64	21.0	21.0	56.1
	pre and post- doubts	14	4.6	4.6	60.7
	pre not resource-rich-post doubts	21	6.9	6.9	67.5
	pre and post- not resource-rich	30	9.8	9.8	77.4
	other	69	22.6	22.6	100.0
	Total	305	100.0	100.0	

We then ran cross-tabulations of this new variable with the moon base and NASA funding questions, and found that people with the same post-information opinion of the value of natural resources on the moon did not strongly differ in opinion based on what their pre-information opinion was. Therefore, we were able to lump them back together, and ran the cross-tabulation of support for a moon base against NASA's budget needs for each category of moon is a good source of natural resources for the post data.

Figure 22: Correlation and Significance Coefficients from Q1 (Should the US build a moon base) (post) vs. Q10 (Is NASA getting enough money) (post)

	Correlation Coefficient	Chi-Square Significance Test
Moon is a good source of natural resources	.479	.000
Don't know	.514	.170
Moon is not a good source of natural resources	.000	.891

This time, the strong correlation was found in those who thought the moon is a good source of natural resources, while there was absolutely no difference for those who did not. Clearly the information session had massively realigned people's thinking about the moon and NASA policy, as well as changing their opinion about the value of a moon base. Connections were being made where they were not before. People who were supporting a moon base for economic reasons were shifting in on top of those who had supported it before for a variety of reasons. The perception of the moon as resource-rich or not is a key variable.

Conclusions

Students have little information and have never been asked to think about the technology available, or the social, economical, and political implications a new space race would have. Their perception of what is on the Moon- what we learned from Apollo- is that there is "nothing there." They probably also started out thinking that the US is the only country capable of placing a base on the Moon, doubtful anyone else would want to do so, and hence saw no urgency in actually building a base. They probably weren't sure if the Moon can be used militarily or if the Moon has any useful resources.

The WPI population is only marginally more informed about what is on the Moon the possibility of a space race. WPI students may have been more likely to read an article or go to space camp, but without some form of rigorous space presentation in the curriculum or highly-publicized talk on campus, they have not set themselves

substantially apart from the high school population on most of the questions. Indeed, they are more skeptical about the value of building a base on the Moon. Questions about a possible US Moon base and available technologies show a distinctive opinion in the college sample, but others about social and political issues just mirrored the high school population.

It was interesting to see that what these students could be taught in a half hour presentation and summarized on a single sheet of paper mattered so much. We wondered if they would change their opinions, or just become more firm on their stance. We found evidence of both, but change toward support for space activity on the Moon was the dominant trend, once people got the idea that there was something there worth having. If the distribution of opinions on support for a moon base, the possibility of useful resources on the moon, or NASA's budget can be changed this much in less than an hour, with no propagandizing involved, how much could they be changed if a high school science class included a serious unit on space, dealing with potential technological breakthroughs like space elevators or single stage to orbit rockets refueling in low Earth orbit on local fuel supplies or nuclear fusion reactors? Should social studies and civics classes be incorporating some of the political and economic issues discussed in this paper? Mining and property rights on the moon will soon become important issues, and cooperation or competition in developing the moon will be a question the public will soon have to vote on. At least the students who will vote on these issues would have a better basis for making informed decisions about space policy if they have a formal exposure to space science, technology, and policy in high school and in college.

BIBLIOGRAPHY

China National Space Administration. "White Paper: China's Space Activities in 2006". 12 October 2006. http://www.cnsa.gov.cn/n615709/n620681/n771967/79970.html.

"Chinese Scientists Announce Plans for Moon Exploration". China Daily. 20 May 2002. http://www.china.org.cn/english/2002/May/32920.htm.

Flaherty, William, et al. "Effect of Cognitive Preference on Forecasting Space Technologies". Worcester Polytechnic Institute. 01 March 2007.

Freemantle, Tony and Mike Tolson. "Majority wants space flights halted until goals set". Houston Chronicle. 20 July 2003. http://www.chron.com/disp/story.mpl/space/2001674.html.

