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Readings, Research, and Resources

Educational Disparities

It’s All in the Genes

3D Printing

Identity Theft
Welcome to the 2016-17 edition of Readings, Research, and Resources. We hope you find this publication to be a valuable resource as your students gather knowledge about Educational Disparities, It’s All in the Genes, 3D Printing, and Identity Theft.

This resource book should be used as a starting point for research on the FPS topics. By the time the book is printed and distributed, some of the information may change or become out-of-date. Keep in mind, however, that observing and studying the changes that take place in a given subject area over a few months or years can be an incredible asset to problem solvers who work with scenarios set as much as 30 years in the future.

A concerted effort was made to find recent articles from as many different perspectives as possible on each of the topics. While FPSPI attempted to present a balance in the range of opinions, some sides of an issue seem to be more popular than others. This does not mean that FPSPI supports that position. FPSPI supports no position. Information contained in this publication is a summary of the original article. It is up to the reader to determine which “facts” to accept.

FPSPI encourages coaches to preview the article summaries to determine whether all information is appropriate for their students. Efforts were made to minimize the sensitivity of the summaries' contents; however, different standards of acceptability apply to each individual student, coach, and local community. Please use your discretion with these materials.

At the end of this publication you will find an appendix containing topic-related Future Scenes from past years and a “Use the Tools” section dedicated to helping problem solvers apply creative thinking tools to their research.

If you have suggestions for making Readings, Research, and Resources more effective, please contact us. Your ideas may help this publication evolve into a better resource for students and it is through your ideas that Future Problem Solving Program International continues to grow.
ACKNOWLEDGMENTS
This publication is a compilation of the hard work of many people. Special thanks are extended to the following dedicated individuals involved in the production of this edition of Readings, Research, and Resources:

Chapter Author:    Emily Miller and Kylo Hart
Editing:    Melanie Musolino and Marianne Solomon
Proofreading:   April Dennis and Sylvia Faure
Layout and Desktop Publishing:  Sandi Williams

A NOTE ABOUT FUTURE TOPIC SELECTION:
FPSPI participants are encouraged to submit topics for consideration. Annually, FPS students, coaches, and evaluators vote for their top five topics from three strands: Science/Technology, Social/Political, and Business/Economics. The results of the voting determine which topics FPSPI uses each year. Information on topic submission and voting can be found at www.fpspi.org.

A NOTE ABOUT INTERNET RESOURCES:
Many internet resources can be easily found. Future Problem Solving Program International, Inc. included specific web site addresses; however, site changes occur continuously. Some of the articles cited in this publication may be found by going directly to the source of the article; however, some articles can only be accessed by using an on-line database such as EBSCO, Gale Group, or Thompson/Gale. Check your local libraries, school districts, and universities for the free databases that may be available in your area.

We strongly advise coaches to screen any sites for appropriate content before making them available to students.
RESOURCES
It has been said that research is the “unofficial” first step of the problem solving process. Research gives Future Problem Solving participants an understanding of the topic and a “jumping-off point” when they are presented with a Future Scene. Although competitors do not use every piece of information they find for each topic, a broad base of knowledge is important. Future Problem Solvers often find they can use the information for other school subjects, or perhaps even for other Future Problem Solving topics.

Research is found in many different places. Coaches and students can find valuable and up-to-date research through use of the internet to add to the provided articles in the Readings, Research, and Resources.

Internet research uncovers many newspaper and magazine articles that are current sources of global information. At the beginning of each topic, participants may find it helpful to create an online collaboration site to gather and organize main issues discovered by research. Reading a number of different types of newspapers and magazines from various locations can increase understanding of a topic. To best use these sources, it is important to consider that articles provide different viewpoints of a topic according to the source. Current trends and consideration of all who may be affected by the topic should also be kept in mind. Articles in both news publications and more entertainment-oriented sources can be very useful.

Another source of information is people. Professionals who work in a field related to the topics are often thrilled to share their expertise with students. Other people can be resourceful as well. Find out what the general public knows about the topic. What are some of the opinions people have about the topic? Which of these opinions are based on facts and which are based on hearsay? Acquiring this information gives Future Problem Solving participants a more complete picture of the topic.

The pages that follow provide insight regarding ways of approaching research. Tips for understanding the topic and guidelines for organizing the knowledge are included. A set of tools that may be applied to the research in order to produce large numbers of creative possibilities is also provided in the resource section. Research and creativity are a powerful combination for Future Problem Solving participants.
A problem solver needs to thoroughly understand a topic before he or she can effectively solve related problems. In Future Problem Solving the goal is to understand the topic from which the problem arises, as well as the problem itself. When participants are presented with a topic for problem solving, they need to understand the nature and scope of the topic and gather as much information as possible about the topic.

**To take an organized approach to understanding the topic, problem solvers should:**

**Determine Prior Knowledge**
Start by determining what you already know about the topic. Generate thoughts about your knowledge as a group, since a group usually knows more than any one individual. As you discuss your prior knowledge about a topic, you are beginning the research process.

**Determine Needed Knowledge**
Determine all angles or subcategories of the topic as you think about what the group would need to learn. Generating ideas and prioritizing what information is the most important to maintain focus on the topic.

**Gather Needed Knowledge**
Gather the information from multiple sources.

a) Talk with the people around you. Other students, parents, teachers, librarians, and professionals in the field possess both research information and a wealth of creative ideas and opinions. Contacting people is an excellent way to compile a variety of ideas.

b) Read everything you can get your hands on - both online and in print. Magazines, books, pamphlets, newspapers, and the internet are a few suggestions. Specific sources may include:
   - news articles - The Australian, Time, Newsweek, BBC News, etc.
   - futuristic periodicals - Omni, The Futurist, Discover, etc.
   - library searches
   - internet searches

  c) Listen to or watch the things around you - YouTube videos, movies, TV shows, videos, to gather valuable information on the topic. Watch for fiction as well as nonfiction. Newsmagazine shows (TVNZ OneNews, 60 Minutes, 20/20, or Dateline, etc.) often have stories with timely information on FPS topics. Public television programming or documentaries are also excellent resources.
Perform Error Analysis
Think about and discuss the reliability of the information gathered. Are you gathering the information with any kind of personal bias about the topic? Are sources of information about the topic biased in any way? In order to know what to trust, it’s important to consider the source and slant of the information being gathered.

Helpful Hints
The following hints will help as you search for information both within and outside of Readings, Research, and Resources:

- Online collaboration tools are beneficial to organize information.
  - Google Drive - http://www.google.com/
  - Drop Box - http://www.dropbox.com/
  - Edmodo - http://www.edmodo.com/

- Keep an electronic “clip file” on each topic. Every time you find an article, video, or infographic on the topic, save the information to your online account to share with your team.
  - Diigo.com is a research and collaborative research tool and a knowledge-sharing community and social content site.
  - LiveBinders.com allows users to collect web resources on any topic. FPS participants may use it to organize their research for the four FPS topics.

- If more than one person is working on the topic, divide up the research responsibilities. One person might do interviews, one person might search through magazines, one person might search for videos.

- Set time limits on your research. Deadlines often create higher productivity and efficiency.

- When looking for information on the internet, discriminate between sites with hard facts and those that offer only biased opinions. While both types of sites can be useful, keep in mind that fact and opinion are not necessarily interchangeable.
Organize the Knowledge

Once you gather information about a topic, you need to organize the information. Organizing information helps make sense of the information to see how it all fits together. The organization process also helps one to remember the information.

One of the best ways to organize information is to categorize it. The goal of categorizing is to highlight connections between the various pieces of information. Several types of category lists exist. You might pick one of the following ways to generate categories to use in understanding the information you gather.

Categories prepared for a specific subject

A Structured Overview is beneficial in organizing information. Issues relating to the topic are organized under the topic with like items recorded together. A Structured Overview example is located in the Appendix.

Categories from the FPS Category List

Almost any issue will fit into at least one of the categories on the FPS Category List provided on the next page. The FPS Category List usually serves as a sufficient starting point for identifying categories for any topic. Keep in mind, however, not every topic has information related to every category on this list.

Categories you generate on your own

You may decide to generate your own category list by generating a sufficient number of categories to classify the information. Do not divide the information into so many parts that the category list becomes a useless form of classification.

Categories that are generic systems of classification

When categories are not emerging easily, turn to some “tried and true” systems of classification. “Animal, Vegetable, Mineral” is an example of a generic system of classification. “Causes, Effects” is another. “Physical, Mental, Spiritual” is a third. You may want to make a list of other generic systems of classification you could use if more specific systems do not cause trends in the information to emerge.
<table>
<thead>
<tr>
<th>Category List</th>
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PROBLEM SOLVING TOOLS FOR GENERATING

Generating tools are used to create new and unique ideas. Although they are often used in creating challenges and solution ideas for a Global Issues Problem Solving booklet, these tools are useful when researching a topic. The most commonly known generating tool is brainstorming and its variations.

Generating Guidelines
When generating ideas, it is important to keep four guidelines in mind:

• **No Evaluation** should be given while generating ideas. Both criticism and praise are ruled out. Evaluation of ideas comes at a later time.
• **Quantity** is important. The larger the number of ideas, the greater the chance of reaching the best ideas!
• **Hitchhiking** is encouraged. Combining and improving ideas leads to great possibilities. When generating ideas, the sum is definitely greater than its individual parts.
• **Wild and Crazy** ideas can be very productive. Offbeat and silly ideas may trigger practical breakthroughs.

Category List
Use a system of categories to spur thinking in various directions. An example is the FPS Category List.

Ladder of Abstraction
When considering a concern or challenge, this tool is used to **broaden** or **narrow** the search for possibilities and new options. Broader or more abstract ideas emerge as you state your concern at the bottom of the ladder and work up the ladder, asking “why;” narrower or more specific options emerge as you work down the ladder, asking “how” you will address your concern.

Morphological Matrix
Using a chart with 4 columns and 11 rows, team members identify four major aspects (for example - people, place, obstacle, goal) of the topic and place across the top row (one per column). Next ten specific topic related elements of each heading are listed in the columns. Random combinations are then formed to create new and interesting possibilities.

SCAMPER
This tool is used to change the attributes of an idea by: **Substituting**, **Combining**, **Adapting/Adding/Altering**, **Minifying/Magnifying**, **Putting to other uses**, **Eliminating/Elaborating**, **Reversing/Rearranging/Reducing**.

Silent Brainwriting
Each team member has a sheet of paper with 3 columns and 4 rows (12 boxes). Each person generates three ideas related to the topic, writing one idea in each of the boxes in the first row. Next, the sheets are passed around the group so the ideas can be read and new ideas are added, row by row, until all sheets are filled and all ideas have been read.
PROBLEM SOLVING TOOLS FOR FOCUSING

Focusing tools are used to evaluate, compare, categorize, and highlight ideas.

Focusing Guidelines
Focusing tools aid in selecting an idea that is workable, relevant, and unique. The following guidelines will help you focus:

- **Use affirmative judgment** to be thorough but positive when analyzing, refining, or choosing possibilities.
- **Follow a plan** and use the tools that assist in focusing.
- **Keep an eye on the goal** to focus on what is wanted and needed in order to accomplish the goal.
- **Stay open to all ideas** that might be workable. Look for new and unusual possibilities.

Category List
Use a system of categories to organize thinking. An example is the FPS Category List.

Identifying Hits
Read through your generated ideas and identify those which are on target for your goal. Develop your “hits” into complete ideas.

Hot Spots
Identify clusters of ideas that share common elements. Discuss how the ideas are similar. How are they different? Which will be most useful for your needs?

Advantages, Limitations (to overcome), Unique Potentials (ALoU)
Consider the advantages of each idea and the limitations you will need to overcome when dealing with the topic. Look for unique potentials one idea may have as compared to another.

Sequencing
Arrange options or possibilities in logical order. One example is time frame for completion (short range, medium range, long range). This is especially useful in developing an Action Plan.

Paired Comparison Analysis (PCA)
When considering multiple possibilities, compare one possibility against another idea, one pair at a time, until all possible pairs have been analyzed. (Comparing A, B and C: A and B would be compared, then A and C, and finally, B and C.) As the favorite option is determined in the pair, a rank of 1, 2, or 3 is assigned according to degree of importance.

As you read articles in *Readings, Research, and Resources*, use these tools to help you generate ideas and focus on multiple options. The Appendix contains examples of tools applied to current topics.
Educational Disparities
accelerated learning: an intense method of study that encourages material to be learned in a relatively short time, allowing academically able students to progress through school more rapidly than others

achievement gap: in education, the disparity in academic performance between groups of students

dual-language immersion program: a classroom program that aims to create bilingualism/biliteracy, academic achievement, and cross-cultural competencies for all students through instruction in two languages for non-native speakers of one of the languages

advanced placement (AP): the placement of a student in a high school course that, if successfully completed, offers college credit

affluent: having a great deal of money; wealthy

blended learning: an educational program in which delivery of content and instruction is at least in part provided via digital and online media with an element of student control over the time, place, path, or pace

developing country: a poor, often agricultural nation, with an underdeveloped industrial base seeking to become more advanced economically and socially

Gender Parity Index (GPI): a socioeconomic index usually designed to measure the relative access to education by males and females which is calculated as the quotient of the number of females by the number of males enrolled in a given stage of education

intergenerational illiteracy: the situation where parents or grandparents are illiterate and the children are not

International Baccalaureate (I.B.): a non-profit educational foundation offering four programmes of international education that develop the intellectual, personal, emotional, and social skills needed to live, learn, and work in a rapidly globalizing world

learning disability: a disorder that is made evident by significant difficulties in the acquisition and use of listening, speaking, reading, writing, reasoning, or mathematical abilities

learning gap: the disparity between what students were expected to learn by a particular age or grade level and what they actually learned
literacy: the ability to read and write

**No Child Left Behind Act of 2001 (NCLB):** the United States government’s flagship aid program for disadvantaged students which supports standards-based education reform on the premise that setting high standards and establishing measurable goals can improve individual outcomes in education

opportunity gap: the unequal or inequitable distribution of resources and opportunities

out-of-school children: children who are not actively attending school

**Programme for International Student Assessment (PISA):** a test conducted every three years by the Organisation for Economic Cooperation and Development (OECD), these tests are based on application of knowledge rather than memorization of facts and are taken by fifteen-year-olds around the world to assess performance in mathematics, science, and reading

poverty: the state of being extremely poor, inferior in quality or insufficient in amount

primary education: the first stage of formal education in a range of basic subjects such as reading, writing, and mathematics

remedial education: a basic skills education designed to assist students so they achieve expected competencies in core academic skills such as literacy and numeracy

refugee: a person who has been forced to leave their country in order to escape war, persecution, or natural disaster

rural area: a geographic area that is located outside cities and the centers of towns

secondary education: refers to the last four years of formal education (grade nine through grade twelve in many countries)

**standardized test:** any form of test that requires all test takers to answer the same or similar questions which is scored in a consistent manner so that the relative performance of individuals can be compared

**STEM skills:** an educational focus on science, technology, engineering, and math that is deemed important because the skills and knowledge in each of these disciplines are essential for student success in life and deeply intertwined in the real world

tertiary education: the educational level following the completion of secondary education which includes universities, community colleges, nursing schools, research laboratories, and distance learning centers

tuition: the charge or fee for instruction, as at a private school, a college, or university

urban area: a well-developed city area in which most inhabitants have nonagricultural jobs and includes a density of structures such as houses, commercial buildings, roads, bridges, and railways
Overview

Every morning, students around the world wake up early and go to school. For those in rural villages, this can mean walking many miles in sweltering summer heat or freezing winter cold. In underdeveloped countries, girls may watch from home as their male counterparts go to school. In other places, children may want to go to school but be forced to work to help provide for themselves or their families instead.

Access to and quality of education is impacted by a number of factors. Gender, race, and income play roles in shaping how much education a child will receive and the effectiveness of that education. For example, malnutrition is known to affect brain development, which can inhibit a child’s ability to problem-solve and pay attention. Compared to their affluent peers, this often means that children from poorer families struggle, fall behind, or do not understand what is being taught in the classroom. In developing countries, girls may be married at very young ages before they are able to complete their education.

Over the last two hundred years, the number of children around the world enrolling in primary school has grown from 2.3 million students to over 700 million. Now at least 90% of children at least begin primary school. Focusing on the opportunity gap alone has not proved to be enough. Once students make it to school, they also need to succeed and complete their classes.

The achievement gap - or the differences in student success in the classroom - has many causes. It can stem from unstable housing, poor health, family economic stress, limited after-school and weekend high-quality learning experiences, and insufficient resources at school.

In the United States, education has historically been viewed as an opportunity for equalizing the American society; however, research shows that while the achievement gap attributed to race differences has narrowed significantly, the gap between rich and poor students has grown substantially. Today, family income is a better predictor of success than race. Is this because wealthy parents invest more time and money in education for their children? Is it because lower-income families find themselves stretched for resources and time?

No matter what the cause, experts agree that parents play the most important role in forming a child’s personality and cognitive ability in the years before children start school. Globally, studies show that children born into poverty will hear 30 million fewer words than their wealthier peers in their first years of life. The differences in average levels of education between rich and poor countries also remains significant. Currently, 100 million children are not completing their primary education. Without significant innovation, it could take up to one hundred years for students in developing countries to average the same number of years of education as students in developed countries.

Illiteracy, the inability to read or write, is also a concern worldwide. More than 781 million people are illiterate, roughly 10% of the world’s population. It is estimated that if all students in low-income countries learned basic reading skills, more than 171 million people could be lifted out of poverty. Illiteracy is known to disproportionately impact women and the wellbeing of their children. If all women achieved secondary education, there could be 49% fewer child deaths in low-income countries. In addition to benefits for women and their children, research shows that an increase in literacy brings about an improvement in economic development and decrease in crime and conflict.
Research shows that gender also plays a role in education. Around the world, millions of girls are not in school. Females face a number of barriers to education, including early and forced marriage, domestic slavery, gender discrimination and violence, and school fees. Despite research that indicates a positive impact on their families when girls attend school, girls from poor families are still the most likely to drop out of school. Experts estimate that if these barriers are removed for young girls there could be a significant impact on social change. The girls’ future wages would increase, infant mortality could decrease, and economies would grow.

Technology also plays a critical and transformative role in improving access to education for people in both developed and developing countries. In India new technology is making it possible to avoid land-based telephone and internet education to deliver learning opportunities directly to students. India also uses EDUSAT, a communications satellite, to provide student access to educational materials at a reduced cost. In Africa, the New Partnership for Africa’s Development (NEPAD) is working to provide the country’s 600,000 primary and secondary schools with internet access, computer equipment, and learning materials by 2022.

Around the world, different cultures will continue to emphasize different aspects of learning and teaching to fit their own norms and values. Factors such as infrastructure and socioeconomic conditions will also continue to play a role in the level and quality of education. Across the globe the fight for a better global education must continue. Parents must fight for their children’s future, teachers must fight for better classrooms, and principals for better schools.
**QUESTIONS FOR DISCUSSION**

1. In what ways do different outside influences impact educational success? For example, how do parents, schools, and communities each play a role in the overall education students receive?

2. Brainstorm a list of factors that contribute to or reduce educational disparity. Review the list and discuss how these factors impact each other to create successful or unsuccessful environments for education.

3. Why is it important to address educational disparities at a young age?

4. How has education changed in the last fifty years? The last ten years? Are changes global or localized?

5. What is the 100-year gap? How might developed countries take action to close the gap? What action should developing countries take?

6. Compare and contrast the achievement gap and the opportunity gap. What common factors impact both?

7. What if every country implemented a mandatory uniform educational system across all their schools? For example, currently not all states in the United States utilize the same standards, the same programs, or the same educational funding structures. Does standardized education lead to better results or does it encourage other types of disparity? Would a global uniform educational platform be feasible in the future?

8. In 2000 the Education for All goals were established at the World Education Forum in Dakar, Senegal. For fifteen years, a global community worked to increase access to and quality of schooling, improve literacy, and narrow gender disparities in education. Which of these goals were accomplished? What were some of the key drivers behind success and failure?

9. Many entrepreneurs and educators are coming up with creative ways to reduce educational disparity. Select and discuss one example of a program or innovative idea that could close the gap between a type of educational disparity.

10. How do culture, government, and economics intersect to contribute to educational disparity or educational success?
I. Trends in Educational Disparity


Test scores indicate that the gap between richer and poorer pupils has widened in England. According to exam results, just one in three disadvantaged students hit the government’s General Certificate of Secondary Education (GCSE) passing score, compared to 60% of the students’ better-off peers. Chief executive of Teach First, Brett Wigdortz says, “...Things are getting worse for poorer children, instead of better.”

Some schools see better results even though most of their student population is disadvantaged. At King Solomon Academy in West London, more than two-thirds of the pupils are eligible for free school meals; however, 93% of the academy’s disadvantaged students achieved passing scores. Even with exceptions like the King Solomon Academy, the gap between disadvantaged pupils and other students is growing overall. The gap between disadvantaged students and those with economic advantages in overall pass rates for the GCSE was 26.7% in 2013 and had increased to 27.2% in 2014.


College dropout Bill Gates is encouraging students to stay in school. Gates says dropping out of college is not the right solution for most people, but it has become an epidemic. He explains that while more than 2 million people will graduate in 2015, America is facing a shortage of college graduates. Gates predicts that these dropouts may end up in an economically challenged “whirlpool”.

By 2025, two-thirds of all jobs will require advanced education. Using current graduation rates, this will mean that the United States will have a deficit of 11 million college graduates to fill those jobs. Since college dropouts are often from lower-economic backgrounds, Gates fears that dropouts will get trapped in poverty as the demand for specialized skills drives up the wages for individuals who have obtained degrees. The United States as a whole will experience even greater income disparity because of educational disparities. The Gates Foundation is actively creating education tech that can help students plan for college, take online courses, and spend college funds wisely.