Hurtak, J. J. "Existing Space Law Concepts and Legislation Proposals". The Academy for Future Science. 2005. http://www.affs.org/html/existing_space_law_concepts.htm.

Johnson-Freese, Joan. "Chinese Chess in Space: New US manned space program should include China as a partner". Yale Global Online. 13 January 2004. http://yaleglobal.yale.edu/display.article?id=3128.

Office of the Press Secretary. "President Bush Announces New Vision for Space Exploration Program". Press Release. 14 January 2004. http://www.whitehouse.gov/news/releases/2004/01/20040114-3.html.

Saunders, Elko, et al. "The Future of Space Exploration: A Second Moon Race". Worcester Polytechnic Institute. 2004.

Sietzen, Frank. "A New Asian Space Race Emerges". 25 January 2000. http://www.fas.org/news/skorea/2000/korea_space_00124.htm

APPENDICES

Appendix A: Initial Survey

Public Opinion of U.S. Space Program

A WPI "Space Policy Initiative" Survey (for the IQP Program of WPI)

Please circle the answer that BEST describes your opinion.

	Strongly Agree	Agree	Slightly Agree	Slightly Disagree	Disagree	Strongly Disagree
1] The United States should attempt to place a permanent base on the Moon.	1	2	3	4	5	6
2] The United States will not be technologically able to colonize the Moon for at least 25 years.	1	2	3	4	5	6
3] Another country will be ready to build a permanent town of 500 people on the Moon before the United States.	1	2	3	4	5	6
4] I am very patriotic.	1	2	3	4	5	6
5] The Moon is a source of useful natural resources for Earth.	1	2	3	4	5	6
6] The Moon is a strategic military location.	1	2	3	4	5	6
7] It is more likely that the U.S., Russia, China, Japan and Europe will cooperate rather than compete in an effort to build an Earth colony on the Moon.	1	2	3	4	5	6
8] Which statement do you agree with most?	A US Moon base will never be able to pay for itself.		A US Moon base will break even on profit and cost.		After 15 years, a US Moon base will be profitable.	
9] Out of a 100 person astronaut corps, what is the highest number of lost astronauts worth the sacrifice to build a permanent moon base?	____/100					
10] What are your feelings about the adequacy of NASA's current funding level?	They need much more		They need some more	They are properly funded.	They are over funded.	They are extremely over funded.

M or F

Race:_____

Appendix B: Information Sheet

Information Sheet

- In January 2004, President Bush announced his approval of NASA's plan to return to the moon by 2018 – but does not promise a greatly enlarged budget
- The current 2007 Budget for NASA included $16.8 billion from congress. - nasa.gov
- China has released its plans for a permanent lunar base
- China, Europe, Russia, and Japan are all currently developing programs to land on the moon.

Brief History

- The total costs of the Apollo project was approximately $14,644,000,000 (1994 dollars) - The Artemis Project

Successes	Failures
Apollo 11 – America is the first to land on the moon in 1969	Challenger – exploded during take off killing 7 in 1986
Hubble Space Telescope	Columbia – exploded during reentry killing 7 in 2003
Voyager 1 and 2	Apollo 1 – a fire during a countdown test kills 3 in 1967

After Apollo . . .

- NASA asked for funding for a Mars mission or funding to build a Space Station and Shuttle
- NASA was granted funding for an unmanned space program by the Nixon administration.
- Unhappy, NASA officials promise a manned program for the same amount – Builds the shuttle "on the cheap" without approval to build a space station, but the shuttle makes no sense without one.
- The average cost of one flight of the shuttle is currently at $1.3 billion - spacetoday.org
- The Space station Mission was approved in the Reagan administration.
- So far the United States has contributed $96 billion to the International Space Station and it is far from completion. - nasa.gov

- Even if completed the ISS will not be in the right orbit to be a departure point for the Moon or Mars
- The Shuttle is to be retired by 2010 and replaced by a new "transfer vehicle" more like an Apollo capsule
- The new NASA administration wants to defund the ISS and shuttle, and resume from where the Apollo program left off.
- The cost to return to the moon is estimated at $104 billion. - USAtoday.com

Moon Resources

- Lunar regolith contains oxygen, silicon, magnesium, iron, calcium, aluminum and titanium.
- Researchers at NASA believe the future of energy production lies with a fusion reactor fuel - helium-3. One ton could supply the electrical needs of a city of 10 million people when combined in a fusion reactor with a form of hydrogen.
- Lunar samples collected by Apollo astronauts show the resource is so plentiful that the Earth's energy needs could be accommodated for at least 1,000 years

Appendix C: Discussion Instructions

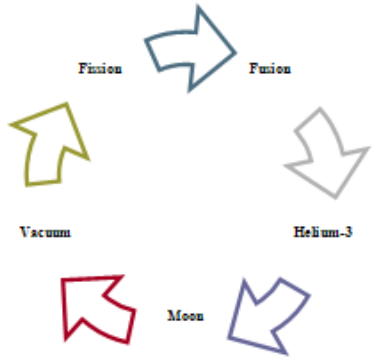
Instructions to Discussion Leader
Note: It is important for students to share (and possibly debate) their ideas and opinions throughout the discussion.

1. Have Students fill out the first survey (10 min)

2. Take time to go through all the points on the information sheet provided. (20 min) This part of the discussion is to be sure that all students have some basic knowledge of NASA's history. It will also give them some idea about the enormous costs to the space program; not only financial costs but also loss of life. Feel free to put these costs into perspective any way you see fit. Add any historic NASA knowledge you can personally add and invite your students to do the same.

3. Next, there are two important points we would like you to make with your students. (20 min) The first point is fusion and Helium-3 and how they may play a major role in Earth's future energy consumption. The other has to do with cooperation or competition between the United States and other "space ready" nations.

Helium-3



Please reproduce the diagram on the right starting with Fission. Explain that fission is the method in use in today's nuclear plants.
Next explain that we need to fully understand fission in order to harness the power of fusion reactions. The main reason we don't fully understand fission is that we haven't been able to produce a 100% vacuum on Earth to study the reaction within. Fusion is probably best described as a "reverse reaction" of fission ultimately resulting in a highly efficient system for creating and harnessing energy.
Next Helium-3 is just like regular Helium, but it has an extra neutron that makes it a very desirable element for use in fusion reactions. However, Helium-3 is not found naturally on Earth, but there is substantial proof that it exists on the Moon. Scientists expect that there would be enough Helium-3 on the Moon to solve our energy problems for up to 1000 years.
Lastly, remind the students (if they haven't already put it together) that the Moon is a vacuum! Show how this leads back to the point of how to perfect fission.
The only logical place to break into this circular problem is to go to the Moon.

Cooperation vs. Competition

Reiterate to the students that China, Russia, and a handful of nations in the European Union (but mostly China) are planning a Moon mission of their own. The bounty of ores and other minerals (including He-3) are understood by scientists of all nations. Contemplate the impact of a nation like China getting to the Moon first and taking the prime positions to harvest the Moons treasures (or the small supply of water located at the South Pole). If China corners the market on He-3 our main energy source of the future could be dependant on our ability to trade with China. What could this mean for the US economy? What would this mean for foreign relations? What new allies or enemies of our country might emerge? If time allows encourage your students to debate these questions and more.

4. Have students fill out the second survey. (10 min)

Appendix D: Second Survey

Public Opinion of U.S. Space Program

A WPI "Space Policy Initiative" Survey (for the IQP Program of WPI)

Please circle the answer that BEST describes your opinion.