Call for global education emergency fund. (2015, July 06). BBC.

When disaster strikes, emergency aid tends to focus on food, medicine, and shelter - not solutions for education. As of 2015, just a small percentage of humanitarian aid goes toward education, meaning that victims of natural disasters or political unrest, like Syrian refugees, may remain without education for months or even years. Before the conflict in Syria, almost every child was enrolled in primary school. Now, almost two million children are out of school.

According to a spokesman for UNESCO, a significant group of vulnerable children do not have access to education. In a summit in Oslo, Norway, attendees will hear warnings about the rising number of refugee families and displaced persons because of natural disasters and conflicts. Together, groups such as Oxfam, Save the Children, and World at School will make a plea for a multi-million dollar global educational fund to help families who are victim of war, disaster, or other emergencies. Around the world, more than one-third of out-of-school children live in conflict-affected countries. It is estimated that it will cost $4.8 billion to provide for the 64 million children impacted by wars and disasters.


In 2014, for the first time in fifteen years, the U.S. Department of Education publicly released civil rights data from every public school in the country. The published information reflects data from all 97,000 public schools and 16,500 school districts, representing 49 million students.

One finding from the data is that racial differences (disparities) in student discipline begins as early as preschool. For example, boys and young men of color are disproportionately affected by suspensions and zero-tolerance policies. Students who have been suspended are not as likely to graduate and are frequently suspended more than once. Students receiving suspensions are also more likely to drop out, repeat a grade, or become involved in the juvenile justice system. To help address this and other disparities, the Departments of Education and Justice recently distributed guidelines to school districts on zero-tolerance policies and discipline tactics.

Other key findings in the report highlight additional disparities across the U.S. educational system. As of 2014, about 40% of public school districts did not offer preschool. Of the public preschool programs that do exist, just 50% are available to all students within a district. In general, students of color have disparate access to advanced placement courses. President Obama has proposed the Race to the Top-Equity and Opportunity (RTT-Opportunity) initiative to incentivize change across school districts, aimed at closing opportunity and achievement gaps.


Despite efforts to achieve universal primary and secondary education, the number of out-of-school children around the world is on the rise. According to research, 124 million children and adolescents are now out of school. The numbers also indicate that 24 million children will never enter a classroom at all. In South and West Asia, 80% of out-of-school girls are unlikely to ever attend school, while only 16% of their male counterparts will be without school experience.

UNESCO's Director General, Irina Bokova, believes that without “serious commitments“ toward increasing education aid the targets set by the international community to achieve twelve years of free and equitable access to education could remain unfulfilled for millions of children. Meanwhile, investment in educational funding is 4% lower in 2015 than it was in 2010. At a time when aid needs to be significantly increasing, it is at risk of stagnating. It is estimated that it will take an additional $39 billion to secure twelve years of education for everyone in low and lower-middle income countries.


Does inequality impact the success of black, Latino, and Native American students in school systems? Research shows that minority students begin experiencing unequal treatment in school as early as four-years-old. After studying the disparities present in school - discipline, early learning, college readiness, and teacher equity - the United States Education Department identified inequality as a major issue in the education system.

The research conducted by the Education Department revealed that black students are expelled three times more than white students. Often, schools with high percentages of black and Latino students do not offer Algebra II. In addition, less than half the minority students have access to a full range of math and science courses, and black students are three times more likely to attend schools where fewer than 60% of the teachers meet all state certification and license requirements.


Widespread support for higher-quality early childhood education could be an investment for the future. For general managers and other company executives, this could mean having a larger pool of talent from which to hire new employees. By age five, the human is brain is approximately 90% developed. Executive function skills which help employees work on teams, display leadership, and think critically begin to develop shortly after birth, with age three as the ideal age for the most dramatic growth of such skills.

Children who attend quality learning programs at a young age are 48% less likely to need special education. They are also 51% less likely to be held back in school and significantly less likely to dropout of high school. Experts have found that quality early education yields impressive long-term benefits to society. Every dollar invested may be worth as much as $17 because of increased earnings, reduced special education and welfare costs, and reduced crime.


Researchers are finding that children born to older mothers may achieve better results in school. Comparison of tests scores for more than 1,000 students shows that a year’s delay in a woman starting her family is associated with a slight increase in her child’s test scores. A seven-year delay has an even more significant positive impact on test scores. Even after controlling for financial status, family structure, level of education, and race, the data pointed toward higher test scores for the children of women who gave birth later in life.

One possible explanation of the data is that quality of parenting increases with age. Psychologists explain that older women are generally more emotionally ready to be mothers than younger women. In general, people develop the ability to take care of the needs of another over time. It is possible that a mother’s age at time of birth plays at least some role in educational achievement throughout a child’s lifetime.


An article published by Princeton University and the Brookings Institution reveals that income may have the biggest impact on childhood development and disadvantaged children face circumstances that may hinder success. Because of how quickly the brain develops during the first few years of life, children are particularly vulnerable to environmental conditions such as poverty. Programs that offer additional income to families during a child’s early years may help reverse the trend.

Once children begin school, the disadvantage continues: wealthier families are able to spend more on books, computers, summer camps, and private schooling. In addition to lacking educational aids, poverty can cause environmental and family stress. Children of low-income families are more likely to live in crowded housing, unsafe neighborhoods, and attend schools of lower quality. All these factors inhibit educational success. According to the article, this situation is unlikely to change quickly. Achievement and attainment gaps between low and high-income children are larger than anytime in the last forty years.


Klein, R. (2015, March 03). The achievement gap in high school graduation rates appears to be narrowing. The Huffington Post.

Data from the U.S. Department of Education shows that high school graduation rates increased for Hispanic, black, white, American Indian, and Asian/Pacific Islander students during the 2011-2012 and 2012-2013 school years. The rate of growth for some groups has been faster than others, narrowing the achievement gap overall. During the 2012-2013 school year, 81% of American students graduated from high school.

Secretary of Education Arne Duncan says the improvements represent a vital step toward college and career readiness for all students. The goal is to improve the educational opportunities for every student across the country, but Duncan cautions that there is still a long way to go.

Retrieved from http://www.huffingtonpost.com/2015/03/16/us-high-school-graduation-rates_n_6878362.html

The assistant secretary for civil rights at the U.S. Department of Education says that the country must end the tired practice of giving students of color less than their white peers. To that end, the Obama administration released a thirty-seven-page document reminding states and school districts to provide the same quality of resources to students regardless of color and income. Quality resources can include strong teachers, rigorous coursework, extracurricular activities, and facilities for students. Title VI of the Civil Rights Act of 1964 does not require that districts provide the same resources to all schools. It does require that all students have equal access to educational opportunities.

States and school districts are in violation of federal law when policies intentionally or unintentionally result in disparate impact among students. According to the Department of Education's findings, students of color are more likely to attend schools with low-quality facilities such as portables. They are also most likely to be assigned ineffective teachers and less likely to have high-level coursework available. Though black and Latino students make up 40% of high school students, they make up just 25% of students taking advanced placement courses.


Lee, T. (2014, May 07). Education racial gap wide as ever according to NAEP. MSNBC.

A number of federal policies have attempted to narrow the gap between white students and their black and Hispanic counterparts, but the policies have been largely unsuccessful. In 2013, the National Assessment of Educational Progress (NAEP) released The Nation's Report Card which confirmed the white-black gap in reading and math scores for high school students. This gap in education can mean that students are unprepared for secondary education and can inhibit them from finding jobs.

In the United States, more high school students are graduating high school than ever before; however, the race gap remains. Compared to 85% of graduation rate for white students, only 68% of Hispanic and black students graduate. A Department of Education report also shows that educators in predominately black and Latino schools are paid less than their counterparts in majority white schools. In addition, black students are nearly four times more likely than their white counterparts to attend a school where less than 80% of their school's teachers are certified, and Latinos are twice as likely to attend such schools.

These gaps are cause for concern across the nation. David Driscoll, chairman of the National Assessment Governing Board, says that many factors, inside and outside of the classroom, play a role in student performance. It is imperative that education communities find ways to foster academic improvement for students.

Researchers estimate that the number of deaths linked to differences in education is growing. In fact, lacking education may be as deadly to an individual as being a smoker. Evidence shows a strong correlation between low education levels and mortality. Experts like Virginia Chang, an associate professor of population health, are calling for public health policy to focus more attention on education. Education is believed to be a more long-lasting solution to healthy behavior and habits.

A recent study looked at individuals born in 1925, 1935, and 1945 to understand how education impacts mortality over time. It revealed that 145,243 lives could have been saved among the 2010 population of adults who had not completed high school if they achieved a GED or high school degree. This rate is comparable to the estimated number of deaths caused by smoking. Additionally, 110,068 deaths could have been saved if adults who had started college went on to complete their degrees. The studies researchers estimate that policies and programs to improve educational attainment could improve survival in the United States population.


A report published by The World Bank, “Thailand’s Economic Monitor,” revealed that one-third of the country’s fifteen-year-olds are “functionally illiterate.” The report also highlighted the disparity between education in rural areas and urban areas in Thailand. These findings reinforce what standardized assessments such as Thailand’s Ordinary National Education Test (O-NET) and the Program for International Student Assessment (PISA) have already shown that students in urban areas consistently outperform those in rural areas.

In addition to education reform, underlying factors must be addressed to improve education. Foremost is the health crisis, which inhibits thousands of rural students from realizing their full potential because of malnutrition and nutrient deficiency. Research shows that insufficient intake of nutrients, including Vitamin A, Vitamin B, Vitamin E, and Iodine, can be detrimental to educational development, resulting in permanent learning disabilities and lower IQs. Thailand’s School Lunch Program provides students with a school lunch, but the food tends to be high in sugar and is often deep-fried. If the malnutrition and nutrient deficiency continue to be prevalent throughout Thailand’s rural communities, thousands of children may never reach their full potential. This failure could impact Thailand’s economic competitiveness and contribute to social and political unrest in the future.


Advocates of significant educational reform in Thailand are disappointed by news that new curriculum will focus on history and loyalty to the three pillars of Thai society. Many believe more significant reforms are desperately needed, and Thailand’s educational shortcomings are regularly documented by PISA and other reports. The reports highlight the educational inequalities that affect disadvantaged students from low-income homes, rural areas, and ethnic minorities.

As the 21st century progresses, nations around the world are adjusting their definitions of educational success. East Asian nations, such as Taiwan and Japan, are recognizing the importance of individualism and creativity in driving innovation and entrepreneurialism. At present, Thailand’s curriculum rewards conformity and discourages individualism. Finland has attracted international attention by landing in the PISA Top 10. While some educational policies can be shared, every nation has its own context and cultural dimensions that determine success. For Thailand’s system to more closely mirror that of Finland’s, sweeping changes to class size, long-term teacher quality, standardized testing, and equal opportunities for education would need to be addressed.

Many countries are adopting the International Baccalaureate (IB) in place of standardized tests. The IB encourages students to give opinions and use reasoning and creativity to assess ability. Among Thailand’s most prestigious schools, the IB is already proving successful. Ecuador rose 30 places on the World Economic Forums’ Global Competitive Reports between 2012 and 2014 after adopting the IB.


Inequality in education impacts the economy because education determines the skills obtained by humans entering and contributing to the workforce. While many years of education are important, so are the cognitive abilities of students completing their education, as confirmed by a new National Bureau of Economic Research (NBER) research study. To promote economic development, the quality of education is just as important as the number of years spent in school. Most legislatures understand the connection between education and economic growth, but ignore the relationship between quantity and quality. For this reason, the money poured into public school systems does not always result in positive outcomes.

In The Declining Importance of Race and Gender in the Labor Market, June and Dave O’Neill write that income disparities between people of different races are the result of differences in education, not discrimination. In some states, parents can select the schools their children attend in what is known as school choice programs. Organizations seeking to eliminate inequality say school choice programs give children from affluent families an upper hand in education. School choice programs are helpful, though, because they move away from a “one-size-fits-all” model for education. Overall, the NBER report provides more evidence that an educated population leads to higher productivity, increased economic growth, and innovation; the report indicates that rather than pouring money into failing economic systems, state governments should implement innovative programs that offer educational quality to all students.


Standardized testing is one of the most controversial practices in education. Advocates argue that standardized tests ensure that disadvantaged students are not neglected. Some civil rights groups believe that standardized tests actually hurt the students they were designed to help because schools focus on teaching to the test instead of offering diverse curriculums. The debate is picking up momentum as Congress is working to determining the future of No Child Left Behind, a law that has become synonymous with standardized testing.

The original purpose of No Child Left Behind was to identify and then close historic achievement gaps. The law requires states to test students to identify if they are making adequate progress toward the ultimate goal that all students in America would be proficient in math and reading by mid-2014. Even if a school’s scores improve, they can miss their annual targets if disadvantaged students are not also making progress. In short, the law highlights achievement gaps and forces states to correct them. To civil rights groups, standardized tests are a tool for finding and fixing differences in achievement. The same civil rights groups believe that states must be required to intervene if schools or subgroups of students perform poorly on tests as they fear the racial and economic achievement gaps will persist. Further, it is not enough for students to become skilled test takers; they need to learn real life skills with which they can succeed.

Still, standardized tests highlight how broad groups of students perform relative to each other, leading groups concerned about the success of historically disadvantaged students to believe standardized tests are very important.


Data from the Department of Education reveals that serious issues with the Philippine public school system exist. Public school students outnumber private school students 13:1, and only nine of those thirteen public school students will complete elementary school, with only five pursuing secondary education. In what is being called a real-life Hunger Games scenario, those who come out on top are rewarded with scholarships. Those who fail are criticized for not trying hard enough or for giving in to poverty.

The disparity between public and private education in the Philippines is undeniable. The root issue is the unequal access to opportunities which are evident in the unequal scholarships, training, and job opportunities afforded to private school students. The government cannot afford to waste the valuable human capital by subjecting the majority of students to overcrowded classrooms, poorly made textbooks, and ill-equipped teachers. To improve as a country, help must be given to the children who need it most so they have an opportunity to succeed in life. Instead of perpetuating the inequalities that exist today, the playing field must be made equal.

According to Scholars at Risk Network (SAR), more than 333 violent and coercive attacks on higher education communities were documented from 2012 - 2015. The attacks happened across sixty-five different countries including Australia, India, and the United States. Though the attacks vary in their severity, at the core they are all related to access to knowledge and the tension between power and ideas.

Research shows that scholars and students are often prosecuted because of the content of their research or teaching, or for exercising their rights to express opinions. While social, cultural, and religious studies are obvious targets, all disciplines are subject to attack by authorities, military and paramilitary organizations, and extremist groups. In many countries, scholars are subject to violence simply because they do have access to higher education.

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**University challenge: Tuition fees must not be allowed to creep ever higher.** (2015, July 30). *The Independent.*

Disparity exists between the number of affluent and disadvantaged British youth who apply to universities. It is important that tuition and fees do not continue to climb indefinitely for British students as lower-income students are less likely to apply. Already, more than three-quarters of teenagers say they are concerned about the cost of living if they pursue tertiary education.

As funding continues to be stripped from universities, undergraduate tuition fees in Great Britain are set to hit £10,000 by the end of the decade. In many ways, the introduction of tuition in the 1990s has helped offset the gaps in funding, but it is no longer sustainable as the total costs of education continue to rise.


**What is the millennium development goal on education all about?** (2015, April 23). *The Guardian.*

At the turn of the century, eight worldwide developmental goals were established. One of those goals centered on education: it called for every child in the world to have access to primary school education by 2015. Progress of the goal has been measured by looking at how many children enroll in primary education, how many complete primary school, and how many fifteen to twenty-four year-olds are able to read and write. Will the goal be met? The short answer is no.

As of 2012, 58 million children between the ages of six and eleven were out of school. Roughly 30 million of these children were in sub-Saharan Africa. Worldwide, about 25% of students drop out of primary school without finishing. In many countries, sons are considered the future breadwinners and their education is prioritized over daughters, leaving young women vulnerable to early or forced marriage. Though boys and girls are now enrolling in primary school at the same rates, there are 117 girls out of school for every 100 boys. By 2030, the sustainable goal for education calls for all girls and boys to complete free, equitable primary and secondary education.


The educational differences between the developed and developing worlds remain significant. Research shows that when the average number of years in school and levels of achievement are compared, the developing world is about one hundred years behind developed countries. This means the average levels of education that were achieved in many developed countries by the early 20th century are only recently being reached by the developing world. The 100-year gap calls attention to serious inequalities in education around the world.

As of 2015, 90% of the world’s children are enrolled in primary school. However, looking beyond enrollment rates reveals that all students are not progressing through school at the same rates worldwide. In fact, adults in the workforce in developed countries average almost double the amount of education as their developing country peers. At this rate of progress, it will take about sixty-five years for developing countries to reach the current rates that developing countries show for twelve years of schooling for students. It is likely to take a full one hundred years for students in developing countries to close the gap with the developed world in terms of the learning achieved through education.


Giving students a successful future means tackling the educational disparities that are still present across America. The nonprofit, First Book, is working to overcome barriers that have made books inaccessible to children, including price, access, and relevance. For example, African Americans, Latinos, Asian Americans, Native Americans, and other communities are virtually invisible on the pages of books that children read. The same is true for many other communities and cultures of people. In fact, Cooperative Children’s Book Center revealed that just 5% of the books they published in 2014 were about African Americans, and only 2% were about Latinos. The message being sent to children early in life is that books are not relevant to them and their stories and cultures are not valued.

These and other inequalities plague the education system in the United States. Students from affluent families gain educational ground while children from poorer families fall behind. A ten-year study indicates that a society of “information-have” and “information have-nots” is emerging. First Book is working to end this disparity by providing books that recognize different cultures and ethnicities to children so they have books that reflect the world immediately around them.

Zinny, G.S. (2015, April 08). Latin America's wake-up call on global school tests. BBC.

It is unclear how best to compare the educational quality and achievement of countries around the world. PISA is one of the most widely recognized international comparison tests. Every three years, the PISA tests rank fifteen-year-olds in mathematics, reading, and science. In Latin America, many countries are wary of participating in the PISA tests for fear of being compared with international powerhouses in education such as Finland and Japan. The highest-ranking Latin American country, Chile, is well below the global average on the PISA tests.

The PISA testing model is not without its criticisms, as there is controversy over its methodology and design. Critics claim it does not accurately capture the quality of instruction or the diversity of different school systems. Currently, just one-third of Latin American countries participate.

Despite the controversy and doubt surrounding standardized tests, they serve a critical purpose in that they illustrate massive expansion in access to education that must also include improvement in quality. The fact that Latin America's countries are far behind the developed world in education can no longer be ignored. Conversations that focus on innovative ways to improve quality are needed. A wave of new, interested participants including private businesses, entrepreneurs, foundations, and advocacy groups are taking the lead as they introduce new methods, technologies, and structural reforms in educational systems.


II. Gender Disparity


Even though there have been significant efforts to educate all communities, women still face discrimination, often because of limited governmental support. In February 2015, a UN report revealed that in more than seventy countries women and young girls have been attacked for seeking education. The UN Office of the High Commissioner of Human Rights (OHCHR) renewed calls for equal access to education for women and girls. OHCHR believes that equal educational rights is the way to end discrimination against women that is deeply etched in many societies. With equal education, OHCHR believes women will be able to utilize their learned skills to achieve similar status to their male counterparts in the workplace.


Hundreds of female students protested recently to highlight a gender bias plaguing Rajsamand in India. Frustrated by the conditions at their schools, students from three villages - Dewair, Bhil, and Barar - boycotted classes for a day and staged demonstrations to call attention to their situations. At the village school in Barar, for example, only three teachers serve three hundred students and the principal’s post has been vacant for eight years. Villagers of Bhil claim there are also serious disparities in facilities, quality of education, and number of teachers among boys’ and girls’ schools. In Bhil, boys’ schools may have 17-18 teachers, while girls’ schools have just 3-4. Not having enough teachers is seriously affecting the school's academic performance. In the last round of examinations, only 50% of the girls had a passing percentage.

The students made demands for their schools to be merged with government-run schools, where they are addressing issues such as student-teacher ratios. Says one student, “There is no teacher to even teach us the basics of science.” Another student explains that girls are often denied admissions to universities because of their low test scores. After a two-hour meeting between civil activists, parents, and education officers, it was agreed that temporary teachers would be provided immediately. Education officers also agreed to fill all vacant positions.


Girls have academic edge the world over: Glasgow study. (2015, January 15). The Australian.

By age fifteen, girls are outperforming boys in reading, science literacy, and mathematics in 70% of countries. This is true even in countries where women’s liberties are severely restricted. In fact, some countries known for their low gender equality ratings such as Qatar, Jordan, and the United Arab Emirates, boast some of the largest achievement gaps in favor of girls.

Researchers believe results from PISA scores may also explain why fewer girls go on to study STEM (Science, Technology, Engineering, Math) subjects at universities. While girls are often stronger in STEM subjects than their male counterparts, they have even higher achievement in reading than mathematics. Boys tend to show the opposite pattern. The tilt seen among young men and women in university study corresponds to the subjects in which they excel. Those better at language related skills (most often women) tend toward language-based professions. Similarly, those with stronger math skills may tend toward STEM industries.


Between 2004 and 2012 the proportion of women to men in higher education grew from 29% to 38%. This is a step in the right direction, but educational disparity persists. In Cambodia, especially among the rural poor, girls may never complete lower secondary school. Though the Cambodian Youth Policy of 2011 requires equal opportunity for girls and boys in education, poor implementation and lack of resources have been barriers. To help overcome the situation, the Merali Foundation and The Asia Foundation established the Cambodia Tertiary Scholarship Program (CTSP) which grants 115 women from poor families in Kampong Cham the opportunity to earn their bachelor’s degrees.