	Strongly Agree	Agree	Slightly Agree	Slightly Disagree	Disagree	Strongly Disagree
1) The United States should attempt to place a permanent base on the Moon.	1	2	3	4	5	6
2) The United States will not be technologically able to colonize the Moon for at least 25 years.	1	2	3	4	5	6
3) Another country will be ready to build a permanent town of 500 people on the Moon before the United States.	1	2	3	4	5	6
4) I am very patriotic.	1	2	3	4	5	6
5) The Moon is a source of useful natural resources for Earth.	1	2	3	4	5	6
6) The Moon is a strategic military location.	1	2	3	4	5	6
7) It is more likely that the U.S., Russia, China, Japan and Europe will cooperate rather than compete in an effort to build an Earth colony on the Moon.	1	2	3	4	5	6

8) Which statement do you agree with most?	A US Moon base will never be able to pay for itself.	A US Moon base will break even on profit and cost.	After 15 years, a US Moon base will be profitable.

9) Out of a 100 person astronaut corps, what is the highest number of lost astronauts worth the sacrifice to build a permanent moon base? _____/100

10) What are your feelings about the adequacy of NASA's current funding level?	They need much more	They need some more	They are properly funded.	They are over funded.	They are extremely over funded.

M or F

Race:_____

11) Would you be interested in learning more about the technologies that could drive the new space race and filling out a questionnaire on their probability of being developed?

Y N

12) Are you interested in pursuing a career in science/technology field?

Y N

13) Which of the following are you interested in? (circle all that apply)

Art	Sports	Science	Music
Math	Reading	History	Computers

14) Would you be interested in participating in an after school program designed to help you learn about careers in science and technology?

Y N

M or F Race:_____

Appendix E: Sample Letter for Contacting Schools for Survey

Introduction/Approval

Department of Social Sciences and Policy Studies
Worcester Polytechnic Institute
100 Institute Rd
Worcester, MA 01609

07 December 2006

To Whom It May Concern:

As part of a continuation of studies for the Space Policies group at Worcester Polytechnic Institute, one of our focuses is to determine the social implications of a space race between the United States and the People's Republic of China. The majority of this project is based upon determining the level of public support for the US space program now and in 2018 when NASA is scheduled to land on the moon. With your help, we wish to determine what the public opinion of NASA and the United States Space Program is and if the opinion may be changed through consciousness raising.

It may be apparent that the US space program is no longer as important to the general public as it was during the Apollo missions and the Space Race. In 2004, President Bush announced his approval of NASA's plan to return to the moon by 2018. Since the students in high school now will comprise a large percentage of the active voting population and/or approximately 6 years out of college in 2018, we feel that their interests need to be examined. We would like to administer a survey to your students in class that would allow us to gauge a number of things including: opinion of NASA, knowledge of available technologies, and interest in space and the Moon. After the survey, we would provide the students with information and other resources that would help to educate them on these and other topics pertaining to space. Then, we would want to poll the students a second time to observe how their new knowledge has impacted their opinions. In order to get an accurate distribution of students in terms of their interest in science, we are hoping for approximately 3-4 classes with about 75-100 respondents. We would like for these classes to be distributed similar to 1 Advanced Placement, 2 Honors, and 1 College Prep class.

Space technology and governmental policy regarding the Moon is changing. The information we would be providing them is not yet available in science books. This process will also help to identify students with an interest in "space related majors". We look forward to working with you to enlighten your students about developing science and technology that will shape the latter 21st century in which they will live, vote, and work.

Thank you,

Prof. John Wilkes

Katie Elliott Derek Pszybysz William Treese

Enclosures (4)

Appendix F: Patriotism Cross-Tabulations

			Q4 I am very Patriotic			
			Strongly Agree & Agree	Slightly Agree	Disagree-All Levels	Total
Q1 US Build Moonbase?	Strongly Agree & Agree	Count	74	42	38	154
		% within Q1 US Build Moonbase?	48.1%	27.3%	24.7%	100.0%
		% within Q4 I am very Patriotic	62.2%	43.3%	45.2%	51.3%
	Slightly Agree	Count	31	31	19	81
		% within Q1 US Build Moonbase?	38.3%	38.3%	23.5%	100.0%
		% within Q4 I am very Patriotic	26.1%	32.0%	22.6%	27.0%
	Disagree-All Levels	Count	14	24	27	65
		% within Q1 US Build Moonbase?	21.5%	36.9%	41.5%	100.0%
		% within Q4 I am very Patriotic	11.8%	24.7%	32.1%	21.7%
Total		Count	119	97	84	300
		% within Q1 US Build Moonbase?	39.7%	32.3%	28.0%	100.0%
		% within Q4 I am very Patriotic	100.0%	100.0%	100.0%	100.0%

Chi-Square Test: .003 Correlation Coefficient: .267

			Q4 I am very Patriotic			Total
			Strongly Agree & Agree	Slightly Agree	Disagree-All Levels	
Q2 Colony 25 years away or more	Strongly Agree & Agree	Count	39	34	29	102
		% within Q2 Colony 25 years away or more	38.2%	33.3%	28.4%	100.0%
		% within Q4 I am very Patriotic	32.2%	35.1%	34.5%	33.8%
	Slightly Agree	Count	34	26	21	81
		% within Q2 Colony 25 years away or more	42.0%	32.1%	25.9%	100.0%
		% within Q4 I am very Patriotic	28.1%	26.8%	25.0%	26.8%
	Disagree-All Levels	Count	48	37	34	119
		% within Q2 Colony 25 years away or more	40.3%	31.1%	28.6%	100.0%
		% within Q4 I am very Patriotic	39.7%	38.1%	40.5%	39.4%
Total		Count	121	97	84	302
		% within Q2 Colony 25 years away or more	40.1%	32.1%	27.8%	100.0%
		% within Q4 I am very Patriotic	100.0%	100.0%	100.0%	100.0%

Chi-Square Test: .389 Correlation Coefficient: -.013

			Q4 I am very Patriotic			Total
			Strongly Agree & Agree	Slightly Agree	Disagree-All Levels	
Q3 Other Countries will have first base	Agree-All Levels	Count	28	17	35	80
		% within Q3 Other Countries will have first base	35.0%	21.3%	43.8%	100.0%
		% within Q4 I am very Patriotic	23.1%	17.7%	41.7%	26.6%
	Slightly Disagree	Count	21	29	21	71
		% within Q3 Other Countries will have first base	29.6%	40.8%	29.6%	100.0%
		% within Q4 I am very Patriotic	17.4%	30.2%	25.0%	23.6%
	Disagree & Strongly Disagree	Count	72	50	28	150
		% within Q3 Other Countries will have first base	48.0%	33.3%	18.7%	100.0%
		% within Q4 I am very Patriotic	59.5%	52.1%	33.3%	49.8%
Total		Count	121	96	84	301
		% within Q3 Other Countries will have first base	40.2%	31.9%	27.9%	100.0%
		% within Q4 I am very Patriotic	100.0%	100.0%	100.0%	100.0%

Chi-Square Test: .000 Correlation Coefficient: -.282

	Q4 I am very Patriotic	Total

			Q4 I am very Patriotic			Total
			Strongly Agree & Agree	Slightly Agree	Disagree-All Levels	
Q5 Moon Source of Useful Resources	Strongly Agree & Agree	Count	32	22	12	66
		% within Q5 Moon Source of Useful Resources	48.5%	33.3%	18.2%	100.0%
		% within Q4 I am very Patriotic	27.6%	22.7%	14.5%	22.3%
	Slightly Agree	Count	37	26	21	84
		% within Q5 Moon Source of Useful Resources	44.0%	31.0%	25.0%	100.0%
		% within Q4 I am very Patriotic	31.9%	26.8%	25.3%	28.4%
	Disagree-All Levels	Count	47	49	50	146
		% within Q5 Moon Source of Useful Resources	32.2%	33.6%	34.2%	100.0%
		% within Q4 I am very Patriotic	40.5%	50.5%	60.2%	49.3%
Total		Count	116	97	83	296
		% within Q5 Moon Source of Useful Resources	39.2%	32.8%	28.0%	100.0%
		% within Q4 I am very Patriotic	100.0%	100.0%	100.0%	100.0%