In 2010, sixty-five women began their university educations through the scholarship program. In 2014, 94% of them graduated and 92% had full-time employment. In the fall of 2015, the second group of students will graduate. By May 2015, 92% of them had already accepted full-time employment opportunities. The CTSP is successful because it helps young women develop the skills and capabilities they need beyond university curriculum. All the young women have coaching on career development and job placement strategies and connect with internship opportunities in the private sector.

Several CTSP graduates now work together by contributing $1 a month to a common fund used to send other girls from Kampong Cham to the University. Each year, they expect to collect about $1,000 which will pay tuition for two or three girls. In addition, the girls' successes are inspiring to the parents in rural Kampong Cham. Villagers think about what girls can do with higher education and are encouraged to send girls to school.


Jones, J. (2015, June 05). Teen designs dress to advocate for women's education. *USA Today.*

Around the world, 62 million girls do not have access to secondary education. Erinne Paisley, a recent high school graduate, fused fashion and activism at her graduation party to call attention to the disparity. Using duct tape, silk, satin fabric, and her old calculus homework, she made a dress for the party. Across the front she wrote, “I've received my education. Not every woman has that right.”

Paisley hopes the dress will spark global dialogue about the disparity in access and rights to education for women. Paisley's dress will be auctioned to raise money for the Malala Fund, a nonprofit that invests in local and national teaching programs and calls for policy reform for disadvantaged communities.

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For years, Morocco has been a noted example of progress in the Middle East and North Africa. In particular, the country has moved forward through a variety of innovative educational reforms and other programs designed to protect women and prohibit discrimination. In fact, the first ten years that King Mohammed VI was on the throne is often referred to as the “Education Decade.” UNESCO estimates that just 41.6% of the Moroccan population was literate in 1990. By 2010, that number had increased to 56%.

Morocco's *mahou al omiya* (Erasing Illiteracy) program is directly tackling the rural gender gap. The free program is available at nearly every public school and is available to adults who did not have the opportunity to attend or complete school. *Mohou al omiya* is particularly helpful to parents of students because they can then help their children with their studies, alleviating intergenerational illiteracy. A 24-hour literacy program is also available on television for adults in rural communities who may not be able to attend distant public schools for education.

Still, the barriers young women in rural communities face are significant. Just 26% of these young women enroll in lower secondary education, compared to 79% of males in their same communities. Though it is illegal, underage marriage is a reality for many Moroccan girls and prevents them from gaining secondary education. Some estimates claim that illiteracy rates for rural women and girls in Morocco could be as high as 90%.

Retrieved from [http://magazine.good.is/articles/morocco-women-girls-parents-literacy](http://magazine.good.is/articles/morocco-women-girls-parents-literacy)


Why do the top-educated girls perform worse at math than the highest-educated boys? Some experts speculate that it is indicative of gender bias in school systems, recent studies suggest that may not be the cause. In the midst of the debate on why girls do not perform as well as boys in STEM subjects, another concern is present: Why are boys falling behind in almost every other subject?

A report published by the Organization for Economic Cooperation and Development (O.E.C.D.) shows that less-educated boys are falling farther behind girls. The O.E.C.D. found that 60% of the underachievers who fail to meet proficiency in subjects such as math, reading, and science were boys. At the bottom levels of education, the gap between males and females is described as enormous, and the lowest performing girls are still 15% ahead of their male peers. The O.E.C.D’s research puts into doubt the prevailing belief that differences in educational achievement are strictly due to gender disparity.


To address the gender gap in technical fields, Google is offering vouchers to any women and minorities who want to learn how to code. Google states that thousands of vouchers are available to eligible individuals. Google's initiative was announced just a few days after a diversity report revealed that just 30% of the company’s employees are female. Also reported was that African Americans make-up 1% of the total workforce, while Hispanics make up just 2%.

Google also launched a $50 million educational initiative, “Made With Code,” which aims to close the gender gap in technology through education. Outside of Google, just 20% of the tech workforce is women, and females attain only 12% of computer science degrees.


Symonds, M. (2015, July 08). Women in Asia buck trend for male business courses. *BBC.*

Gender balance in education has had major gaps in the past, producing a much higher percentage of male graduates in master programs in Business Administration. In leading United States business schools, females now make up 40% of the student population, up from 30% just ten years ago. Across the world, women represent just 43% of individuals taking the Graduate Management Admissions Test (GMAT). In central and south Asia, that number of individuals increases to 60%. In China, 65% of those taking the GMAT are women, resulting in more women obtaining their Masters of Business Administration (MBA).

Even greater involvement from women can be seen in “pre-experience” masters programmes, which are usually taken right after earning an undergraduate degree. At Hong Kong University of Science and Technology, 30% of MBA students are women, while a majority of the school’s Masters in Management students are female. Across the Asia-Pacific region there is a growing demand for highly qualified individuals, but at the moment, not enough people who meet the criteria are available to meet the demand. In the years to come, it is likely that women will be the winners of the “war on talent.”


Educational disparities in gender are evident in all levels of academia. Men, for example, earn more than 70% of Ph.D.’s in fields such as computer science and physics. Women are enrolling in and graduating from universities and colleges at a higher rate than men.

A report published by the Organisation for Economic Cooperation (OECD) provided analysis of the growing achievement gaps between males and females across sixty-four countries. The study found that boys make up a disproportionate percentage of underachieving students in all subject areas except for math. The study found that the average fifteen-year-old boy was about three months ahead of girls of the same age in math. In reading, girls outperformed boys in all sixty-four countries. In science, achievement was about the same between males and females.

The study also found that boys are punished more frequently and harshly than girls, even in higher educational settings, where women make up 56% of the student enrollment. By 2025, experts predict that the number of females in higher education will climb to 58%. Women are also more likely than their male counterparts to graduate. While it is important for women to continue to make strides in fields that may have been “off limits” historically, it’s also important that educational systems do not forget about the boys.


III. Overcoming Disparity & The Future of Education


In Washington, D.C., legislation has failed to fully fund basic education, meaning that wealthy districts flourish, while poorer districts struggle. Senate Bill 6130 is an example of bipartisan collaboration that could improve education. To get the same amount of money from taxes, some districts may require a tax rate four times what a wealthier district would. In the past, the Legislature has attempted to minimize the difference with “levy equalization,” but the system is far from equal.

Despite the Washington Constitution mandating a “general and uniform system of public schools,” education still varies significantly by zip code, creating a system the opposite of uniform. Senate Bill 6130 aims to reduce school levies and increase legislative funding for teacher salaries. It also includes measures that would help monitor district spending. The bill is unlikely to be met with enthusiasm from the entire population as teachers will not be eager to lose the additional pay they can gain from local levies. Communities thriving under the current system may not be thrilled about losing their advantage. Shifting from state levies could cost $3.5 billion.


Girls Who Code (GWC) is a program for young women that teaches new concepts and works to end misconceptions that girls cannot be successful in STEM careers. In addition to learning about graphic design, JavaScript, and html coding, GWC members participate in field trips. One field trip was to Capitol Hill where the girls met congresswomen who encourage STEM education. One female student reported that the GWC classes gave her more collaborative experiences than those in her high school. She felt what she was learning in school was less relevant than the skills obtained from GWC.

Other students report that their experience with GWC is encouraging them to challenge the status quo. Though they may not be able to explain the disparity between men and women in the tech industry, they understand that a place exists for females, too. The CEO of The Software Alliance states that fixing the disparity between the demand for programmers and the number of qualified programmers is important. Currently, the United States is only producing 39% of the graduates who will be needed to fill the computing jobs that will be available in 2022.


In Australia, a number of secondary schools are participating in the University of Auckland’s Starpath Project. The goal of the project is to increase tertiary participation for Pacific and Maori students. The participating schools are using data to determine what students are in need of additional help. Every student’s attendance, attitude, achievement, and behavioral data is logged and monitored. Director Cindy Kiro says the data driven approach will help keep save disadvantaged children in the classroom. Now, instead of guessing what students may be failing, data ensures that no students slip through the cracks. Students in jeopardy of failing are given immediate, targeted attention.

At Tamaki College intensive learning boot camps are in place to help pull students out of the danger zone. In the first year of the program, student achievement grew to 50%, up from 23% the prior year. Since one teacher oversees student performance, parents have a single point of contact for their child. Parent participation has grown from 20% to 80% since the program was launched.

Retrieved from [http://www.stuff.co.nz/national/education/69798098/data-key-to-fixing-education-inequality](http://www.stuff.co.nz/national/education/69798098/data-key-to-fixing-education-inequality)

In the largest ever ranking of the quality of global schools, Asian countries were consistently ranked highly and African countries appeared at the bottom of the list. Singapore was listed first, with Ghana last. The OECD's rankings were based on test scores across seventy-six countries. The OECD's education director says the rankings can give countries, both rich and poor, the ability to compare themselves against the world's educational leaders to discover their strengths and weaknesses and to understand what long-term economic gains could come from improved educational quality.

As recently as the 1960s, Singapore, the top performer, had widespread illiteracy, highlighting how much progress can be made in a relatively short period of time. In the United Kingdom, about one-fifth of students leave school without achieving a basic level of education. The OECD estimates that reducing this number could add trillions of dollars to the UK economy. If Ghana improved so that all fifteen-year-olds had basic academic skills, the report estimates that it would expand its current GDP by thirty-eight times.


Coughlan, S. (2015, April 09). World fails to reach millennium education targets. *BBC.*

It is official. Education for All, the global pledge by world leaders to guarantee primary education to all children by 2015, has not achieved its goal. Signed by 164 countries in April 2000, the pledge was intended to systematically improve education. Though none of the six education goals making up the pledge were fully achieved, millions more children are in school than if the trends of the 1990's had continued. The children most likely to still be missing out on school are girls from poverty-stricken families, particularly in sub-Saharan Africa. In addition to lack of funding, poverty, discrimination, corruption, and rising populations contributed to the goals being missed. The six Education for All targets include the following:

- Early childcare and education (achieved by 47% of the countries)
- Universal primary education (accomplished in 52% of the countries)
- Equal access to learning (universal enrollment in lower secondary school provided by 46% of countries, with one in three students in low-income countries not completing their lower primary education)
- Adult literacy cut by 50% (achieved by only 25% of the countries with 50% of women illiterate in Africa)
- Gender parity (gender parity in access to primary school achieved by 69% of countries)
- Improvement of the quality of education (the student to teacher ratio improved in 75% of the countries)

New goals will be set for 2030; and it is anticipated that they will emphasize educational quality, rather than the number of students in school. Despite the overall failure to reach all goals, UNESCO is calling the progress that has been made a “qualified success.”


Nelson Mandela once said, “Education is the most powerful weapon with which you can change the world.” How does education give people the power to change the world? Universities provide skills individuals will need to make a positive contribution to the world. Because of education the world has doctors, teachers, and engineers in addition to scientists, artists, and entrepreneurs. Individuals in poor countries have a better chance of getting a job if they have a college degree. In fact, every additional year of tertiary education is worth a 21% increase in pay in Sub-Saharan Africa. For many, education is a way out of poverty and provides equality of opportunity.

Between 1994 and 2009, educational enrollment in South Africa increased by 71%. By 2030, experts estimate that 1.6 million South African students will be enrolled in school. Further, educational research produces relevant and reliable information. Postgraduate level students engage with scientific research that helps generate new knowledge that offers solutions to a variety of challenges. In upcoming years, South Africa plans to achieve greater social justice that includes equitable access to quality education. Even years after Mandela’s death, the challenge to use education for change is still strong.


According to researchers, music education can help close the achievement gap. The Auditory Neuroscience Laboratory at Northwestern spent two summers observing students in the Harmony Project, a non-profit organization. The organization provides free music education to disadvantaged students in a Los Angeles community. To understand how music education changed children’s brains, students were hooked up to a neural probe, allowing scientists to watch how children distinguished between speech sounds, a skill linked to reading and language skills.

Experts concluded that if students practice music regularly, their studies can have a profound lifelong impact on learning and listening. Since 2008 over 90% of the high school seniors who were part of the Harmony Project’s free music learning program went on to college. It is believed that the experience of learning to make music helps create a more efficient brain that is capable of learning and communicating, especially through sound.

Retrieved from [http://www.huffingtonpost.com/2014/09/02/harmony-project-music-study_n_5755448.htm](http://www.huffingtonpost.com/2014/09/02/harmony-project-music-study_n_5755448.htm)
Klein, R. (2014, December 18). Researchers think they have found a way to help close the achievement gap. The Huffington Post.

Growing up in a poor family can affect a child's performance at school. In fact, the brains of students from low-income families function differently from those of their affluent peers. Researchers at the University of Texas at Dallas may have discovered a method for helping low income students close this gap with their peers. In a study, more than 900 students from all backgrounds were split into two groups. One of the groups received a specific “learning intervention” while the second did not. The students who received the cognitive intervention completed group exercises and written activities designed to teach them how to analyze information and extract main ideas from texts.

The results showed that kids from low-income families showed as much improvement as other students. Research is increasingly pointing toward the possibility that kids raised in poverty are able to overcome the deficits in brain development. Interestingly, the study conducted by the University of Texas at Dallas showed that males and females responded to the learning intervention differently. Both seventh and eighth grade girls showed significant improvement; for boys, only eighth graders showed significant improvement, suggesting that the program might be most successful after boys have a slightly longer development period.

Retrieved from http://www.huffingtonpost.com/2014/12/18/research-achievement-gap_n_6344528.html


Compared to other nations, the United States thrived in the 20th century due to critical masses of people obtaining the skills and knowledge demanded by the economy; but slowly the United States is beginning to fall behind. Experts predict that by 2020 more than two-thirds of jobs will require postsecondary degrees or tertiary education. In 2015, just 40% of Americans reach that level of educational attainment, and the United States already lags behind ten other nations in postsecondary degree attainment.

Closing that gap will mean ensuring that all Americans have access to and opportunities for education beyond high school, many experts believe such equality will require a complete reform of higher education. Congressional leaders can make progress if they concentrate on three areas of focus:

- First, pathways to high-quality degrees need to be clear. Lots of options for higher education degrees, skills-based certification programs, and even work-based apprenticeships exist. All these options should be recognized.
- Next, educational quality needs to be achieved. Federal funds should be used to help serve the students, including first-generation students, working adults, and minority students who are in school. Prioritizing quality student learning, rather than time spent in the classroom, will help promote such equality.
- Finally, Congress needs to address the rising costs of education. Models that help deliver education more efficiently and at a lower cost should be made widely available.

Collectively, these focus areas will help improve overall attainment for all individuals who seek higher education.

Mungai, C. (2015, July 20). Do you want to learn, or pass exams? There is actually a difference, and this cool tech tries to achieve both. *Mail & Guardian Africa.*

In 2012, 122 million children enrolled in primary school in sub-Saharan Africa. The total enrollment in 2012 was 75% larger than total enrollment fifteen years prior, the most significant gain in enrollment achieved by any region in the world. While these students are attending school, assessments indicate that learning is extremely low. Focusing on increasing enrollment and participation is getting more students to school, but it is critical that quality is also addressed.

IBM Research-Africa is working on a way to deliver personalized education to students. The Cognitive Learning Centre (CLC) bridges the gap between traditional classroom delivery by teachers and learning delivered through a digital tutor on a tablet. Using CLC, teachers can assign personalized homework depending on how they are doing in the classroom. The CLC also collects data to show the teacher how students are doing in terms of learning and assessments. The program is able to capture information about the environment where students use it; for example, it can report back data on light quality and noise level. The biggest challenge in the CLC being widely adopted is integrating it in a school system that focuses on exams rather than personal student experiences.


Descomplica (“Uncomplicated”), A Brazilian startup, is rethinking how education is delivered. Descomplica is a for-profit test prep platform with a library of 15,000 videos and daily live streaming. In Brazil costly test prep courses have historically been unattainable by low-income students. In contrast, access to the Descomplica platform costs only $3.00 per month, less than 1% of the cost of a typical prep course in Brazil. By making test prep courses available at a low cost, founder Marco Fisbhen hopes lower-income students will begin securing acceptance into public universities. In effect, this would break down the opportunity gap between affluent and low-income students.

Already, Descomplica students average eighty minutes per visit on the site and log on every three days. 78% of Descomplica students out-perform the national average on higher education entrance exams. In 2014 Descomplica had 12 million students and the number continues to grow. Fisbhen believes that as a for-profit company Descomplica will be able to find a healthy business model that remains affordable for future users.


Elias Bou Saab, Lebanon’s Minister of Education and Higher Education, faces a difficult challenge. He must determine how to handle the influx of refugees from Syria while improving the quality of Lebanon’s own public education system. Since the war in Syria began, Lebanon has received over a million refugees. Saab believes all children on Lebanese soil should have access to quality education. He hopes this will mean that Syrian students one day return to Syria with the skills and knowledge they need to rebuild their country. Saab’s ministry is working with UNICEF and the United Nations High Commission for Refugees to develop the Reaching All Children with Education (RACE) strategy. RACE formalizes a commitment to the children and youth displaced from Syria, a nation that had received near universal enrollment before the crisis.

Already more than 1,000 public schools have been opened to non-Lebanese students. By using classrooms in double shifts, 106,795 Syrian refugee children have access to education. By 2016 Saab intends to increase that number to 200,000 students. The biggest challenges to achieving this goal will be inadequate funding and resources, so Saab has urged the international community to provide for their financial support.


According to research, children born into poverty hear 30 million fewer words during their first year of life than children with stable economic conditions. This word-deficit often leads to disparities in vocabulary and overall school readiness. This disadvantage is sometimes called the Achievement or Opportunity Gap.

The town of Princeton, New Jersey is attempting to tackle this educational disparity head on by investing in full-day preschool classes and a dual-language immersion program. Superintendent Steve Cochrane is also implementing a “1,000 Books” campaign aimed at exposing children to at least 1,000 books before they start kindergarten.

Strive, a non-profit from Cincinnati, Ohio, is trying to address the opportunity gap through collective, community involvement. They are utilizing existing organizations such as schools, non-profits, businesses, and governments to coordinate efforts across their community. Instead of working separately, these organizations view one another as partners. Together the partners developed fifteen Student Success Networks, each focused on different specialties such as tutoring or early childhood education. Since Strive launched the program, there has been a 10% increase in kindergarten readiness in the community. Strive also saw positive improvements in forty of the fifty-three educational outcomes being measured.


Online learning is a profitable and popular business. By 2016 global revenues from e-learning instruction are expected to exceed $51 billion. E-learning helps to bring a sharing of ideas and cultural diversity to the global education market. At present the United States and Western Europe have the most learners (based on enrollment), while Asia, Eastern Europe, Africa, and Latin America are expected to have the highest rates of growth in coming years.

In many cultures, education is viewed as the most important factor in personal and professional success, promoting highly competitive learning marketplaces. South Korea, Singapore, Japan, and other Asian countries prioritize high performance in education as a core value. These and other nations are emerging as leaders at the forefront of what is being called an “online learning revolution.” One challenge to global online learning is language diversity. In addition to students needing to learn multiple languages to remain competitive, online learning platforms are pressured to offer courses in more languages than ever before. Additionally, many online learning providers must accommodate for different learning styles. Some utilize live chat, interactive whiteboards, and breakout rooms, but many students may have a preference for more independent styles of learning.

In many countries, education contributes to economic mobility. For this reason, online learning is becoming more and more popular as people look for an accessible and fast pace learning environment. China, home to the world’s biggest economy, is also seeing a rapid growth in e-learning due to an increasing demand for highly trained workers. Access to affordable broadband internet is also crucial to e-learning success. As more countries gain reliable internet access, the reach of online education grows. South Korea, the world's leader in internet access and broadband speed, has emerged as a world leader in e-learning.


In the United States, school vouchers are considered one of the most effective anti-poverty programs available in education; however, they are often criticized and protested by teachers’ unions. Tar Heel Republicans passed a small reform in 2013 to offer low-income students $4,200 in scholarships to assist them in attending private schools. The law mandates that all participating schools report their test scores and graduation rates and complete an annual report that compares the educational achievement of voucher recipients and public school students.

A recent lawsuit called the reform into question, claiming that it did not accomplish a public purpose since private schools are not regulated by state education standards. The Institute for Justice, which represented the case in favor of vouchers, argued that five of six low-income students fail North Carolina's end-of-grade math and reading tests. North Carolina's high court ruled in favor of vouchers, 4-3. In 2014, 4,500 families applied for just 2,400 vouchers.


In Singapore many parents struggle to help their children with the highly demanding homework that accompanies a competitive state-school system. To offer better help and support to their children, many parents are going back to school themselves. The workshops offered by private tuition centres and schools help parents understand what students do at school and how to solve complex problems using the right methods. This knowledge then helps parents coach their children at home. Students report that parents exhibit better understanding of their challenging coursework and demands after the parents themselves have returned to school.

At private tuition centres, parents can participate in four full-day workshops for about $500. Often, the adults are split into groups based on ability and knowledge of mathematics. The tutoring offered by tuition centres are popular because they have sessions available frequently and cater sessions to the differing abilities of parents. In Singapore $827 million a year is spent on educational tuition.


Wang, A. (2015, June 29). Can an online teaching tool solve one of higher education’s biggest headaches? *Slate.*

Providing access to education is problematic, even at the tertiary or post-secondary level. For Carnegie Mellon University, too many students want to enroll in computer science coursework which has the potential to contribute to educational disparity between students who are and are not able to take the course. Rather than use an application or lottery system to determine which students will be admitted to the course, the university is exploring a new, innovative approach using blended learning. Instead of jamming students into a stadium-style lecture hall, the university will combine video lectures, optional mini lectures, and face-to-face group meetings for students and instructors.