Chi-Square Test: .076

Correlation Coefficient: .231

			Strongly Agree & Agree	Slightly Agree	Disagree-All Levels	
Q6 Moon is Strategic Site	Strongly Agree & Agree	Count	43	13	19	75
		% within Q6 Moon is Strategic Site	57.3%	17.3%	25.3%	100.0%
		% within Q4 I am very Patriotic	35.8%	13.4%	22.9%	25.0%
	Slightly Agree & Slightly Disagree	Count	44	42	29	115
		% within Q6 Moon is Strategic Site	38.3%	36.5%	25.2%	100.0%
		% within Q4 I am very Patriotic	36.7%	43.3%	34.9%	38.3%
	Disagree & Strongly Disagree	Count	33	42	35	110
		% within Q6 Moon is Strategic Site	30.0%	38.2%	31.8%	100.0%
		% within Q4 I am very Patriotic	27.5%	43.3%	42.2%	36.7%
Total		Count	120	97	83	300
		% within Q6 Moon is Strategic Site	40.0%	32.3%	27.7%	100.0%
		% within Q4 I am very Patriotic	100.0%	100.0%	100.0%	100.0%

Chi-Square Test: .002

Correlation Coefficient: .225

			Q4 I am very Patriotic			Total
			Strongly Agree & Agree	Slightly Agree	Disagree-All Levels	
Q7 Space faring Nations likely to Cooperate	Strongly Agree & Agree	Count	46	25	27	98
		% within Q7 Space faring Nations likely to Cooperate	46.9%	25.5%	27.6%	100.0%
		% within Q4 I am very Patriotic	38.7%	25.8%	32.1%	32.7%
	Slightly Agree & Slightly Disagree	Count	44	52	32	128
		% within Q7 Space faring Nations likely to Cooperate	34.4%	40.6%	25.0%	100.0%
		% within Q4 I am very Patriotic	37.0%	53.6%	38.1%	42.7%
	Disagree & Strongly Disagree	Count	29	20	25	74
		% within Q7 Space faring Nations likely to Cooperate	39.2%	27.0%	33.8%	100.0%
		% within Q4 I am very Patriotic	24.4%	20.6%	29.8%	24.7%
Total		Count	119	97	84	300
		% within Q7 Space faring Nations likely to Cooperate	39.7%	32.3%	28.0%	100.0%
		% within Q4 I am very Patriotic	100.0%	100.0%	100.0%	100.0%

Chi-Square Test: .081

Correlation Coefficient: .094

			Q4 I am very Patriotic			Total
			Strongly Agree & Agree	Slightly Agree	Disagree-All Levels	
Q8 Will Moon Base Pay for Itself?	Never pay for self	Count	57	49	39	145
		% within Q8 Will Moon Base Pay for Itself?	39.3%	33.8%	26.9%	100.0%
		% within Q4 I am very Patriotic	47.5%	50.5%	47.0%	48.3%
	Breakeven	Count	28	20	15	63
		% within Q8 Will Moon Base Pay for Itself?	44.4%	31.7%	23.8%	100.0%
		% within Q4 I am very Patriotic	23.3%	20.6%	18.1%	21.0%
	Profitable after 15 years	Count	35	28	29	92
		% within Q8 Will Moon Base Pay for Itself?	38.0%	30.4%	31.5%	100.0%
		% within Q4 I am very Patriotic	29.2%	28.9%	34.9%	30.7%
Total		Count	120	97	83	300
		% within Q8 Will Moon Base Pay for Itself?	40.0%	32.3%	27.7%	100.0%
		% within Q4 I am very Patriotic	100.0%	100.0%	100.0%	100.0%

Chi-Square Test: .829

Correlation Coefficient: .028

			Q4 I am very Patriotic			Total
			Strongly Agree & Agree	Slightly Agree	Disagree-All Levels	
Q9 Acceptable Loss per 100 Astronauts	0 Astronauts	Count	42	27	30	99
		% within Q9 Acceptable Loss per 100 Astronauts	42.4%	27.3%	30.3%	100.0%
		% within Q4 I am very Patriotic	61.8%	58.7%	61.2%	60.7%
	20 or less Astronauts	Count	6	5	6	17
		% within Q9 Acceptable Loss per 100 Astronauts	35.3%	29.4%	35.3%	100.0%
		% within Q4 I am very Patriotic	8.8%	10.9%	12.2%	10.4%
	Greater than 20 Astronauts	Count	20	14	13	47
		% within Q9 Acceptable Loss per 100 Astronauts	42.6%	29.8%	27.7%	100.0%
		% within Q4 I am very Patriotic	29.4%	30.4%	26.5%	28.8%
Total		Count	68	46	49	163
		% within Q9 Acceptable Loss per 100 Astronauts	41.7%	28.2%	30.1%	100.0%
		% within Q4 I am very Patriotic	100.0%	100.0%	100.0%	100.0%

Chi-Square Test: .972

Correlation Coefficient: -.004

			Q4 I am very Patriotic			Total
			Strongly Agree & Agree	Slightly Agree	Disagree-All Levels	
Q10 Adequacy of the NASA Budget	They need much more money	Count	16	18	15	49
		% within Q10 Adequacy of the NASA Budget	32.7%	36.7%	30.6%	100.0%
		% within Q4 I am very Patriotic	13.3%	18.9%	18.5%	16.6%
	They need some more money	Count	47	27	28	102
		% within Q10 Adequacy of the NASA Budget	46.1%	26.5%	27.5%	100.0%
		% within Q4 I am very Patriotic	39.2%	28.4%	34.6%	34.5%
	They are properly or over funded	Count	57	50	38	145
		% within Q10 Adequacy of the NASA Budget	39.3%	34.5%	26.2%	100.0%
		% within Q4 I am very Patriotic	47.5%	52.6%	46.9%	49.0%
Total		Count	120	95	81	296
		% within Q10 Adequacy of the NASA Budget	40.5%	32.1%	27.4%	100.0%
		% within Q4 I am very Patriotic	100.0%	100.0%	100.0%	100.0%

Chi-Square Test: .489

Correlation Coefficient: -.027

Q3 Other Countries will have first base (post) * Q4 I am very Patriotic (post)

			Q4 I am very Patriotic (post)			
			Strongly Agree & Agree	Slightly Agree	Disagree-All Levels	Total
Q3 Other Countries will have first base (post)	Agree-All Levels	Count	46	31	28	105
		% within Q3 Other Countries will have first base (post)	43.8%	29.5%	26.7%	100.0%
		% within Q4 I am very Patriotic (post)	38.7%	41.9%	45.9%	41.3%
	Slightly Disagree	Count	34	19	14	67
		% within Q3 Other Countries will have first base (post)	50.7%	28.4%	20.9%	100.0%
		% within Q4 I am very Patriotic (post)	28.6%	25.7%	23.0%	26.4%
	Disagree & Strongly Disagree	Count	39	24	19	82
		% within Q3 Other Countries will have first base (post)	47.6%	29.3%	23.2%	100.0%
		% within Q4 I am very Patriotic (post)	32.8%	32.4%	31.1%	32.3%
Total		Count	119	74	61	254
		% within Q3 Other Countries will have first base (post)	46.9%	29.1%	24.0%	100.0%
		% within Q4 I am very Patriotic (post)	100.0%	100.0%	100.0%	100.0%

Chi-Square Test: .901 Correlation Coefficient: -.059

Q5 Moon Source of Useful Resources (post) * Q4 I am very Patriotic (post)