The program received support and $200,000 backing from Google’s Computer Science Capacity Awards Program and will debut in the fall of 2015. The program is expected to perform better than solutions that address course supply and student demand constraints that have been used in the past in massive open online courses (MOOCs). MOOCs offer free knowledge, but performance is generally lackluster. In 2010 a report published by the U.S. Department of Education showed promising results from blended learning programs for K-12 students. For example, blended learning was credited with helping poor-performing high school Algebra students bridge the learning gap with their peers. Blended learning, or hybrid classes, have not become popular at the university level yet because of cost and wariness that such courses could dilute a school’s brand.

IT’S ALL IN THE GENES
adaptation: a change or the process of change by which an organism or species becomes better suited to its environment

deoxypentulose acid (DNA): a self-replicating material present in nearly all living organisms that carries genetic information

Animal and Plant Health Inspection Service (APHIS): a United States Department of Agriculture agency, responsible for protecting animal health, animal welfare, and plant health

embryo: an unborn offspring in the process of development

biopharmaceutical: a medicinal product manufactured in, extracted from, or semi-synthesized from biological sources

Federal Food, Drug, and Cosmetic Act (FFDCA): a set of laws passed by Congress in 1938 giving authority to the US Food and Drug Administration (FDA) to oversee the safety of food, drugs, and cosmetics

biotechnology: the exploitation of biological processes for industrial and other purposes, especially the genetic manipulation of microorganisms for the production of antibiotics, hormones, etc.

Food and Drug Administration (FDA): the federal agency in the US responsible for protecting and promoting public health through the regulation and supervision of food and drug safety

bovine: an animal of the cattle group, which includes buffalo and bison

gene: a unit of heredity that is transferred from a parent to offspring and determines some characteristic of the offspring

embryo: an unborn offspring in the process of development

gene expression: the process by which possession of a gene leads to the appearance in the phenotype of the corresponding character; the process genetic instructions are used to synthesize gene products

gene sequencing: the figuring out of the order of DNA nucleotides, or bases, in a genome; the order of As, Cs, Gs, and Ts that make up an organism’s DNA

gene therapy: an experimental technique that uses genes to treat or prevent disease; the transplantation of normal genes into cells which are missing specific genes or to replace defective cells in order to correct genetic disorders

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genetic engineering: the use of tools of modern biotechnology and molecular biology to introduce new characteristics or traits into organisms

cell: the smallest structural and functional unit of an organism, typically microscopic and consisting of cytoplasm and a nucleus enclosed in a membrane

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chromosome: a threadlike structure of nucleic acids and protein found in the nucleus of most living cells that carries genetic information in the form of genes

disease resistant: the reduction of pathogen growth

cell: the smallest structural and functional unit of an organism, typically microscopic and consisting of cytoplasm and a nucleus enclosed in a membrane

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genetic engineering: the use of tools of modern biotechnology and molecular biology to introduce new characteristics or traits into organisms
**genetic mutation:** a permanent alteration in a gene’s DNA sequence resulting in a sequence that differs from what is found in most organisms

**genetically modified organism (GMO):** an organism whose genome has been altered by the techniques of genetic engineering so that its DNA contains one or more genes not normally found

**genome:** the complete set of genes or genetic material present in a cell or organism

**genomics:** a discipline in genetics that applies recombinant DNA, DNA sequencing methods, and bioinformatics to sequence, assemble, and analyze the function and structure of genomes

**herbicide:** a substance that is toxic to plants and is used to destroy unwanted vegetation

**heritable:** transmissible from parent to offspring

**hybrid:** the offspring of two plants or animals of different species or varieties (a mule is a hybrid of a donkey and a horse)

**metabolism:** the chemical processes that occur within a living organism in order to maintain life

**molecular characterization of the construct:** a description of the DNA construct and how it is assembled

**pathogen:** a bacterium, virus, or other microorganism that can cause disease

**pesticide:** a substance used for destroying insects or other organisms harmful to cultivated plants or animals

**phenotypic characteristic:** the expression of a specific physical trait such as stature or blood type, based on genetic and environmental influences

**plant geneticist:** a botanist concerned with the origin and evolution of plants through its genetics

**ribonucleic acid (RNA):** a polymeric molecule that plays a role in coding, decoding, regulation, and expression of genes; one of the three major biological macromolecules that is essential for all known forms of life (along with DNA and proteins)

**tissue:** any of the distinct types of materials of which animals or plants are made, consisting of specialized cells and their products

**trait:** a distinguishing quality or characteristic, typically one belonging to a person, plant, or animal

**transgenic:** containing genetic material artificially transferred from another species

**virus:** a small infectious agent that replicates only inside the living cells of other organisms

**vitamin:** any of a group of organic compounds that are essential for normal growth and nutrition; required in small quantities from the food intake because they cannot be synthesized by the body
Genes are everywhere! Genes are the basic biological structures that make up plants, animals, and people. Scientists, including botanists and geneticists, discover more about how genes work. The study of genes and genetic modification (GM) can be used to create life-saving medicines. GM technology also protects crops and animals from harmful environmental threats like global warming and can help them become more nutrient-rich. The manipulation of genes for better productivity, resilient plants and animals, and even medicinal use is not without controversy. Many people refuse to consume genetically modified organisms (GMOs) and others fear that gene therapies may be unsafe for plants, animals, and people.

More than a decade ago, the US National Institute of Health (NIH) launched the Human Genome Project. It was thought that genetics would lead to discoveries about why people get sick and how to cure disease. Today patients still have little idea of how genetic testing works, what purpose tests may serve, and/or whether they should get tested for certain conditions. Even though research projects like the Human Genome Project and cloning successes like Dolly the sheep generated lots of conversation about genetics, scientists know very little about how to apply their data for practical applications to plants, animals, and people.

To date, farmers have widely adopted GM technology. Between 1996 and 2013, the total surface area of land cultivated with genetically modified crops increased by a factor of 100. This growth encompassed approximately 1,750,000 km (432 million acres) of land. By 2014 in the United States, GM crops made up the planted area of 94% of soybeans, 96% of cotton, and 93% of corn. GM technology has expanded quickly into the developing world as well. By 2013, more than 18 million farmers grew 54% of the world’s GM crops in developing countries. Many scientists believe that through genetic modification and increased plant growth a solution to the world’s food scarcity can be found. With an ever-growing worldwide population, could genetic modification be the solution to feeding hungry people around the globe?

Despite promising arguments that genetic modification can have positive results, safety continues to be a big concern around the world. Even though genetically engineered crops have been helping produce greater yields of crops with higher nutritional values since the 1970s, most developed nations do not consider GMOs safe. Across more than 60 countries around the world, including Japan, Australia, and the countries of the European Union, there are significant regulations and even outright bans on the production and sale of GMOs. Many consumers are taking matters into their own hands and choosing not to eat foods that contain GMOs. Some businesses even require that all foods containing GMOs be labeled so they can be identified by consumers. In 2014, a survey by the Pew Research Center found that 57% of Americans said it’s generally “unsafe to eat genetically modified foods,” however, the World Health Organization (WHO), the American Medical Association (AMA), the National Academy of Sciences (NAS), and the American Association for the Advancement of Science (AAAS), have all declared that no good evidence showing that GMOs are unsafe exists.

Critics claim there are serious ethical, ecological, and economic issues with genetic modification techniques. The largest debates surround the ethical implications, safety, and potential for political and economic war that may come with genetic modification, especially in humans. Is it okay that domesticated...
animals are being genetically modified to produce proteins that have applications for human medicine? Should scientists continue their research in hopes of finding proteins that will control blood clotting or kill cancer cells? If we are able to create designer babies, should we?

Already, genetically modified animals are being utilized to grow transplant tissues and human transplant organs, a concept called xenotransplantation. Implications involving genetic modification are not fully understood. GM crops can cross-pollinate with non-GM crops, creating unpredictable characteristics in plants that can be dangerous to humans. Bioherbicides and bioinsecticides can be added to crop seeds, but are not always effective.

Promising research is underway that indicates genetic study and manipulation are here to stay. A new technique called gene editing allows scientists to target a particular strand of RNA and replace it with a new strand. This method has been described as being similar to the cut-and-paste feature in word processing programs. By activating or de-activating portions of genes, researchers can document how specific adjustments to the genetic code can change an organism. In Britain, researchers used a “self-limiting” gene to control an invasive species of moth that causes serious damage to cabbages, kale, and other crops. Still, other researchers are focused on making plants resilient to drought conditions, which is of increasing importance as food scarcity is quickly becoming a global issue.

Another core technique of genetic engineering is the process of recombining DNA to give it new traits by removing DNA from one organism and inserting it into the DNA of another organism. Recombinant DNA can be used to make crops resistant to pests or disease. It can also make livestock leaner or larger. In medicine, the technique is used to create drugs, vaccines, and to reproduce important human hormones and proteins.

What will be the long-term impact of genetic modification of plants and animals? How can scientists with limited information predict the result of these genetically modified plants and animals for future generations? If plants and animals are genetically modified to resist pathogens, will new, more resistant pathogens wipe out entire plant and animal populations in the future? Already, GM has led to international controversy, trade disputes, protests, and restrictive regulations on commercial products containing genetically modified organisms. How do we move forward in a way that betters humanity for many generations to come using the powerful technology that is offered by genetic manipulation?
Questions for Discussion

1. A number of ethical questions surround the practice of genetic engineering or manipulation. Discuss some of the key arguments that are made by those in favor and those opposed to genetic engineering. How do arguments on the ethics of genetic engineering change depending on whether such engineering is intended for plants, animals, or humans?

2. What might happen to the world's ecosystems if more plants and animals become genetically controlled or modified?

3. Scientists have not proven that genetic modification is harmful to people or the environment. Experts argue that more research is needed to truly understand how genetic modification affects the human population and the environment. How will scientists know if the long-term effects of genetic modification are harmful? How will they know if the long-term effects of genetic modification are helpful?

4. What are the key reasons for needing to genetically modify or engineer plants? Have these reasons been a result of the environment or imposed by man?

5. What economic promise does genetic engineering hold for third world countries? What kind of complications does it cause? How do your answers change if you are discussing the economic promise for developed countries?

6. Many experts fear that gene therapy technology is advancing so quickly that governments and other regulating bodies may not be able to stay ahead of scientific possibility. Describe some of the concerns that need to be addressed. How do decision makers stay ahead of scientific possibility to ensure that important ethical values are upheld as research continues?

7. If scientists are able to produce more food crops and more nutrient rich products using genetic engineering, will hunger and disease in third world countries decline? Is it possible that people will still be hungry and susceptible to disease even with greater quantities of nutritious food?

8. Describe the way businesses influence genetic engineering? Consider the livelihoods of scientists, farmers, grocers, and even investors as you describe these influences.

9. Consider the food labeling trends impacting business marketing and government regulation of GMO-free food and foods that contain GMOs. Why do businesses want to label food as GMO-free? Do governments have a scientific reason behind decisions to require GMO food labeling?

10. What is the best way to balance scientific progress and the crossing of ethical lines? Do technological breakthroughs justify the sacrifice of beliefs for the sake of knowledge and understanding?
Below are three major themes for understanding the topic “It’s All in the Genes.” Because most of the articles contain important information on more than one theme, the articles have not been arranged by themes and are presented as one group.

- Genetically Modified Organisms
- Genetic Modification: Insects, Plants, & Animals
- Applications of Genetic Study

A Structured Overview (found in the Appendix) can strengthen understanding of the various themes and to organize facts on the topic.


In July 2015, the Conference of the International Society of Computational Biology met in Dublin. A key message for the 1,500 scientists that attended was presented: Gene therapies are advancing faster than the understanding of the technologies themselves. Scientists are now able to find and repair genetic faults, creating great potential for gene therapies.

New techniques for altering genes are developing quickly. So far, results have been promising. Scientists have successfully altered laboratory cells to remove HIV and sickle cell anemia using gene-editing technology called CRISPR. Researchers say CRISPR has the potential to one day repair defective genes responsible for cystic fibrosis. Scientists have also developed a way to sequence the human genome which provides information about a person’s genetic makeup. The idea is that scientists and doctors will be able to provide patients with personalized advice and treatments based on their own genome. In 2000, the first human genome was sequenced for $1 billion. Scientists called the breakthrough the “dawn of personalized medicine.” In 2015, a human genome could be sequenced for about $2,000. By 2017, experts expect it to cost just $200 to sequence a human genome. This advance will lead to more data than what doctors, farmers, and scientists can easily put to use with real-world applications.


An international team of scientists has been studying the effects of alcohol on fruit flies. Fruit flies react to alcohol much like humans do. The flies are livelier when given small amounts of alcohol, heavier doses cause them to sleep or pass out, and the flies have exhibited addiction-like symptoms to alcohol. In studies, the team of scientists discovered a gene in the fruit fly that is linked to alcohol sensitivity. When the gene RSU1 is working in flies, they act drunk. Alcohol sensitivity is reduced when the gene is not working correctly.

Humans possess the same RSU1 gene as the fruit flies. Using brain imaging, the scientists monitored the brain activity of over 1,400 young adults to determine whether the gene was associated with the brain’s reward system. Additional testing revealed that the RSU1 gene affects a human’s preferences for alcohol as well as the brain’s reaction to it over a lifetime. The scientists hope that studying the gene will lead to a better understanding of how to treat alcohol addiction.


Harvard geneticist, Clifford Tabin, has been researching cavefish that live in underground caverns in northeastern Mexico. Tabin’s study reveals that the fish show a mutation in the gene MC4R. Because of the mutation, the fish are genetically wired to have huge appetites whenever food is available. The fish are extremely fat from binge eating and have low nutrient levels.

Life in the caves has likely made the cavefish resistant to starvation. The fish dwell in the dark and only have access to food a few times each year. The fish store fat and live from it over long periods of time between feedings. Even though they are severely overweight from food binges, the fish are able to live long and healthy lives. MC4R mutations in people are close, if not identical, to what is seen in many of the cavefish. According to researchers, the gene has been identified as the most common single-gene mutation causing inherited obesity. Researchers are still studying how the fish maintain long, healthy lives, hoping to one day offer help to people who are obese.


Scientists assure consumers that genetically modified foods are safe for consumption. Even though it is not necessary, consumers are likely to see more products labeled “GMO-free” on the shelves of their local supermarkets soon. Many food companies are moving toward labeling because they think that is what consumers want. Whole Foods Market, with 410 stores across the United States, Canada, and Britain, will require all foods containing GMOs to be labeled by 2018. Similac Advance began selling a GMO-free version of the nation’s most popular baby formula to give consumers “peace of mind.” In 2014 Vermont passed a law requiring that all foods containing GMOs be labeled accordingly. Already, similar labeling requirements exist in sixty-four countries, including those in the European Union, Russia, Japan, China, Australia, and Brazil. Despite widespread food scarcity, many African countries have labeling laws and reject American exports because they contain GMOs.

Humans have been genetically modifying food for centuries. In the past, people would cross existing plants with relative species with more desirable characteristics. In total, it took years or decades to yield a desirable plant or crop. With genetic engineering, the desired outcome is possible in a single generation of a plant or animal; the outcome provides desirable characteristics such as tolerance to frost, drought, or salt and are immediately available. It no longer takes years or decades to yield crops with improved characteristics. The Food and Drug Administration (FDA) and the Environmental Protection Agency (EPA) evaluate and approve the GMOs before they are eligible to be sold in stores. To many, this means the food choices available in the marketplace are absolutely safe for consumption.


Baehr, L. (2014, July 25). This salmon will likely be the first genetically modified animal you eat. Business Insider.

Americans already eat genetically modified corn and soybean, and soon they may be eating genetically modified salmon. A new breed of salmon called AquAdvantage is waiting for FDA approval. A Canadian company, AquaBounty, created AquAdvantage, an Atlantic salmon that contains two other fish genomes. It contains the growth-hormone gene from a Pacific Chinook salmon and another gene known as the promoter gene from an Ocean Trout. Technically, this new GMO fish has little to no more nutritional value over regularly farmed salmon, but it grows more quickly due to the added growth hormone gene. Because this fish grows more quickly, it requires less food for growth, making the AquAdvantage salmon less expensive (production cost of about 75 cents a pound versus a dollar a pound for conventional salmon).

The GMO fish, nicknamed “Frankenfish,” has several critics that oppose its production. Some fear that the fish will escape into the wild and overtake wild stocks of salmon. Others fear that food allergies to the GMO fish may arise, even though the fish is made from all edible fish genes. Because of these concerns, the FDA had been examining and researching the fish for over nineteen years. In 2012, the FDA approved the GMO salmon safe for consumption and opened a public comment forum regarding the fish. The forum ended in April of 2013, yet AquaBounty, the maker of the fish, still has not received the go ahead to sell the fish in the U.S. Experts say that it will take approximately two years for the fish to hit the market, when and if it is finally approved for sale.


Just like the weather, human gene expression changes with the seasons. In winter, human bodies pump up the levels of gene expression linked with inflammation and triggering swelling and discomfort that protect people from colds and the flu. In summer, a different set of genes is highly expressed, regulating blood sugar to help curb cravings and burn off excess fat.

A study published in May 2015 estimates that 25% of the DNA controlling behaviors and traits in the human body shifts with the seasons. The study’s researchers looked at data from 1,000 people across six countries including Australia, Germany, and Gambia. The data shows how people’s gene expression changes over time and by location. In Gambia, for example, inflammatory genes were highly expressed during rainy months when the risk of malaria is highest when mosquitoes thrive. A similar study from 2014 found that gene expression in red blood cells changed seasonally. Scientists believe the research may explain how evolution affected the way people respond to potential sources of infection or illness during certain time periods.


Burke, F. (2015, June 28). Would you be willing to reveal your genetic code to your employer? The Irish Times.

A United States jury in Georgia awarded $2.2 million in damages to two warehouse workers who were forced by their employer to provide a medical sample with genetic information that contained DNA. The demand was initiated by the warehouse owner to determine if the workers had defaced property at the warehouse. The case was filed under the United States Genetic Information Nondiscrimination ACT (GINA) and was the first of its kind to be won. “We’ve been waiting for a case like this for a long time,” says Dr. Aisling De Paor of Dublin City University’s School of Law and Government which specializes in genetic policy. To date, Europe has been slow to adopt a policy similar to GINA. The closest Ireland gets to protecting someone’s genes is under Part 4 of the 2005 Disability Act which states that genetic test results cannot be used in employment circumstances. This issue also falls under the data protection law, which states that information from an insurer must be discounted regardless of what the tests say.

With the advancement in technology comes the possibility of abusing the technology. Laws and policies need to be discussed in detail to guarantee people’s genetic safety both at home, in public, and at work.


The body's biological make-up requires the precise activation of specific genes to work correctly. If the sequence is out of order or if one gene turns up only partially, the outcome is often disease. Bioengineers at Stanford have developed a programmable genetic code that gives them control over activating and deactivating genes in live cells. Their technique is an adaptation of CRISPR methodology.

CRISPR consists of two main components: the first is a short RNA (strand of molecules) that matches a particular spot in a genome, the second is a protein called Cas9 that "cuts" the DNA in the RNA location. With gene-editing technology such as CRISPR, scientists control where a genome is cut. Then, they insert a new gene into the cut and patch the genome back together. Stanford bioengineers are building off the idea of inserting new genetic code into a genome. Their work includes telling a cell how much or how little to express a particular gene, which changes its behavior. Much like a car that has a wheel for direction and an engine to control speed, scientists can manipulate what genes are present and to how great or little they are expressed.


Chen, S. (2015, July 06). Genetically modified animals will be on your plate in no time. *Wired*.

No genetically engineered animals have been approved for human consumption. Biologists are still manipulating animal genomes, working to increase animal muscle mass, speeding up growth rates, and discovering traits that the food business values. It is probably safe to say that genetically modified animals will soon be on dinner plates. A team of molecular biologists at Seoul National University showed pictures of pigs with extremely large backsides, a trait that is valuable to the food business. They created the "porkier Porky" by deleting a gene that normally inhibits muscle growth by using a gene-editing technique called TALEN. While some say it is similar to breeding and that over time farmers and scientists could have had the same result, others say that bigger pigs are not always better. Despite opposition, the pigs' creators say the chance of eating a genetically modified pig in the next five years is high.

In 1989, Canadian scientists developed fast-growing salmon, and it has been a topic of debate ever since. Compared to the standard three years it takes for normal salmon to reach market size, the fast-growing salmon reaches market size in 16-18 months. Although the FDA has been slow to approve the sale of the modified salmon, the FDA declared the fish safe to eat in 2010. Many companies were still reluctant to sell the fish.

Ranchers often practice dehorning their cattle to make them less likely to injure other animals or people that work with them, but the practice seems to reduce dairy production. After using the TALEN method to insert a gene from a hornless Angus into Holsteins, ranchers saw the horns disappear but they still could not produce milk.

On a positive note, there is promise for gene modification becoming a factor in eliminating harmful nutrients for infants allergic to milk. Up to one-third of infants are allergic to milk according to a New Zealand study. The genetic engineers used a technique called RNA interference which knocks out the gene that makes the protein without altering milk production. This technique is still far from the marketplace but provides hope for many.


Over 5,000 years ago, the Babylonians were the first to practice genetic modification. The ancient farmers added a yeast fungus to grain to create the first beer. Today, genetic modification is done through biotechnology and is created in a systematic and scientific fashion in order to grow crops faster and increase overall production.

Scientists tend to have varying opinions about genetic engineering processes. In a study done in January of 2015, 88% of scientists surveyed stated genetic engineering was safe, while just 11% declared it to be unsafe. Among the general population in the United States, only 37% feel that GM foods are safe for consumption. People are concerned and confused over the possible safety hazards and health issues that could come with eating genetically modified foods.

To date there is no significant evidence of harm from eating GM foods. The Genetic Literacy Project conducted a study of 197 GM foods. The organization identified twenty-four of the foods as healthier than ordinary foods. Just eleven of the foods studied were determined to be less safe than regular foods, and the remainder of the foods tested showed inconclusive results. GM crops are becoming more and more prevalent in Latin America, Asia, and Africa. The United States is the largest producer of GM crops, with Brazil being the second largest in the world. Compared to the United States and Brazil, there are significantly fewer GM foods produced and consumed in Europe.


The European Union has established a legal framework for the regulation of GM food, GMOs, and feed products. According to some experts, the framework is a symbol of defeat for science. The regulation could seriously limit further genetic engineering in individual European nations as well. Currently, only one GM crop, a pest resistant corn, is approved for growth and consumption in the European Union. There are no animal derived products available because they are largely considered unsafe for animal or human consumption. Even though the public within the United States has a mistrust of GM foods and animal products, the federal government has no legislation controlling GMOs and there is a strong movement calling for mandatory GMO labeling in the United States. There are currently sixty-four countries worldwide that require GMO labeling, but the United States is not one of them.

Nigeria, where food is in short supply, is active in the GMO debate. Those in support of GM technology in Nigeria point out that the country faces challenges in food production, population growth, and competition for fertile lands. Because of this, supporters argue that Nigeria must turn to foods that can be grown quickly and will be sustainable in severe climates and drought situations. Supporters also state that the use of GMOs will lead to a better understanding of biological and physiological growth in vital plant production. Already, GM techniques have helped generate crops with improved protein content, higher levels of hormones and vitamins, and growth factors that could improve health care. Even with the support of scientists and the public, the Nigerian government has yet to approve GMOs. The government cites fear and mistrust over the use of GMO Agent Orange during the Vietnam War. Agent Orange was used to destroy foliage and food crops that resulted in damage to an estimated 10 billion hectares of agricultural land.


The World Food Program estimates 795 million people do not have enough food to lead healthy lives. This global statistic is equivalent to one in nine people in the world. With the next global food crisis predicted to happen within the next four years, experts are working fast to find alternative ways of feeding the world’s people. Genetically modified (GM) crops could be the solution scientists need. To be effective, the crops need to be developed under a regulatory framework that is safe for farmers, consumers, and the environment.

So far, genetic engineering techniques are far from perfect and remain controversial. Lab tests still result in unintended mutations, sometimes with fatal results for plants, fish, and human cells. In 2015, GM crops covered 170 million hectares of land, about 11% of all arable soil. Golden Rice, designed to be nutrient-rich in vitamin A, could save one million lives each year. Even though Sygenta, a biotech company, has offered to grow the Golden Rice for free, its approval has been delayed. Strict regulations are lacking on most GM techniques. For this reason, biotech companies might choose to experiment with crops in developing countries where the need for food is greater than the political will to protect the masses. The world is in desperate need of nutrient-rich, environmentally safe food production. Gene-editing in crops may be the solution, but regulatory measures are necessary to ensure the safety of new food technology.


Jose Dinneny and his research team at the Carnegie Institution for Science has developed a unique system to identify how roots grow best and adapt in soil during drought situations. The technique known as the GLO-Roots system involved the genetic engineering of plants and the combination of an enzyme from fireflies called luciferase. The enzyme causes the plant roots to glow in the dark of the soil. Light-sensitive cameras then follow the light emitted by the roots and allow the researchers to view the roots through the surrounding soil. The team used many different genetically encoded luciferases, so that each one would produce light with a different wavelength. Through the process, the team was able to track an entire root system's architecture, as well as the gene expression of the growing plants.

The team's discovery may be very significant in the study of how plants survive in drought conditions. The GLO-Roots system will allow the researchers to study and predict the genetic pathways in the soil environment and further allow them to create more drought tolerant plant species in the future.


Climate change is warming the Arctic and sub-Arctic more than twice the global average, which means that permafrost is not so permanent any more. Melting permafrost has allowed scientists to discover a 30,000-year-old giant virus in the frozen wastelands of Siberia. Now, scientists have set their sights on reanimating the virus or bringing it back to life for study.

The virus, known as Mollivirus Sibericum or “Soft virus of Siberia,” is the fourth pre-historic virus found since 2003. Lead researcher, Jean-Michel Claverie, says there are a few viral particles that could still be infectious, “If we are not careful, and we industrialize these areas without putting safeguards in place, we run the risk of one day waking up viruses such as smallpox that we thought were eradicated.” Scientists will attempt to revive the virus under safe laboratory conditions. They have successfully revived viruses found in the same location; reviving this virus may lead to numerous scientific discoveries about virus genes.


Scientists have successfully reconstructed Anc80, an ancient virus believed to be 2,000 - 200,000 years old. Why do scientists want to recreate a virus that became extinct thousands of years ago? They believe it could be key in treating genetic diseases such as muscular dystrophy and cystic fibrosis. In initial tests, scientists used the virus as a vector, or vehicle, to transfer genetic material to a target cell. In mice, they were able to safely treat liver, muscle, and retina conditions using the technique.

The Grousbeck Gene Therapy Center at Harvard says the study could be the first step toward a collection of fully synthetic viral vectors used to treat genetic disorders. Many of the viruses currently being used as vectors are variations of modern-day viruses that humans have encountered before. When familiar vectors are used, the body’s immune system attacks the virus, which can cause gene therapy to fail. The Center’s therapy is leading the way for synthetic vectors. One day, researchers may have a set of synthetic viruses that are not currently present in nature. In gene therapy, genes are used to fight or prevent diseases that are present because of genetic mutations. The simple virus structure, a strand of DNA or RNA surrounded by a protein coat, means they can easily infiltrate the immune system to deliver healthy genes to a target area.

**Genetic modification: The most critical technology’ for feeding the world.** (2015, August 20). *Science Daily.*

Nina Fedoroff, former Science and Technology Adviser to Hillary Clinton and Condoleezza Rice, says that genetic modification is the most critical technology in agriculture in that it will help scientists meet the challenges of feeding a growing global population. Fedoroff maintains that today’s version of GMOs are the safest new crops ever introduced into human and animal food chains.

Based on current trends, by 2050 food production will need to increase by 70% just to meet the basic nutritional needs of the population. Citing water issues, land issues, and global malnutrition, Fedoroff believes that the positives in using GM food crops far outweigh the negatives.

In addition to using GM food crops to prevent famine, the use of GM crops has also reduced the need for pesticides to grow crops and helped increase crop yields. According to Fedoroff, people must have the wisdom to overcome fear of new technologies. It is by overcoming such fears that the agricultural research and development will be utilized to increase agricultural productivity and decrease its negative environmental impact.


One gene mutation in a single species can cause dramatic changes in whole biological communities. Scientists from Trinity College Dublin were able to replicate the impact on ecological systems in a lab environment. Their work revealed that mutations of a single gene can change how one bacterial species interacts with others. The experiment’s “social mutants” completely altered the structure of the multi-species microbial community. Researchers compare the impact of the changed genes to that of a predator that could cause the extinction of the entire species.

Results of the study suggest that there is a place for small-scale genetic engineering with widespread impact. It also calls for greater attention to the importance of microevolution of species alongside research focused on big factors such as environmental change, deforestation, and temperature changes. Lead author of the study, Deirdre McClean says, “It is amazing to know that just one change in a single gene has the potential to have such a huge effect that it can change whole ecosystems.”


For more than twenty-five years, scientists have developed genetically modified fish that overexpress growth hormones. Unlike domesticated crops, these fish are not available for commercial production. A team of government and academic researchers is looking at the possible outcomes of an accidental release of transgenic fish into the wild. To better understand if genetically modified fish could survive in the wild, the researchers focused on salmon. Genetically modified salmon were found to possess a set of traits that could render them more or less fit than wild-type salmon in the wild. For example, GM salmon expressed enhanced feeding motivation. This could mean that GM salmon would out-compete wild-type salmon for food. At the same time, more competitive feeding might put GM salmon at greater risk of attracting predators, lowering their overall fitness in the wild. Unraveling the possible outcomes and consequences is a significant challenge for decision makers and regulators.

Another troubling scenario is the possibility of an invasion in an ecosystem. In theory, GM salmon could become an invasive species, putting pressure on the other organisms present in the ecosystem they invade. Whether or not GM salmon can be released into the wild without significant environmental consequences is uncertain until further research is done.


British scientists claim they have developed a way to genetically modify an invasive species of moth. By controlling the moth population, scientists can reduce the damage moths cause to cabbages, kale, canola, and similar crops. Globally, diamondback moths cost farmers $5 billion in vegetable production loss annually. In tests, researchers genetically modified diamondback moths with “self-limiting” genes, inhibiting reproduction. Similar experiments have been done with dengue fever-carrying mosquitoes. In trials, the self-limiting technique reduced mosquito populations by more than 90% in Brazil, Panama, and the Cayman Islands.

Researchers genetically engineer male moths to produce only male offspring. In trials, releasing the modified moths into the population caused a crash in moth numbers in just eight weeks. The gene-limiting method is celebrated for being very species-specific because it impacts just one pest and leaves other bugs unaffected. This sets the technique apart from other methods that have been used to control moths like conventional and organic pesticides that can also harm other insect populations. Moths are becoming more resistant to insecticides, which makes self-limiting research especially promising. The gene is non-toxic, meaning birds and other animals that eat moths do not suffer any harmful effects.

Retrieved from http://www.reuters.com/article/2015/07/30/us-gm-moths-idUSKCN0Q42L020150730

A protein that enables scientists to cut-and-paste DNA was unknown to humans four years ago and is now considered world changing. The discovery is receiving the recent backing of a CRISPR focused company, Editas Medicine. Their investment of $120 million dollars was led by Boris Nikolic, and includes Bill Gates. The group of investors belongs to BngO, a newly created firm. The funding for the project includes funding from major companies including Deerfield Management, Viking Global Investors, Fidelity Management & Research Company, Google Ventures, EcoR1 Capital, and more.

While this technology has yet to be tested in patients, it has the potential to create a survival benefit for the population. Editas, a leader in this technology, is looking to first test this drug in Leber’s Congenital Amaurosis Type 10, a genetic form of blindness. The CEO of Editas believes it is a good first choice for the treatment because the disease is in the eye, where gene therapies are easier to deliver and because a single genetic misspelling that can be deleted out is the cause of the disease. The idea behind this is that deleting genes is easier than rewriting the genes.

The Editas team is focused on deleting genes for now, but has a plan to rewrite genes in hemoglobinopathy, a type of genetic condition in which the molecule that carries oxygen in red blood cells is defective. The projects are likely to take years of time, but the investors are willing to wait to see a return on investment because they understand the extensive time and research that genetic modification projects take.


Farmers and agriculturalists may soon be able to produce crops that are resistant to heat due to environmental changes. Shanghai scientists have been studying the gene known as ERECTA, using it as a layer of sunscreen in the membrane of plant cells.

Since 1961, the world’s grain output has been decreasing. The Chinese scientists have attributed this decline in part to global warming. Creating more heat resistant plants will increase plant growth and the crop yield as well. The scientists have tested this gene therapy on rice, tomatoes, cabbage, and mustard. The rice treated in the Shanghai experiments had a 70% survival rate. The team also found that when the activity of the gene is increased in a crop, it will be more resistant to pests, disease, and drought. Because China has 22% of the world’s population but only 7% of the agricultural area, making use of gene therapies with high success rates is important to sustain future populations.


A major consequence of climate change and global warming is drought. When there is a drought, plants may struggle to survive and cause a decrease in crop yields. Over time, plants adapt so they can survive drought conditions. In recent years, climate change and global warming have progressed so quickly that plants have not been able to adapt and evolve fast enough. The scientific community is under pressure to develop drought resistant crop varieties that can withstand drought conditions. To be successful, biologists must understand the genes that helped plants to evolve and adapt in nature so they can then apply them to cultivated crops.

Recently, scientists at the University of Nebraska-Lincoln found that two genes in particular (At3g03940 and At5g18190) contribute to drought-resilience in plants. In studies, mutant plants lacking the two healthy genes showed increased susceptibility to drought conditions. They wilted faster and had early deaths compared to healthy plants without the defective genes. Over time, researchers hope to understand and reproduce genes that have the opposite effect - plants that are more resilient to changing environmental conditions. Another team of researchers from Seoul National University also found promising results while studying the role of NAC016 gene in drought response. They found that plants with under expressed NAC016 were more resistant to drought conditions than those that over-expressed the gene.


There is a proposal to introduce the technique of rewilding into the genetic engineering process. Rewilding is a process where scientists take a gene from an ancient plant variety and combine it with a modern species to make it resistant to drought and disease. Known as “precision-breeding,” the technique is often considered a natural type of genetic engineering. Because the technique uses genes from natural plants, some believe it is a more organic method of genetic modification and that it is the best way to improve plants through precision-breeding.

Opponents of the technique say that precision-breeding is not an exact science, and it is still a form of genetic engineering. Some scientists worry that there could be unexpected effects on other genes when a new gene is added or an existing one is deleted. In Europe and many other countries, rewilded genes are still considered GMOs.

The idea of replacing lost genes in plants is not new. For years, scientists have been using traditional genetic breeding methods to cross modern plants with ancient ones until they have the gene they want in a particular plant. An example of this precision breeding is flood resistant rice which was developed in 2006. More than 4 million farmers in Southeast Asia now grow rice that has the genetic makeup to resist floods. The argument continues over whether or not rewilding is creating new plants through genetic modification, modern ingenuity, or just an older technique being revitalized.

Lewis, D. (2015, August 27). Some brands are labeling products ‘GMO-free’ even if they don’t have genes. *Smithsonian.*

It is pretty difficult to genetically modify salt because salt does not have genes; however, that is not stopping the Evolution Salt Co. from adding a “GMO-free” label to their products. The company’s owner believes that the label sets Evolution Salt apart from other competitors’ salts at the supermarket. After decades of enthusiasm for processed foods, Americans are becoming more concerned with the foods they consume. Even though little evidence exists to suggest that genetically modified foods are unhealthy, an increasing number of companies are adjusting their labels to boast GMO-free ingredients. In fact, sales of products with labels such as “non-GMO” grew to $1.1 billion, a 30% growth between 2014 and 2015. For some companies, claiming food to be GMO-free is a marketing strategy. For Chipotle, Ben & Jerry’s, and Cheerios, making non-GMO claims may be a means of gaining ground in a competitive, rapidly growing market.

The Non-GMO Project is the only organization that can label food as “GMO-free.” The non-profit organization is dedicated to preserving and building the non-GMO food supply, educating consumers, and providing verified, non-GMO food options. For a fee, the organization will certify foods as “GMO-free” or as low-risk for genetically modified ingredients. The number of vendors that want their fruits and vegetables certified (even when there is no GMO alternative) has climbed substantially over the last several years.


Lewis, T. (2015, July 29). A single gene has been linked with being a psychopath - and it's very controversial. *Business Insider.*

No single factor can explain what causes psychotic behavior, but new research suggests genes may play a role. In particular, monoamine oxidase a (MAOA) is thought to be responsible for increased violent and aggressive behavior. This so called “warrior gene” controls the production of a protein responsible for breaking down brain-signaling chemicals that influence mood. An excess of the brain-signaling chemicals builds up, causing sleep disorders, mood swings, and violent tendencies. People who have a variant of the gene, known as MAOA-L produce less of the protein.

Neuroscientist James Fallon was studying the brains of violent criminals when he accidentally discovered his brain looked a lot like theirs. He later found he too possesses the MAOA-L gene. So why isn't James Fallon a violent criminal? He believes the environment people are exposed to influences the way they act, and research supports his theory. Further, scientists do not fully understand the entire human genome and how the same gene can cause different effects in different people.

Science shows that it is not that simple to reduce complex psychiatric conditions to a single gene. While there is still much to discover, research on this topic is already influencing decisions in the courtroom. In 2009 an Italian appeals court shortened the sentence of a convicted murderer who had the MAOA gene associated with violence.


Humans have been altering the genetic makeup of produce for thousands of years or more. People attempt to edit the genetic makeup of favorite plants to give them desirable traits such as resistance to pests and harsh weather conditions. In fact, many of the foods humans enjoy most would taste and look much different today if they were not genetically modified. Even though scientists and farmers have been finding ways to alter the genes in common fruits and vegetables for years, a number of consumers prefer to stay away from products containing GMOs.

What were fruits and vegetables like thousands of years ago? In the 1600s, watermelons had swirly shapes embedded in six triangular pie-shaped pieces. Over time, people have bred watermelons to have the red, fleshy interior they are known for today. Compared to its ancestor, the modern banana has smaller seeds, tastes more appealing, and is packed with nutrients. The first carrots, grown in the 10th century in Persia and Asia Minor, were purple or white with thin, forked roots. Today, corn is 1,000 times bigger than it was 9,000 years ago.


George Church, a leading genetics researcher, thinks gene-editing technology will soon make humans healthier and stronger. In fact, MIT Tech Review calls gene-editing the “biggest biotech discovery of the century.” In theory, gene-editing technology, called CRISPR, will give scientists the ability to search a person’s genetic code and replace less attractive genes. The technology is presently only accurate about 20% of the time, but scientists are hopeful they will soon be able to use it regularly with success. In 2015 alone, researchers anticipate more than 1,100 papers will be published about CRISPR technology.

Experts are already thinking about the edits possible to genetic codes. Some edits will make humans stronger, coding for extra-strong bones and lean muscles; others will make life easier or more attractive by coding for less sensitivity to pain or lowering body odor production. Still, other edits will improve overall health by reducing the risks of coronary disease, Alzheimer’s disease, or diabetes.

Readings, Research, and Resources

It's All in the Genes

Loria, K. (2015, September 25). We might not want to know the dark secrets lurking in our genes. *Business Insider.*

Researchers believe it will be normal for most people to have their genomes sequenced in the future. Bioethicist, George Annas, says there is one obvious challenge if all people know their DNA makeup: they may not like the answers. The biggest problem in knowing a person’s DNA makeup is that this information may not be usable and doctors or scientists may not know how to solve associated concerns. People could end up living large portions of their lives knowing they are “sick,” without being able to address the illnesses or diseases.

Annas predicts that each person who chooses to have their genome sequenced will find five to ten potentially lethal codes in their genome. On the other hand, the sequencing of genomes may allow for anticipation of what diseases will occur later in life and enable treatment of these diseases from birth.


**Millions of genetically modified mosquitoes could be released in Florida Keys if British researchers win approval to use the bugs against painful viral diseases.** (2015, January 25). *Daily Mail.*

If researchers secure approval, millions of genetically modified mosquitoes could be released in Florida to fight dengue and chikungunya, two viral diseases which are both growing threats in the United States. While mosquito controllers say they are quickly running out of ways to control the viruses, many people are more fearful of being bitten by a genetically modified mosquito than they are of the diseases. At present, there are no vaccines or cures for dengue, the “break-bone fever,” or chikungunya which causes painful contortions. Worldwide, dengue sickens 50 million people each year, killing about 2.5% of those affected. In the Caribbean, more than a million people contracted chikungunya in 2014.

Oxitec’s solution proposes releasing only male mosquitos into the population. When those males mate with females in the wild, the offspring die and ultimately reduce the mosquito population. If approved, the experiment would be very similar to Oxitec’s 2012 release of 3.3 million modified mosquitoes in the Cayman Islands. Over six months after the release, 96% of the targeted insect population was eliminated.

Critics are concerned that being bitten by modified mosquitoes would mean genetically modified DNA would enter human bloodstreams. Oxitec has released 70 million mosquitoes across a number of countries, and so far no reports of harm to humans caused by bites have been received. Many experts believe Oxitec needs to do more testing to prove that synthetic DNA transferred by mosquitoes causes no harm to humans.


Obesity, a condition that affects 500 million people worldwide, might be considered curable since scientists have discovered an “obesity gene.” Researchers at Harvard and MIT have broken ground in discovering that tweaking a piece of the DNA code in the region responsible for fat mass and obesity-associated protein could lead to an acceleration of metabolism and ultimately burn excess fat that would otherwise be stored. The discovery came from associating the genes IRX3 and IRX5 with the condition. These genes prevent fat from being burnt through a process of thermogenesis, which happens naturally in those with healthy FTO gene regions.

Thermogenesis has been proven successful in mice and human cells in lab testing, but has not yet been practiced on humans. This discovery could change the world, and scientists are calling this a “big deal.” The discovery is groundbreaking because obesity can lead to other medical conditions such as type 2 diabetes, cancer, and cardiovascular disease. Scientists remain hopeful that this discovery will be tested and implemented in the near future.


Scientists warn that Earth has entered the period of its sixth mass extinction - the last such extinction killed the dinosaurs 65 million years ago. Some professionals believe species are becoming extinct 100 times faster than normal. The Global Genome Initiative is in a hurry to collect and deep freeze genomes of plants, animals, and microorganisms over the next two years. Experts leading the initiative estimate that it will only take six months to gather samples from half the world’s plant families. The initiative to collect plant genomes is relying on volunteer “citizen scientists” for a majority of the samples. A significant portion of the collection is happening in the Washington area at the US Botanical Gardens, the National Arboretum, and the Smithsonian Gardens.

Alongside the Global Genome Initiative, efforts are being made to save and store the seeds of plants in special vaults around the world. Because DNA begins to degrade within three minutes of an organism’s death, plant samples must be frozen immediately in canisters of liquid nitrogen and transported to a cryo-storage facility. At least twenty-five storage facilities have been created and can be found on all continents except Antarctica. Of the estimated 11 million species in the world, only two million have been documented, and only 1% of the planet’s known genomes have been sequenced.