			Q4 I am very Patriotic (post)			Total
			Strongly Agree & Agree	Slightly Agree	Disagree-All Levels	
Q5 Moon Source of Useful Resources (post)	Strongly Agree & Agree	Count	88	47	39	174
		% within Q5 Moon Source of Useful Resources (post)	50.6%	27.0%	22.4%	100.0%
		% within Q4 I am very Patriotic (post)	73.9%	64.4%	63.9%	68.8%
	Slightly Agree	Count	15	14	10	39
		% within Q5 Moon Source of Useful Resources (post)	38.5%	35.9%	25.6%	100.0%
		% within Q4 I am very Patriotic (post)	12.6%	19.2%	16.4%	15.4%
	Disagree-All Levels	Count	16	12	12	40
		% within Q5 Moon Source of Useful Resources (post)	40.0%	30.0%	30.0%	100.0%
		% within Q4 I am very Patriotic (post)	13.4%	16.4%	19.7%	15.8%
Total		Count	119	73	61	253
		% within Q5 Moon Source of Useful Resources (post)	47.0%	28.9%	24.1%	100.0%
		% within Q4 I am very Patriotic (post)	100.0%	100.0%	100.0%	100.0%

Chi-Square Test: .524 Correlation Coefficient: .161

Q8 Will Moon Base Pay for Itself? (post) * Q4 I am very Patriotic (post)

			Q4 I am very Patriotic (post)			Total
			Strongly Agree & Agree	Slightly Agree	Disagree-All Levels	
Q8 Will Moon Base Pay for Itself? (post)	Never pay for self	Count	37	32	24	93
		% within Q8 Will Moon Base Pay for Itself? (post)	39.8%	34.4%	25.8%	100.0%
		% within Q4 I am very Patriotic (post)	31.4%	43.2%	40.0%	36.9%
	Breakeven	Count	23	20	16	59
		% within Q8 Will Moon Base Pay for Itself? (post)	39.0%	33.9%	27.1%	100.0%
		% within Q4 I am very Patriotic (post)	19.5%	27.0%	26.7%	23.4%
	Profitable after 15 years	Count	58	22	20	100
		% within Q8 Will Moon Base Pay for Itself? (post)	58.0%	22.0%	20.0%	100.0%
		% within Q4 I am very Patriotic (post)	49.2%	29.7%	33.3%	39.7%
Total		Count	118	74	60	252
		% within Q8 Will Moon Base Pay for Itself? (post)	46.8%	29.4%	23.8%	100.0%
		% within Q4 I am very Patriotic (post)	100.0%	100.0%	100.0%	100.0%

Chi-Square Test: .074 Correlation Coefficient: -.193

Q10 Adequacy of the NASA Budget (post) * Q4 I am very Patriotic (post)

			Q4 I am very Patriotic (post)			
			Strongly Agree & Agree	Slightly Agree	Disagree-All Levels	Total
Q10 Adequacy of the NASA Budget (post)	They need much more money	Count	49	16	15	80
		% within Q10 Adequacy of the NASA Budget (post)	61.3%	20.0%	18.8%	100.0%
		% within Q4 I am very Patriotic (post)	42.2%	21.9%	25.4%	32.3%
	They need some more money	Count	35	25	19	79
		% within Q10 Adequacy of the NASA Budget (post)	44.3%	31.6%	24.1%	100.0%
		% within Q4 I am very Patriotic (post)	30.2%	34.2%	32.2%	31.9%
	They are properly or over funded	Count	32	32	25	89
		% within Q10 Adequacy of the NASA Budget (post)	36.0%	36.0%	28.1%	100.0%
		% within Q4 I am very Patriotic (post)	27.6%	43.8%	42.4%	35.9%
Total		Count	116	73	59	248
		% within Q10 Adequacy of the NASA Budget (post)	46.8%	29.4%	23.8%	100.0%
		% within Q4 I am very Patriotic (post)	100.0%	100.0%	100.0%	100.0%

Chi-Square Test: .023 Correlation Coefficient: .251