Google owned biotech company, Calico, is working with AncestryDNA, a personal genetics company. AncestryDNA maintains a database that contains genetic and genealogical information for its paying customers. This partnership is designed to work with pharmaceutical companies to develop drugs and technologies to increase a human's lifespan and create a large database for research purposes.

Participants pay $100 per DNA sample provided to companies like AncestryDNA so they can collect genetic data as well as family history data. Approximately 90% of AncestryDNA's customers agree that the company may use their DNA sample for research purposes. AncestryDNA has not announced their profit in the venture, but the genetic database that is being compiled is most likely invaluable. Through the relationship with AncestryDNA, Calico will be able to compare data of an individual's genetic information and of their family's ancestors.


Plants have body clocks just like us: Petunias release scent after sunset to lure nocturnal insects to help them pollinate. (2015, June 29). *Daily Mail*.

A new study reveals that plants have “body clocks” that alert them that it is time to emit scents. Researchers from Washington University discovered that the emission of scents is repressed in petunia flowers in the early morning due to a gene called LHY. Petunias with lower LHY release fragrances four to eight hours sooner than those with high LHY activity. With the discovery, scientists may be able to engineer crops so they emit smells at different times to appeal to a different group of pollinators.

This technology could be revolutionary if it can help increase food production. If experts can engineer crops to emit smells at times tailored to insects, it will help improve pollination. By improving pollination, scientists will have greater control over the volume of crop yields. This is the first time that a flower’s circadian clock has been linked to scent, providing researchers with an opportunity for genetic advancement. The next step in testing the process is to determine if pollinators have a preference between normal garden petunias or ones with altered LHY activity.


In hopes of alleviating confusion and promoting public confidence, the Obama administration has committed to updating the way the government regulates genetically modified crops and other biotechnology products. They believe that the current system is too complex and can make it difficult for the public to understand the safety of the products. The current system has not been updated since 1992, when genetically modified crops were not yet being marketed. Critics of biotechnology crops believe the current system is too lax, while executives in the biotechnology industry and academic scientists say the regulations are unnecessarily tough. These rigid standards are making it costly and difficult for many academic researchers and small companies to bring genetically engineered crops to market.

During the first year, the government will clarify which products or product areas each agency is responsible for regulating rather than changing the regulations. The biggest concern is that while the regulatory system ensures safety it does not ensure confidence in the public that products are safe; therefore, there is an understanding that there is a need for more transparency in the food system. The White House is committed to providing a well-rounded regulation system that is “timely, predictable, based upon the best available science, and incorporates 20-plus years of experience with the technology.”


Most of us already consume some form of genetically modified food. Canola oil is found in most foods on the market today and it, along with cookies, chocolates, and soy milk, all contains some form of GMOs, or “frankenfood.”

One of the largest global, genetically engineered crops is soybeans. DNA is manipulated in laboratories and then inserted into the soybean. Some scientists say 90% of soy is GM, and soy is used for lecithin, which goes into a variety of other foods. Canola and cotton are major GM crops grown in Australia. While cotton is not a food, cottonseed oil is an ingredient found in many foods on the market.

Experts believe there hasn’t been enough research done on the long-term effects of GM foods on humans. Stephen Leeder, professor of Public Health and Community Medicine at the University of Sydney, maintains that no one can say with confidence that GM foods have no effect on the human body. Jessica Harrison, of the GM Free Australia Alliance, states that 60 percent of the processed foods consumed in Australia contain GM ingredients. Harrison also states that GM foods could cause liver damage as well as issues on the reproductive and immune systems. Because of these findings, many Australians are concerned that they do not know what they are eating or feeding their children.

A great debate is occurring in Australia over the labeling of GM foods. Some experts there report that genetic modification in foods is too difficult to monitor due to the long process of production. On the other hand, GM foods are produced less expensively and use less resources, which is better for consumers and the environment. Many Australians are more concerned about pesticides, additives, and herbicides in their food than genetic modification, and ultimately it seems the public wants a voice and choice in the genetic modification matter.


Genetic research was once thought of as something akin to rocket science, and many believed that this type of technology would not be possible. Today, that school of thought has drastically changed as now, more than ever, scientists, teachers, students, Congress, and Hollywood better understand the genetic engineering process and the potential societal changes.

Through an informational and educational project known as the Personal Genetics Education Project or pgEd, people can take brief genetics quizzes and locate their ancestry on a world map. Through involvement of the general public and a countrywide campaign that has spanned ten years, the pgEd project has encouraged many to be more accepting of genetic engineering. Although many are still skeptical of genetic modification, the idea that it is a science fiction topic has changed more to a question of what this might do for me personally or for future generations.


Scientific research funders in the United Kingdom are calling for discussion on the ethics of genetically modifying human embryos and other tissues to prevent disease. Rapid progress in the field of genome editing means science will soon get ahead of public opinion. The powerful genome editing tool has the potential to transform how rewriting the DNA code of certain cells treats genetic conditions. Researchers believe genome editing will lead to transformative new therapies that treat disease. For instance, new treatments might edit immune system cells so they attack cancers. Editing the genomes of embryos could also give couples with genetic disorders the chance to give birth to healthy children.

Some scientists have voiced concerns that genome editing is becoming so low-cost that a “rogue” researcher could use the procedure to edit human embryos and implant them into women, causing many people to call for an end of all genome editing research on embryos. Most scientists feel the genome editing technique is too new to fully understand whether it is safe, and in the United Kingdom it is illegal to implant modified embryos into women. Any embryos used for experimentation in the UK must be destroyed after fourteen days. In the United States, there is no law prohibiting genome editing of embryos. The National Institute of Health views any editing of the human genome as, “a line that should not be crossed.”


A research group at the University of California, Riverside has reached a new milestone in the sequencing of the barley genome. The researchers have sequenced large portions of the genome that together make up nearly two-thirds of all barley genes. This work is important because the barley genome is very similar to that of the wheat genome.

Through continued research study efforts, the team has been able to identify several genome sequences that will enable them to make better cross breeding connections and develop higher yields of barley and wheat crops in the future. This team’s work could also lead to other useful data to assist in the complete sequencing of the wheat genome.


Researchers recently announced that they have created a chemotherapy drug from an endangered Himalayan plant that has the potential to be highly successful. This work could ensure an abundant supply of an anticancer drug and make it easier for chemists to modify the compound to create a safer and more effective way to treat cancer. The Himalayan Mayapple is the source of podophyllotoxin, which has been used to treat cancer since 1983. Originally, scientists used toxins extracted from the plant to create Etoposide, which has been used to treat dozens of different cancers, from lymphoma to lung cancer. Today, podophyllotoxin is mainly harvested from the more common American mayapple. While the American version is not endangered, it is slow growing and produces only very small amounts of the compound.

Previously it was not known which exact genetic pathway of the plant made it the most potent; researchers only knew that podophyllotoxin was not always present in the plant. It seems the plant only manufactured the vital podophyllotoxin when its leaves were damaged. After several investigative and thorough trials and tests, chemical engineer, Elizabeth Sattely, has isolated a group of ten enzymes that allows the plant to make the necessary molecules called (-)-4’-desmethyl-epipodophyllotoxin. It is hoped that this new powerful genetic structure will lead to new and potentially more successful cancer fighting drugs.


The US Defense Advanced Research Projects Agency (DARPA) has launched a program designed to genetically modify living organisms so they can survive on Mars. While previous projects have involved sending robotic crafts to Mars and setting up bases that scientists can later utilize, this is the first project of its type that involves sending living organisms to survive on the red planet.

DARPA hopes to create an environment that is one day stable for human life to thrive. Alicia Jackson, from the Biological Technologies Office at the Pentagon said, “For the first time, we have the technological toolkit to transform not just hostile places here on Earth, but to go into space not just to visit, but to stay.” Because the characteristics of Mars are very different from the characteristics of Earth, the genetically modified organisms to be shipped off to the planet will be unlike any that have been seen previously. DARPA is confident the plants they will configure will survive in the extreme cold and contribute to the warming up of the planet.


As scientists learn more about gene-editing, a future with designer babies becomes more real. Imagine a future where the privileged can edit their DNA and where those with genetic imperfections are part of a lower genetic class system. When imagining this future, do not forget to imagine the possibility of eliminating thousands of diseases from the world - the message scientists are trying to pass on to people who are fearful of gene-editing.

On April 18, 2015, Chinese scientists announced they had edited the DNA of (nonviable) human DNA. Since then, scientists and the public alike have been calling for a “time out” to get educated. Scientists need to know what they are capable of achieving with gene-editing and whether it is safe. At the same time, society should be voicing opinions about what they are comfortable with and making themselves technical experts to inform their decisions. The biggest fear of many science professionals is that average citizens and the governments that serve them will determine the rules about gene-editing without fully understanding the topic, ultimately preventing researchers from being able to eliminate heritable diseases from the human genome. There will undoubtedly be years of research ahead before experts begin to understand the safety of embryonic gene-editing.


Over a fifteen-year period, scientists at Buxton Climate Change Impacts Laboratory at the University of Liverpool studied the genetic responses of different wild plant species to simulated climate changes. The scientists found that climate change can alter the genetic makeup of wild plants. At the laboratory, the species-rich limestone grassland provided the perfect testing ground for the researcher’s work with climate change.

Based on the results of the study, scientists believe that they will be able to alter or buffer plants against the harmful effects of climate change, eventually allowing an “evolutionary rescue.” Since there has been so little testing, scientists still have a lot to understand about the effect of climate change on wild plants. Even so, the initial research for wild plants undergoing extreme climate conditions is promising.


China is spending billions of dollars each year on biomedical research, but being at the forefront of science may come at an even higher price. In April, the science community was shocked to learn that a team of scientists at Sun Yat-sen University had experimented in editing the genes of human embryos. One day the same technology, called CRISPR-Cas9, may be used to eliminate inheritable illnesses, but in theory, it could also change traits such as intelligence and eye color.

For many in the field of science, experimentation on human embryos is considered unethical. General consensus among experts in the field is that it is not yet the time for the genetic engineering of humans. Scientists in China argue that the field of genetics is progressing too quickly not to continue human experimentation. In 2013 alone, the country invested $190 billion in the development of scientific research and experimentation. Deng Rui, a medical ethicist at Shanxi Medical University, explains that ethics is closely tied to culture. Depending on religious influences, scientists may or may not believe they are experimenting on humans when working with embryos. In China, scientists can only experiment on embryos that are less than fourteen days old.

Professionals in the scientific community are pushing for greater ethical oversight. One proposed solution is to establish a global medical ethics body run by the World Health Organization (WHO) to regulate scientific experimentation.

CRISPR is the most simple and easy way to manipulate genetic engineering processes to date, and the possibilities for CRISPR genetic modification seem endless. The research being done on the potential uses for CRISPR genetic engineering is creating much excitement in the genetic research community. CRISPR can be used for biotechnology, molecular biology, medical research, and gene therapy as a whole. CRISPR is so impressive because it can be used to introduce or remove a number of different genes at one time. Most disorders are not caused by the mutation of one gene, so being able to manipulate many different genes in a cell line whether it is plant or animal opens a variety of options for geneticists. Serious diseases such as autism, diabetes, heart disease, and possibly cancer are being studied for the potential use of CRISPR. Scientists are also considering using CRISPR for stem cell editing for neurological disorders.

CRISPR can also be used where other techniques have failed. Genome editing through CRISPR could make it possible to eliminate viral infections within the human body or engineer pig organs so that the human body does not reject them. There is also much testing going on for the use of CRISPR in pharmaceuticals. Currently there are clinical trials testing for the use of CRISPR to treat HIV and sickle cell diseases through stem cell applications. One of the most promising uses of the gene treatment is for fighting cancer cells because CRISPR can make it possible to add a less invasive genetic change through the T-cells.

The possibilities of CRISPR may be endless; but, the genetic changes through CRISPR aren’t perfect. The biggest hurdle of the use of CRISPR, like other genetic engineering techniques, is still the ethical use of such therapies.


A new technology known as CRISPR-Cas9 allows researchers to edit almost any gene they target. The process is described as similar to a word-processing program that allows researchers to find and then replace specific genes. In April 2015, scientists in China experimented with the gene-editing technology with human embryos, igniting serious ethical debates. Though the embryos were not viable (and could not have developed into babies), the research was controversial.

In response to concerns, the National Academy of Sciences (NAS) plans to explore the scientific, ethical, and policy issues that come with human gene-editing studies. In 1975, NAS was tasked with developing guidelines and regulations for recombinant DNA, a gene-splicing technology. Now, the NAS committee is tasked with recommending regulations for gene-editing technologies.

Retrieved from http://www.reuters.com/article/2015/05/18/science-genes-nas-idUSL1N0Y910020150518

The United States Department of Agriculture (USDA) created a new certification and labeling system for foods that do not contain genetically modified organisms (GMOs). The certification is the first of its kind. If approved, foods with the new label will be clearly marked as “USDA Process Verified.” Under the new system, companies could volunteer to use the label and would need to pay to do so. It is believed that the department’s new process is being developed at the request of a leading unnamed global company. Despite interest in such a label, the government continues to stand behind statements that GMOs on the market are safe and that such labels are not necessary. Consumer groups argue that shoppers still deserve to know what is in their food.


In a Pew poll, 83% of Americans said it is not appropriate to genetically alter babies’ genetic characteristics to make them more intelligent. If this is indeed possible, will the strong vote to not genetically alter babies’ characteristics really matter? There is a strong possibility that other countries will disagree with the American government and start using this technology to advance the intelligence of their next generations and possibly advance their nations’ success because of it.

Without strict regulation, countries will begin to self-regulate genetic alteration. Hopeful parents may travel overseas to have this opportunity for their unborn children, causing another concern in that only the wealthy will be able to afford the technology. Only the top 20% of the population will have access to the process, leaving the middle and lower classes without the option. With extreme medical advancements, there is always unpredictability and the possibility of failures, and it is possible that genetically altered babies could be born with severe birth defects or other medical conditions. Medical teams are confident that by copying the genetic makeup of naturally intelligent individuals and repeating that genetic makeup will yield successful results.

Embryo genetic modification is coming up in multiple discussions, meeting government and efficacy requirements, and could be carried out in the near future. While many debates need to take place, many believe that genetically modified babies may be “morally acceptable” under certain circumstances.

Scientists of the Hinxton Group believe that genetic modification in human embryos is important and could provide value to scientific research. While the Hinxton group understands the negative opinions on the subject, they continue to weigh the potential advantages and harms of human genome modifying, leaning towards positive outcomes. Debra Mathews of the Johns Hopkins Berman Institute of Bioethics and lead member of the Hinxton Group believes that embryo genetic modification provides beneficial advancements and could restore some of the negative feedback that genetic modification receives from the public.

Professor Emmanuelle Charpentier, who was on the team that developed the CRISPR/Cas9 DNA gene-editing, believes otherwise. She does not feel it is ethical to manipulate the human genome for the goal of modifying the genetic traits that will be transferred over generations. Mixed feelings exist about gene modification in embryos and extensive discussion is necessary.

There are very few regulations in the United States that regulate genetic modification. The first GM law came about in the 1980s under the Reagan administration. Since that time genetic engineering has expanded tremendously. In addition, there is much debate over the exact definition of genetic modification. Today, companies like Monsanto are examining how to spray RNA in entire fields of plants to block certain plant genes without directly changing the plants. These types of new technologies are making the original rules for genetic modification obsolete.

Companies are getting around the limited GMO regulations because three different agencies are tasked with the monitoring and regulation of the antiquated laws. The USDA regulates potential plant pests and weed control, the EPA regulates crop engineering, while the FDA regulates GM livestock and animal drugs. Because of the loopholes and lack of communication within the three agencies, the White House tasked the agencies to begin rewriting the GMO rules in July 2015. The difficulty the agencies are having is whether or not the GMOs should be regulated based on the process used to create them or on the originality of the DNA sequences. Meanwhile, technologies such as CRISPR and TALENs continue to push forward with potential breakthroughs on the genetic engineering front.

**Terms and Definitions**

2-dimensional (2D): a shape that has width and height, but no thickness or depth

3-dimensional (3D): an object that has height, width, and depth

4-dimensional (4D): a dimension in addition to length, width, and depth, to be able to employ geometrical language in discussing phenomena that depend on four variables

3D Hub: an online 3D printing service platform which connects 1 billion people around the world to a network of 3D printers

3D printing: a manufacturing process in which a three-dimensional object is created layer by layer from a digital model; also known as additive manufacturing

aerospace: the branch of technology and industry concerned with aviation and spaceflight

alternative-printing technique: any non-traditional or non-commercial photographic printing process

automation: the use of electronic devices and machines to reduce the need for human involvement in manufacturing and other processes

biomimetic: human-made processes, substances, or devices that imitate nature

bioprinting: the 3D printing of biological tissue and organs through the layering of living cells

Computer-Aided Design (CAD): the use of computer systems to create, modify, or improve graphic designs of physical objects

consumer: a person who purchases goods and services for personal use

cross-section: the surface or shape that is revealed when a straight cut is made through an object

digital manufacturing: a method of production in which computer technology is responsible for producing products with little or no involvement from humans

digitize: the process of changing pictures or sounds into electronic forms that can be processed by a computer

entrepreneur: a person who organizes and operates a business, or businesses, and takes on greater than normal financial risks in order to do so

fabrication: the act of making a product from raw materials

filament: the type of material, similar to ink in a traditional printer, used to construct objects in 3D printing

insourcing: a business model in which all of a business’s activities are completed within the business without the help of another company

intellectual property (IP): creations of the mind such as inventions, artistic works, designs, symbols, and images

layering: a concept used in 3D printing where an object is designed and printed in small, stacked pieces that come together to form the full object

machining: a form of manufacturing used to create objects by braiding, cutting, drilling, grinding, and/or shaping the material

manufacturer: a person or company that makes goods for sale
**mass production**: the production of high volumes of standardized products, typically performed on assembly lines

**nanofabrication**: the design and manufacture of devices with dimensions measured in nanometers (1 nanometer is $10^{-9}$ meter, or a millionth of a millimeter)

**nanotechnology**: the branch of technology that focuses on the manipulation of individual atoms and molecules

**on-demand**: a technology in digital printing in which a product can be printed or created at the click of a button

**open source**: software or designs that are freely available and can be accessed, distributed, and modified by anyone

**outsourcing**: a business model in which an outside company is responsible for some of the primary business's activities

**photopolymer**: a material used in 3D printing that changes characteristics when exposed to light

**polyethylene terephthalate (PET) plastic**: a clear, tough, and shatterproof material that is commonly used in fibers for clothing, containers for liquids, and as filament for 3D printing

**polymer**: a substance that has a molecular structure consisting chiefly or entirely of a large number of similar units bonded together

**printhead**: a moveable part in a printer that holds the material that will be used for printing

**prosthetic**: an artificial device used to replace a missing or defective body part, such as a limb or a heart valve

**prototype**: a sample or model of a product that is built as a test to be learned from or copied

**rapid prototyping**: the use of 3D Computer-Aided Design (CAD) data to quickly produce a 3D printed model

**resin**: a sticky, flammable substance produced by plants and trees that is insoluble in water

**stereolithography**: a 3D printing technique in which structures are built from liquid polymers that harden when they come into contact with computer-controlled laser light

**textile**: a type of cloth or woven fabric

**thermoplastic**: a plastic material, or polymer, that can be easily molded or shaped at high temperatures and becomes solid at cool temperatures
The 3D printing revolution has begun. Also known as additive manufacturing, 3D printing involves the layer-by-layer creation of a three-dimensional object from a digital model. It can be used to manufacture prosthetics, spare parts, food items, toys, and even on-demand organs. This exciting technological breakthrough is rapidly spreading across the globe. The positive impact that 3D printing may have on society appears to be limitless. Its range of applications is vast. The cultural contributions of 3D printing may ultimately prove to be even greater than futurists previously imagined.

Additive manufacturing would not have expanded without major advances in technology and computer-directed modeling. In recent years, digital design software has evolved and become more accessible. Today, scanners are more powerful, affordable, and easier to use than ever before. Nevertheless, many people are only now hearing about 3D printing technology. They do not realize that engineers and designers have already been using large, expensive 3D printers for nearly three decades. Their efforts have produced parts for aerospace, automotive, and defense companies. Ten years ago, it took weeks to generate a digital 3D model. Now, it takes only hours.

There are a number of steps in the 3D printing process. First, the object must be digitized. When creating a completely new object, the virtual design of the object is made through a Computer-Aided Design (or CAD) file using a 3D modeling program. For an object that already exists, a 3D scanner can be used to create the digital file. Engineers or product designers can scan an existing object by shooting thousands of points of light at it and loading its “point cloud” into a computer. (The point cloud is a 3D ghost image of the original object.) No matter how it is created, once a digital file is available, printing begins. During printing, successive layers of material are repeatedly laid down, under computer control. The process continues until an entire object is created. Each layer can be thought of as a thinly sliced horizontal cross-section of the final object. Some 3D printing methods use melting or softening material to produce the layers.

Some of the most promising applications of 3D printing are emerging in medicine. For example, the printing of cartilage, organs, skin, and tissue holds great promise for transforming healthcare and extending life. So far, there has been mixed success in printing organs. Constructing organs by hand is hard work, and it is plagued by human error. A few handmade, printed bladders have been functioning in several patients for many years. Currently, scientists at the Wake Forest Baptist Medical Center’s Institute for Regenerative Medicine are working with other labs to systematically find ways to print muscle, kidneys, and bones.

Other research is focused on improving the organ transplant process. This involves using a patient’s own tissues to print organs for transplantation. Once perfected, it promises to reduce the risk of a body rejecting implanted organs. Waiting times for kidneys and other donor organs will decrease. Organ traffickers may be put out of business. However, researchers are still years away from perfecting the printing process for organs and tissue.
Doctors around the world are now using 3D printing to create customized body parts for their patients. Entrepreneur Daniel Stolyarov is experimenting with 3D printing using graphene for applications in the human body. Graphene is a flexible, transparent substance that is a hundred times stronger than steel. Researcher Carlos Kengla has spent the last few years focusing on the production of ears. He prints them using cells taken from human ear cartilage. The Alfred duPont Hospital for Children is working with engineers to build durable exoskeletons using 3D printers. Experts predict that 3D bioprinting will completely reshape modern healthcare. In part, that is because prescription drug companies are eager to test new drugs and therapies on rapidly prototyped organs and tissues, rather than on animals or human subjects.

In the technological arena, futurists predict that handheld devices such as smartphones will soon contain integrated 3D scanners. That will make digitizing real objects into 3D models as easy as taking a picture. Already, prices of 3D scanners range from very expensive industrial models to $30 do-it-yourself devices for the home. The Ford Motor Company uses 3D printing to make prototypes of parts for its vehicles. Brake rotors, cylinder heads, shift knobs, and vents are all made with 3D printing. Yahoo! is teaching blind children to search the internet using a machine called Hands On Search. It combines voice recognition technology with a MakerBot 3D printer to turn spoken queries into physical objects. In the aerospace industry, NASA is making history with its 3D printed rocket engine injector, which passes major hot fire tests. In a recent test, the injector generated ten times more thrust than any previous injector made from 3D printing. Astronauts on the International Space Station successfully printed a wrench in space after engineers on Earth emailed the design file to them.

It is predicted that nano-3D printing will be the next big thing in 3D printing. This involves applying 3D printing concepts to nanotechnology. Doing so is expected to make nanofabrication faster, cheaper, and more efficient sooner than many futurists originally envisioned. Batteries the size of a single grain of sand can be used to power 3D printed miniature medical devices, compact electronics, and tiny robots. Princeton University scientists have already created a bionic ear using nano-3D printing. The goal of their experiment was to find an efficient way to merge electronics with tissues.

Thanks to 3D printing, ordinary individuals around the world continually enjoy a wider range of impressive devices, innovations, and opportunities. It is clear, however, that 3D printing will not be restricted to just business applications or available only to the wealthy. Instead, technologists claim that 3D printing will soon be so accessible that the public will be freed from the dominance of mass manufacturing. Rather than products being mass-produced, manufacturing is expected to become personal and customized.

What does the future of 3D printing look like? Biz Stone, Twitter’s co-founder, recently predicted that Nike could be a pure software company in ten years, with consumers printing its footwear at home. Before long, products will be at an individual’s disposal. Imagine a woman is at home when she realizes that one of the wheels on her dishwasher has broken. She easily looks up the part on the Internet and then prints a replacement at home, or at a neighborhood printer using the 3D Hubs network. What if a child outgrows his current pair of customized 3D printed shoes? Simply drop the old pair in the material recycler and print out a new pair in a larger size.

With 3D printing, the future lies at the fingertips of those with innovative ideas. How will 3D printing be used to improve the lives of others or change the world? The answers may be just a few clicks on a computer and a quick print away.
1. 3D printing promises to be an innovative, creative solution for solving problems in a number of industries. Using what you know about 3D printing, select two industries and describe the impact 3D printing has already had in those industries. What are new ways 3D printing could improve each of the industries you chose?

2. Using three categories from the FPS Category List, discuss the challenges associated with 3D printing. For example, what are challenges associated with 3D printing in recreation?

3. Discuss at least three ethical concerns people raise about 3D printing.

4. Many people feel that creative uses of 3D printing will improve the world. If you had the resources to use 3D printing to create anything, what would you create that would have a great impact on a real challenge faced by humanity?

5. What is the 3D printing process? In detail, outline how a person could go from an idea to a 3D printed object. Make sure to consider how the object is designed, what type of material would be used, and what type of 3D printer you would use.

6. Scientists developed 3D printing filters that help treat malaria in humans. In Amsterdam, 3D printers are printing full-scale bridges. NASA has successfully printed tools in space. Considering all the progress that has been made with 3D printing, how might history have been different if 3D printing was invented sooner?

7. Describe a few 3D printing innovations that help promote human health or welfare. How do the innovations affect important world issues such as population growth and hunger? What other global issues could 3D printing help solve?

8. Define manufacturing. How does 3D printing work within traditional manufacturing practices? How does 3D printing disrupt traditional manufacturing practices?

9. To protect the environment and reduce waste, Coca-Cola and Will.i.am. teamed up to develop 3D printing technology that utilizes cheap plastic from old soda bottles. Does all 3D printing reduce waste? Overall, would you argue that 3D printing helps or harms the environment?

10. The ability to print low-cost, affordable housing is already a reality. 3D printed homes are expected to be especially valuable in developing countries. With low-cost, affordable housing in mind, consider the economic promise 3D printing holds for developing countries. What are some of the benefits? What complications could 3D printed homes cause?
Below are three major themes for understanding the topic “3D Printing.” Because most of the articles contain important information on more than one theme, the articles have not been arranged by themes and are presented as one group.

- Process Involved in 3D Printing
- Medical Applications of 3D Printing
- Continued Adoption of 3D Printing

A Structured Overview (found in the Appendix) can strengthen understanding of the various themes and to organize facts on the topic.

**Ackerman, E. (2014, November 18).** 3D printed robots teach themselves to move. *IEEE Spectrum.*

Humans continue to send robots to unfamiliar places. Many of them are far from Earth. The robots must be able to handle unexpected circumstances. The goal is for them to solve problems without help from humans.

Researchers at the University of Oslo are meeting this challenge. They are creating a robot with its own 3D printer. The printer can help the robot to get out of tricky situations. In theory, it might even allow the robot to print a new robot with better problem-solving skills. Such advancements are helpful to robots that must operate far from human support. Robots with 3D printing abilities may one day be sent to work in radioactive disaster areas, the Antarctic, or on distant planets.


China is the world’s leader in mass production. That may change in the coming years. The manufacturing industry is undergoing a transformation. 3-D printing may play a part in such change. In the manufacturing industry, 3-D printers are known as rapid prototyping tools. They enable entrepreneurs to easily draft designs and build models. For designers, digital printing can produce sample designs in a short time.

Unfortunately, today’s 3-D printers cannot handle the volume that mass production requires. They are unable to move fast enough to meet large-scale demands. If a 3-D printer could work quickly enough for mass production, the quality of its products would disappoint consumers. Beyond creating prototypes, few industries have yet found value in 3-D printed products. The medical and aerospace industries are exceptions because they thrive on customized parts.

Supporters of local manufacturing are seeking new ways to make 3-D printing successful. 3D Hubs, a Dutch startup, connects people who want to print with a network of more than 22,000 3-D printers. Amazon has filed a patent for delivery trucks containing 3-D printers. CloudDDM has invested in 3-D printer “farms” within UPS’s logistics hubs. CloudDDM’s one hundred printers are largely automated. They can operate with little human supervision. Nevertheless, low-volume, high-quality production with 3-D printers is expensive. As a result, it may never become the norm in product manufacturing.


In the future, 3D printed teeth may improve dental health. Every year, bacteria cause millions of dollars of damage to people's tooth implants. Andreas Herrmann of the University of Groningen is using antimicrobial plastic to combat this problem. Using the plastic, Herrmann and his colleagues can 3D print teeth that kill harmful bacteria.

The researchers' first challenge was to find materials that could kill bacteria yet be safe for humans. Once they found the right mix, they tested the results in 3D printers. To date, they have successfully printed orthodontic braces, implants, and replacement teeth. In addition, their experimental creations have killed 99% of bacteria that cause tooth decay. However, more tests are needed before their 3D printed teeth can be used in humans. The researchers must prove that they can produce long-lasting teeth. They must also show that their 3D printed teeth can withstand hygiene products such as toothpaste.


Hershey's chocolate scientists are taking their CocoJet 3D printer on the road. They are showing chocolate lovers across the United States their futuristic machine. It can print unique, delicious designs. Consumers use an iPad to select from a library of patterns. Next, they print their desired chocolate design. Options include complex hexagons and detailed lace patterns.

The CocoJet is believed to be the most advanced chocolate 3D printer in operation. It can allow consumers to upload designs of their own for printing. In fact, company representatives claim that the CocoJet can print almost anything in chocolate - even a figurine replica of a person.


The possibilities for 3D printed medical devices seem endless. Hearing aids have already been made through 3D printing. So have dental implants and prosthetic hands. However, devices made from rigid plastics are not appropriate for use in growing children. As a result, scientists are now working to create 3D printed items that can shape-shift, or be 4-dimensional, after printing.

Recently, a team of specialists designed the first 3D implants capable of changing shape over time. The implants were for three young babies with the medical condition known as tracheobronchomalacia. This life-threatening condition causes the windpipe to collapse from time to time. The collapse prevents normal breathing. As a last resort to keep the babies alive, the specialists received an emergency clearance from the FDA to use these special implants. Because 3D printing allows for customization, they were able to print splints for each baby's airway with the specific length, diameter, and thickness measurements. Their efforts were the first time 3D printing has been used to create an implant to treat a life-threatening disease.

Today, all three children are living at home with their families. The specialists have filed a patent application. They are also working with the FDA on a possible clinical trial to use their 4D biomaterials on other children afflicted with tracheobronchomalacia.

Coca-Cola and Will.i.am’s 3D printer uses recycled bottles as filament. (2014, July 2). Dezeen.

A new 3D printer created by soft drink maker Coca-Cola and musician Will.i.am can turn trash into treasures. Their Ekocycle 3D printer uses filament from recycled plastic bottles. It transforms recycled polyethylene terephthalate (PET) plastic into user-designed items. Users can print bracelets, robots, shoes, vases, and other objects.

Humans create millions of tons of waste each year. Much of this waste is cheap PET plastic. The new Ekocycle gives consumers a way to reuse discarded plastic bottles to print things they want. It features a touch-screen interface and prints in a range of colors. Each of its filament cartridges contains the equivalent of three PET plastic bottles.


Research partners H. Jerry Qi and Martin L. Dunn have developed a process they call 4D printing. They use special composite materials in 3D printers. These materials are made of “shape-memory” polymer fibers. Once heated or cooled, a printed object has the ability to transform into a new 3D shape.

The researchers’ process is based on what we currently know about the self-assembly of materials. The key to successful 4D printing is unique “printed active composites” (PACs). PACs are made up of glassy polymer fibers that are programmed to assume 3-dimensional shapes. They can be used to create bent, coiled, and twisted shapes. When used with 3D printing, they give scientists the ability to control the shape-shifting that occurs.

Like many 3D printing processes, the 3D architecture of the fibers is designed using a CAD file. In technical terms, droplets of polymer ink are used to create a smooth film and then photopolymerized. Multiple film layers are then printed together. This process creates an individual layer or lamina. The complete 3D structure results from multiple layers of lamina being printed together, to form a laminate. The difference is that Qi and Dunn’s process gives individual laminates the ability to twist, curve, bend, or coil in desired ways. It is expected to be of greatest value to the aerospace, biomedical, manufacturing, and packaging industries.

Retrieved from https://www.asme.org/engineering-topics/articles/manufacturing-processing/4d-printing-next-level-additive-manufacturing

It looks, feels, and tastes like a raspberry, but it is not a real raspberry. Instead, it is the creation of the Nufood Robot 3D Printer. This device was created by the UK-based firm Dovetailed. It allows its users to customize various aspects of the food they print. These aspects include color, shape, and taste. They also include texture and nutritional content.

The printer’s creators envision a day when people will be able to create any food items they want. To do so, “flavour bomb” liquid capsules are used to replicate existing foods or create entirely new ones. These capsules are made from all-natural ingredients. First, the user selects the desired flavour bomb. Then, he or she uses a special app to design the shape of the food.

The Nufood Robot 3D Printer’s lead developer hopes the device will soon be an everyday kitchen appliance. It is currently in the prototyping stage. Dovetailed is seeking crowdfunding to scale up production. Although other 3D food printers already exist, the Nufood Robot 3D Printer has a few distinct advantages. For example, this printer offers unique flavors and textures that are not otherwise available. In addition, it is made specifically for 3D food printing. This means it is cleaner and more hygienic than competing offerings that simply modify existing 3D printers to work with food.


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Nadir Gordon is a design student in Buenos Aires. She is working to create the swimsuit of tomorrow. However, one of her recent 3D printed swimsuits has been described as “terrifying.” That is because it looks so different than the typical swimsuit. (One critic said it resembles a costume from the futuristic film *The Fifth Element.*)

Without question, swimsuits have evolved substantially over the last hundred years. At one time, potato sack-like suits were common. Later, bikinis and Speedos became all the rage. Gordon’s 3D printed swimsuit hints at where fashion could go next. Her creation called Waves is a one-piece garment with a large Elizabethan collar that resembles “wiggly sea anemones.” It features a modern interpretation of the mermaid shell bra and a thick bustle on the lower half. Gordon prints the mesh-like suit in fourteen different pieces on a MakerBot. Then, she fuses the pieces together with a soldering iron. Gordon says she drew inspiration from fashion-forward designers Iris Van Herpen and Francis Bitonti, who use 3D printing to create “otherworldly garments.”


Palestinian territory hospitals are short on medical supplies. More than 150 types of medicine and 340 medical items are in limited availability. International donors have been slow to assist. Tarek Loubani is a Canadian doctor of Palestinian descent. With the help of a 3D printer, he has found a unique way to help. Loubani has created a stethoscope that can be 3D printed for $2.50. That is much cheaper than traditional stethoscopes. Even more impressively, tests show that Loubani's stethoscope outperforms today's industry-leading stethoscopes.

Loubani hopes his stethoscope is the first of many inventions that will address the shortage of medical supplies in Gaza. He plans to create other equipment, such as an ear-inspecting device and an electrocardiogram. The doctor's plans will be completely open sourced. Anyone with access to a 3D printer will be able to access his design file and print stethoscopes. By utilizing 3D printing, the devices can be printed locally, resulting in an ongoing supply that does not depend on political regulations or donors. Before Loubani's invention was available, doctors in Gaza were pressing their ears against patients' chests to listen to heartbeats.

Retrieved from http://www.huffingtonpost.com/entry/tarek-loubani-3d-printing-stethoscope-gaza_55f2f570e4b077ca094ec2f5

Fairs, M. (2015, October 19). Joris Laarman's canal bridge in Amsterdam could take 3D printing 'to a higher level'. Dezeen.

Engineers in Amsterdam are taking digital fabrication to new heights. The world's first 3D printed pedestrian bridge will be “drawn” in steel by six robots. The bridge's Dutch designer, Joris Laarman, believes the project could mark the beginning of a new era in digital manufacturing. When complete, the bridge will be eight meters long and four meters wide. The structure will be printed in one piece in a former shipbuilding hangar. It will then be transported to the city center.

Work will begin in summer 2016. Laarman and his team are not yet sure how long it will take to complete the bridge's printing or fabrication. They do not expect completion before 2017. Laarman started a new company, MX3D, to develop the technology needed to build the bridge. The resulting design will require programming robotic arms to control welding machines. The project represents a milestone in 3D printing of structures at an architectural scale.

Finley, K. (2015, January 8). 3-D printing helped these teens build a smarter wheelchair. *Wired.*

NuVu is an experimental high school in Cambridge, Massachusetts. Its students learn practical skills by designing and carrying out hands-on projects. Rather than completing traditional courses, they spend several months creating animated videos or customized robots. The school term begins with a one-week crash-course in relevant technical skills. These include computer-aided drafting, 3D printing, laser cutting, and computer programming.

A recent project was the transformation of student Mohammad Sayed’s wheelchair. Each piece the students added, transformed, or developed utilized a 3D printer. Sayed and his classmates added a laptop tray and a canopy. They also rebuilt the chair so that Sayed can propel it with a rowing motion, rather than the traditional pushing motion. Each upgraded part for the wheelchair cost between $2 and $3. Sayed and his classmates are open sourcing their work so that anyone can access the blueprints to 3D print the new wheelchair components themselves.


Microsoft’s smartphone app MobileFusion allows people to print 3D objects using photos taken with their cell phones. The app stitches together, or digitizes, multiple two-dimensional photos to create a printable 3D object. 3D printers have been available for years. Often, they cost thousands of dollars and require sophisticated technology. However, a smartphone with scanning capabilities means 3D printing will be more widely available. It will also provide 3D printing at a much lower cost.

Google’s Project Tango is an experimental 3D imaging system. Google has partnered with Intel to bring the RealSense 3D camera to smartphones. Australian startup Eora 3D uses a laser built into a tripod mount. The laser connects with phones over Bluetooth. It communicates with an app to share precise calculations about the shape and depth of a scanned object. A similar app, 123D Catch, uploads images and then stitches them together into a 3D model. Next, they are uploaded to the cloud. As a result, the day when travelers can create 3D souvenirs from their travel photos may not be far away.


By 2025, technology will play a crucial role in reducing food waste across Europe. One way to reduce food waste is through 3D printed “smart foods.” According to agriculture and food development authority Teagasc, 3D printing with nanotechnology will give consumers more information about the foods they eat. For example, “smart packaging” could tell consumers if food has spoiled or reached its use-by date. Similar sensors could determine if food is contaminated when it is being packaged. This would prevent bacteria from entering the food supply chain.

It is already possible to 3D print hamburgers and pizzas. Experts predict ongoing enhancements to the technological benefits of printed food. Nanotechnology is already used widely in the healthcare industry. It will likely be used widely in the food production industry in the coming years.


Soon, the idea of “designer drugs” may be a reality. For the first time, the U.S. Food and Drug Administration (FDA) has approved a 3D printed drug product. Aprecia Pharmaceuticals Company’s ZipDose Technology platform can print an oral prescription for the treatment of seizures for those affected by epilepsy. ZipDose Technology uses a rapid disintegration method. This enables drugs to be delivered with just a sip of water. ZipDose is designed to be quick and easy for every patient. It is especially helpful for those with swallowing disorders or who struggle to follow a treatment plan.

The use of 3D printing in the medical field is still fairly new. Nevertheless, it is rapidly picking up momentum. Bioprinting has already successfully been used to print live tissue. Similarly, the use of 3D printed implants helps to distribute medicine within the body. It is hoped that Aprecia’s work will help pave the way for future 3D printed drugs.


The good applications of 3D printing will hopefully outweigh the bad. The 3D printing revolution will have a positive impact on society. It is expected that 3D printing will improve human lives through the manufacturing of foods, organs, prosthetics, and even toys. However, a recent report by Gartner Group raises concerns about intellectual property losses. It estimates that such losses resulting from 3D printer counterfeiting will total $100 billion by 2018.

*Scientific American* states that 3D printing could be the counterfeiter’s best friend. That is because 3D printers are a groundbreaking technology at an increasingly affordable price. The materials they use are widely available and can make copies of valuable things. All that is needed is the right software to make counterfeiting with 3D printers relatively easy. As 3D printing technology evolves, the art of counterfeiting is likely to grow in ways that have never been anticipated.

It is likely that a cat-and-mouse game of counterfeiting and measures to stop it will be common in the coming years. The use of easily detectable nanomaterial for legitimate copies may soon become the norm, allowing experts to quickly distinguish counterfeit goods. Tight regulations can prevent the easy purchase of high-value raw materials used to produce highly specialized, dangerous, or restricted objects. Experts also expect an intellectual property revolution to emerge. This will affect how patents, trademarks, and copyrights are applied to 3D printing.


Researchers from the University of Michigan have released Keysforge. It is a web-based tool that enables individuals to 3D print keys containing “do not duplicate” warnings. Its existence shows that unique key shapes and “do not duplicate” messages no longer offer the security they once did. In many instances, all that is needed to 3D print a copy is the key itself and a photo of the front of the lock that it opens. From there, Keysforge creates a CAD file for 3D printers to use. “We’ve proven that restricted keyways are no longer a defense,” said one Michigan researcher.

In 2013, MIT students released software that could copy lock-maker Schlage’s Primus keys. Lock-pickers Jos Weyers and Christian Holler also successfully 3D printed “bump” keys that open locks by bumping internal pins upward. However, Keysforge is the first tool that works on a variety of lock systems. By releasing it to the public, the Michigan researchers hope to show that restricted keys are easily copied. They urge the industry to integrate more advanced security measures in locks, such as moving or magnetic components.

The researchers also studied which 3D printable materials work best for duplicating keys. They found that the cheap polylactic acid (PLA) plastic used in popular MakerBot printers was a good choice. It is stronger than more expensive materials, such as acrylic and nylon. Medeco is one of many lock companies whose restricted keys can be duplicated with Keysforge. A company spokesperson referred to the Michigan researchers’ work as being important and informative. The spokesperson added that Medeco is working on advanced lock components that cannot be 3D printed.


The World Health Organization estimates that malaria results in more than $12 billion per year in healthcare costs and lost wages in Asia, Latin America, and Sub-Saharan Africa. Malaria also contributes to an estimated 800,000 deaths annually. Currently, there is no cure or vaccine for malaria. However, MediSieve Ltd., a company from University College London, believes it may have a solution to the problem.

Blood cells infected with malaria have slightly magnetic properties. As the malaria parasite multiplies and spreads, the cells become magnetic. Dr. George Frodsham has developed 3D printable magnetic blood filters that can remove 90% of a patient’s infected blood cells in just a few hours. The filters attract only magnetized cells. As a result, they allow uninfected cells to pass through. Frodsham’s filtering process may have a wide impact on the science of infectious diseases. He is hoping to use the filtering technology to help hundreds of thousands of people. Because of this scale, he is unsure whether 3D printing will be the most efficient means for high volume manufacturing.


New 3-D printing software can turn medical scans of a patient’s heart into surgical models. The software, created by MIT and the Boston Children’s Hospital, uses a computer algorithm and MRI data to overlay two hundred cross-sectional slices across the patient’s organ. Next, a human expert interprets where the organ’s edges are for a small number of cross-sections. Then, the software follows the human’s lead to correctly identify the rest of the heart’s anatomical structures. The software results agreed with a human’s interpretation of all two hundred cross sections 90% of the time.

Prior to 3-D printing, the interpretation process of MRI scans took an average of eight to ten hours. Now, it is possible to print a complete, highly accurate 3-D model of a patient’s heart in just one hour. Several cardiac surgeons will begin testing the accuracy and usefulness of the new 3-D printed heart models in late 2015.


The 3D printing industry continues to mature. Across Europe, digital manufacturing is on the rise. Proto Labs is the world’s fastest-growing manufacturer of low-volume, custom prototypes. The company began offering 3D printing services after learning that 75% of its customers were using other services to create prototypes for 3D printing. It was an effective way to diversify Proto Lab’s range of services.

CEO Vicki Holt has worked in the manufacturing industry for thirty-five years. She says that digital manufacturing makes this a very exciting time. Two trends are helping Proto Labs to grow. First, engineers and companies want to get products to market as quickly as possible. Second, designing using 3D CAD enables innovators to share designs with manufacturers and have models printed in just a few days. By accommodating fast, low-volume production, Proto Labs is emerging as an industry leader in digital manufacturing.


3D printing first emerged in the 1980s. Since then, it has surged in popularity. Each week, news articles talk about innovative uses for the technology. They include a 3D printed wrench used on the space station and 3D printed cars. Nowadays, 3D printers can be purchased for less than $1,000. This reality encourages people to find creative uses for them. A key aspect of 3D printing is that it allows anyone to be part of the design process. They can easily prototype and manufacture their ideas.

In education, teachers can use 3D printing to create hands-on learning environments. Some schools even offer courses in 3D printing. Another area of educational activity involves teachers and students using 3D printing to teach math concepts. They realize that physical, tactile tools can help learners understand complex ideas. Mathematical 3D printed tools can also be used to inspire curiosity and wonder. One tool, the hyperboloid tool, captures students’ attention as they watch a straight bar pass through a curved hole. It encourages students to ask questions and apply mathematical concepts to figure out how it works. The availability of 3D printers also enables educators to print out full-scale experiences. A good example is the popular math problem involving two trains approaching each other at different speeds. With 3D printing, students can build models of the scenario to help them find the answer. In addition to bringing awe-inspiring experiences into the classroom, 3D printing helps students to develop STEM and problem-solving skills they will use in the future.


Katz, L. (2015, October 12). Trippy 3D-printed glasses let you swap looks often. *CNET.*

Nasim Sehat is both a designer and architect. She recently created Biz Eyes, her unique line of far-out 3D-printed glasses. The glasses are bold and unusual. They are perfect for someone who wants to make a statement. Biz Eyes attach easily to a standard pair of eyeglass frames. The wide variety of designs provides their wearers with plenty of ways to express their individuality. For example, one can choose to have butterflies or bright pink sea anemones attached to their specs. Biz Eyes glasses are unusual in appearance and versatile. Creative individuals can sport a different design style around each eye. The 3D-printed Biz Eyes are available for pre-order, ship internationally, and cost between $95 and $120.

Designer Sehat was raised in Iran and learned her 3D printing techniques at the Institute for Advanced Architecture of Catalonia in Barcelona, Spain. Her Biz Eyes attachments are 3D-printed in white nylon and resin. Sehat calls Biz Eyes a daring and cosmopolitan means of expressing one’s personality. She cites superheroes and pop culture as inspirations.


Some of the biggest and most famous toy companies are moving into the 3D printing market. Hasbro believes that children and adults will welcome the ability to customize their toys. As a result, the company is opening up its intellectual property to fans of the My Little Pony brand. Fans can showcase their creativity through 3D printed designs on the new website SuperFanArt.com. Competitor Mattel is also giving 3D printing a try. The company is selling sheets of printable fabric to children who want to design clothes for Barbie dolls.

Why would giant toy makers allow their customers 3D printing capabilities? They feel that 3D printing offers unique opportunities to the toy industry. With 3D printing, the manufacturing process becomes faster and cheaper. It can allow toy giants like Hasbro to develop prototypes more quickly than ever before. It also gives toy manufacturers the ability to make smaller batches of toys to test in the market. However, the president of the Toy Industry Association expects 3D printing to produce new challenges involving piracy and intellectual property.


The benefits of 3D printing are not just for people. It can also be used to help animals in need. To date, 3D printing has given Derby the Dog a new leg, Ozzie the Goose a new foot, and Akut-3 the Turtle a new face. Now, it has also given Tieta the Toucan a new beak.

Tieta was rescued from an illegal animal shelter in Brazil. Half of her upper beak was missing. In July 2015, Tieta got a 3D printed plastic prosthesis to repair her broken beak. Researchers from the wildlife preservation group Instituto Vida Livre and the Federal University of Rio de Janiero worked together to provide this solution. They generated a number of prototypes to create the perfect bill for Tieta. Their final design was a lightweight bill with a coat of non-toxic varnish and a castor-oil-based polymer for durability. It took Tieta three days to fully adjust to her prosthetic appendage, but she now eats normally. Tieta will spend the rest of her life in the safety of an animal sanctuary.


Koslow, T. (2015, October 5). Starers beware! This 3D printed garment knows when you’re looking at it. *3D Printing Industry*.

Do you ever feel like someone is staring at you? Fashion designer/architect Behnaz Farahi has created a wearable 3D printed garment that knows when someone is looking at it — or you. Using a combination of 3D printing and motion sensing cameras, Farahi’s “The Caress of the Gaze” shirt moves and changes its shape whenever someone is staring at it. When it senses a stare, the top begins to resemble human body language during interactions by contracting and expanding.

To make the shirt a reality, Farahi used an Objet Connex500 Printer. It has the ability to fabricate prints that vary in flexibility and density. The printer also enables the user to combine material properties into one print. After printing, a motion camera is implanted at the top of the shirt. Farahi was praised for bridging the gap among technology, design, and fashion.


Chuck Hull invented 3D Printing in 1986. At its most basic, 3D printing is a process for taking a digital 3D model and turning that digital file into a real-life object. There are a number of 3D printing methods, including Stereolithography and Fused Deposition Modeling. However, all rely on layer-by-layer fabrication. Often, 3D printing is referred to as additive manufacturing, especially in a manufacturing context. All 3D printing relies on coded instructions from computer files for printing.

Initially, 3D printing was a technology for prototyping. Today, it is being used in almost every major industry. In medicine, 3D printing is becoming popular among surgeons as an alternative to 2D and 3D models on computer screens. Having 3D replicas that surgeons can touch helps them better understand procedures they will perform. Within the next two decades, it may be possible to print entire human organs for transplantation. In the aerospace industry, companies such as Boeing and Airbus use 3D printing to reduce the weight of aircraft. This saves money on fuel costs. As 3D printing becomes more popular, it is also becoming more accessible. Best Buy, Home Depot, and Walmart now sell 3D printers.


Cornell University engineers have created a new, soft, artificial muscle. It is made using readily available materials and 3D printing. The team used a technique known as biomimetics. This term refers to human-made processes that imitate nature. The team's discovery is important to the future of more advanced robotic devices that are inspired by nature.

To achieve muscles that are agile and rubbery, the team developed a new method for 3D printing. It is called a digital mask projection stereolithography system. They designed this new method to produce muscles that mimic the function of octopus tentacles. The resulting artificial muscle can move in a full 180 degrees of motion. Such motion is comparable to living muscle. Until now, 3D printed muscles have been less pliable and less effective.


Getting supplies to astronauts on the International Space Station has always been risky and expensive. Those days may be over, thanks to 3D printing. In December 2014, astronaut Barry Wilmore was able to 3D print a wrench he needed while in space in only four hours. This ratcheting socket wrench was the first “uplink tool” ever printed in space. The process began on Earth, where engineers designed the tool. The engineers then emailed the design to the space station for printing, or manufacturing. From start to finish, the process took less than a week.

Made in Space’s 3D printer is the first to operate in zero gravity. It printed its first object in space - a needed part for the printer itself - in November. In the future, NASA’s 3D print manager hopes parts can be designed on the ground and printed in space in less than two hours. The on-demand capability of 3D printing is expected to revolutionize space missions, which historically have been restricted to mission-critical supplies. These developments also hold promise for missions that venture farther from Earth and last longer.


In 2014, the jewelry and watch industry generated nearly $300 billion in revenues. A new report from SmarTech Markets Publishing explores the potential of 3D printing in that industry. It estimates that the value of rings, necklaces, and other consumer fashion jewelry items made by 3D printing will reach $11 billion by 2020.

The report, *3D Printing in Precious Metals*, discusses some additional uses for metal in printing. For example, it lists titanium as the primary material for biomedical uses such as hip implants. It also explores applications in dental and electronic fields. It proceeds to offer an analysis of key “players” in the jewelry space, including 3D printer manufacturers 3D Systems, Solidscape (wax models), Concept Laser, and EnvisionTEC.

As in many other industries, 3D printing threatens to disrupt what is currently being done in the jewelry industry. It offers greater opportunities for individual artisans to compete for significant market share. Shapeways, for example, recently released CustomMaker. This device allows artisans to add consumer customization to jewelry items. At the moment, however, there are few (if any) systems in operation on 3D Hubs that use metal.


Recently, contestants on the reality TV show *Project Runway* were tasked with designing and creating a 3D printed garment. The show’s producers brought in Annie Shaw, creative director of 3D Systems, to teach them about 3D printing. Shaw introduced the contestants to designing through 3D files. Then, she provided examples of 3D pieces that would come out in five-inch squares of printed material. The contestants were given a budget of $200 and two days to complete their work. They utilized the new 3D Systems Fabricate line of 3D printed textiles to design and create their fashion items. The designers also used Cube 3D printers, which are common when printing 3D fashions. The printers are popular in fashion because they allow a mixture of 3D printing materials to be combined with textiles like leather.

The producers inspired the contestants by asking them to mimic local famous architectural bridges, such as the Brooklyn Bridge and the Manhattan Bridge. The contestants went on to create dresses, ponchos, and bracelets. Enthusiasm for both digital design and the 3D printing process grew as the episode progressed. All of the designers experimented with and produced 3D prints. Their creations emphasized texture, shape, and creativity. Designer Kelly Dempsey won with her architecturally inspired dress. It was angular and featured a 3D printed brown mock crocodile skin. This was the first time 3D printing was required as part of a challenge on *Project Runway*.


Proven Reality may be the first 3D experience of its kind. This technology combines virtual reality, augmented reality, and 3D printing with the Bible for a unique experience. First, participants slide their smartphone into the Proven Cardboard headset. Then, they use the Proven One app to “experience a quiet and powerful moment” in a virtual world as the Bible comes to life.

The goal of Proven Reality is to share the stories of the Bible like never before. A Kickstarter campaign is helping the company to spread the message of Christianity using new technologies. Particularly intriguing is the company’s application of 3D printing to achieve augmented reality. The company has a line of 3D printable “App-wear Apparel.” Its offerings include heart-shaped cookie cutters, a peace sign, a lightning bolt, and a crucifix. The Proven One Experience can be obtained for a $50 pledge on Kickstarter. Whether one’s interests lie in religion or new gadgets, Proven Reality is an intriguing example of combined technologies.


3D printing impacts traditional insourcing/outsourcing relationships. It also affects the equation between globalization and localization. In general, experts believe 3D printing favors insourcing and localization. In the “pre-3D printing era,” outsourcing helped companies in several ways. For example, it often improved efficiency and lowered costs. It also enabled products to be developed more quickly. As globalization drove up competition, outsourcing helped companies transfer business activities to third parties, both locally and abroad. Over time, globalization has fragmented the full supply chain. Rather than one company handling all of the activities in product production, many are involved. Globally, this intensifies competition. It also eliminates customization in favor of high-volume production.

In the “3D printing era,” the advantages of outsourcing are less clear. Additive manufacturing allows companies to perform all of the production-related activities they need in house. Companies using 3D printing maintain control of their full product supply chain. An additional benefit is reduced transportation costs that favor localization. At this point, the biggest hurdle 3D printing must still overcome involves the speed of process. As 3D printing efficiency increases, localization and insourcing are likely to become popular choices in manufacturing.


Imagine being away from home and having an emergency that a 3D printer could solve. That is when a portable 3D printer comes in handy. The Freaks3D printer is about the size of a laptop. It weighs 3 kilograms (approximately 6.5 pounds) and is compatible with standard power banks. This lightweight printer comes with its own carrying handle. For ease of use, it can print from an SD (image) card or a USB from a laptop. Although it is unlikely that people will often encounter urgent situations where 3D printers are necessary, at times they can come in handy. The size of the printed objects is somewhat limited because of the Freaks3D’s compact shape. Otherwise, this printer is a reliable on-the-go solution.


For NASA, 3D printing is the key to future spacecraft design. NASA is currently testing fuel pumps and other parts made via additive manufacturing. The goal is to reduce the costs and risks associated with building today’s rocket engines. NASA calls its 3D-printed turbopump “one of the most complex, 3D-printed rocket engine parts ever made.” It has been tested more than fifteen different ways to simulate the force and environment that rocket thrust can cause. The turbopump generates 2,000 horsepower, almost double that of a NASCAR engine. A NASA engineer reports that printing the rocket cut the turbopump production time in half. The world has already seen a 3D printer used in space by an astronaut. How soon will that astronaut be in a completely 3D-printed spaceship?


Oran, N. (2015, October 16). Solar powered 3D printing could be the answer to providing medical supplies in remote areas. MedCity News.

Dr. Julielynn Wong is a Harvard graduate and physician. Along with other researchers, she explores the use of 3D printing to get medical supplies to remote areas. A benefit of 3D printing is that it can occur on an as-needed basis. This eliminates excess supplies or medical equipment going unused for long periods of time. Wong’s company, 3D4MD, is particularly interested in the 3D printing of medical supplies using solar-powered printers. Solar-powered printers are small, easy to use, and easy to transport.

In remote areas, it does not make sense to have excess medical supplies in storage. As a result, the use of 3D printers in such areas can reduce unnecessary expenses. It can also deliver customized care to patients. If a patient needs a finger splint, for example, a 3D printed version can be made to fit the patient perfectly. The traditional alternative would be a generic splint that is on hand but may not provide the best medical care. Wong believes 3D printing is the future of affordable, accessible medical supplies, whether in space or rural areas around the globe.


As of 2015, all five remaining rhino species are considered threatened or critically endangered. Biotech startup Pembient wants to save the rhinos. Its idea is to produce animal-free rhino horns using 3-D printing. The belief is that if printed rhino horns have the same look, feel, and even DNA as real ones, they could drive poachers out of business. In some cultures, rhino horn is believed to cure cancer or to protect individuals from the negative effects of excessive alcohol consumption. As a result, one rhino horn can sell for $300,000. CEO Matthew Markus explains that his company can meet the demand for rhino horns at a fraction of current black-market prices.

To create the horns, Pembient runs synthetic keratin through chemical reactions. This converts it into a specific type of keratin protein, which matches that of a real rhinoceros. Then, the company adds rhino DNA into the mix and uses the keratin “ink” in a 3-D printer. The company expects its first horns to reach the Beijing market in late 2015. After conquering rhino horns, Pembient hopes to apply the technology to creating elephant tusk and tiger bone substitutes.


Presto, S. (2014, November 27). Space, the final frontier for 3D printing. CNN.

In November 2014, the U.S. space agency released a picture of an astronaut holding a white printer part. The astronaut was Barry “Butch” Wilmore. In the photo, he is holding a 3D printed object containing the words “Made in Space.” “Made in Space” is not just the label identifying the object made in space. It is also the name of the company that designed and built the space station’s 3D printer with NASA’s guidance. The printer part is the first item ever to be 3D printed in space. According to a NASA spokesperson, many challenges accompany living and working in space. One of those challenges is when a part or tool breaks or malfunctions and the nearest spare piece is back on Earth. Explorers traveling to Mars or nearby asteroids face similar dilemmas.

NASA's International Space Station 3D printer will likely solve the problem. The 3D printed part represents a historic achievement for the space program. In this case, engineers were able to email the schematics for the hardware to space, rather than launching it using a resupply ship. This marks the first time in the history of the space program that humans were not dependent on sending all of the supplies they need from Earth. Do pieces printed in space have the same physical characteristics as those made on Earth? Do the printed layers bond in the same way without Earth’s gravity? Experts hope to find answers to these questions next year, when the samples are returned to Earth.

Robertson, A. (2015, April 21). MakerBot’s Thingiverse 3D printing library is getting a print-on-demand button. The Verge.

The Thingiverse library is an online catalog of more than 700,000 user-created 3D print designs. MakerBot, the company that created the Replicator line of 3D printers, runs the online catalog. To make the catalog of design files more accessible, MakerBot is partnering with 3D Hubs, a global 3D printer-sharing service. Founded in 2013, 3D Hubs connect people who own 3D printers with customers who need local services.

Under the partnership, Thingiverse consumers are connected with a “get this printed” button. It lets visitors order specific designs through 3D Hubs. Because 3D Hubs handles the printing, Thingiverse visitors do not necessarily need to own a 3D printer to have a file printed. Technically, all Thingiverse files are open-source and available for free. However, designers can ask for donations for their work. The partnership makes 3D printing accessible to everyone, not just serious tinkerers.


Nike chief operating officer Erik Sprunk imagines a not-too-distant future when people will print Nike footwear at home. First, they will log on to the Nike website and pick a pair of shoes. Next, they will customize the style to their desired specifications. Then, they will buy the design file from Nike and set it up to print at home on their 3D printer. (Alternately, consumers could take the file to a Nike street shop and have the company print the shoe for them.) For intellectual property protection, Nike will still own the trainer file.

Unlike current manufacturing techniques, a 3D printed Nike trainer shoe results in little waste. Sprunk is excited about the “manufacturing revolution” at Nike. It involves using technologies such as 3D printing, automation, and robotics to improve the company’s current processes.


While the idea of 3D printing has been around for decades, 3D printing human tissue is a new endeavor. Organovo, a 3D bioprinting firm, is challenging itself to transform the future of medicine by printing human tissue.

Several companies are interested in partnering with Organovo. The cosmetics company L’Oreal hopes to create 3D printed human skin for testing makeup and beauty products. Merck & Co. is interested in testing medicine toxicity on 3D printed liver cells. Currently, testing medicine toxicity is one of the biggest challenges to getting new drugs to patients quickly. Developing tissues for drug discovery holds a lot of promise. However, 3D printed organs are what CEO Keith Murphy is even more excited about. There are a number of challenges that must be overcome before 3D printed human organs will be possible. The most significant challenge involves keeping them alive. Live cells require oxygen and nutrients. In the body, a full vascular system exists to get oxygen and nutrition to those cells.

Technology research company Gartner predicts governments could be debating whether 3D bioprinting should be banned as early as 2016. The debate will likely occur over ethical and moral objections to the technology. Murphy argues that 3D bioprinting is a platform with many possible applications. Eventually, he hopes Organovo’s bioprinting techniques will be so successful that they keep people off transplant wait lists.


Experts predict that by 2018, more than 2.3 million 3D printers will be sold. Most of them will be consumer desktop 3D printers for use in consumers’ homes. As of 2015, however, it is still unclear why consumers need 3D printers in their homes. Those who currently own them are primarily printing plastic toys. The printers are still expensive, too, with prices ranging from $460 to $2,500 each. There are a number of printers on the market today. Each contains its own proprietary software, which can be tricky for users to understand and use. In addition, most 3D printer manufacturers have limited customer-support teams. It often takes days for consumers to receive responses to their questions or concerns.

Taiwan-based XYZprinting aims to make commercially available printing technology more accessible. The company is actively working to bring down costs, open call centers for support, and simplify software. Software companies will work with developers to improve the overall user experience. Autodesk and 3DPrinterOS are simplifying their software so that many different 3D printers can utilize their technology.

Retrieved from http://www.ibtimes.co.uk/will-3d-printing-consumers-ever-become-popular-1503012

In December 2014, Airwolf 3D set a world record for having the most 3D printers operating at the same time - 159 to be exact - in its California offices. This earned Airwolf 3D a spot in the *Guinness Book of World Records*. The main purpose of the event was for volunteers to produce prosthetic hands for charity.

In just 24 hours, the volunteers created more than 200 prosthetic hands. Airwolf CEO Eva Wolf says it felt good to use the company’s 3D printing farm for a worthy cause. According to data from the research firm Canalys, the 3D printing industry is expected to grow to $16.2 billion by 2018.


Big Delta is the largest 3D printer in the world. It is an open, matrix structure made of steel with several arms that can move horizontally and vertically for printing. Some describe it as being similar to the skeleton of an outdoor music stage. Developed by the Italian company WASP, this printer is big enough to print entire houses. The company created it with the goal of building cost-efficient homes in developing countries.

The Big Delta can be erected almost anywhere. Once filled with locally sourced materials, it can effectively print homes. Once it gets to work, the only help the Big Delta needs from a human involves keeping its clay reservoir filled. In 2015, the printer was demonstrated at a three-day event in Massa Lombarda, Italy. WASP’s creator Massimo Moretti explains that 3D printed houses are no longer just a dream. Their existence demonstrates that housing can be affordable and sustainable. Next, WASP is working with Italian company Health R&S to 3D print houses with insect-repelling walls. Insect-repellant solutions are critical where civil populations need to fight infection to survive.


Created by students, the Dextrus prosthetic hand looks like a human hand. It has smooth and rounded contours. It also includes the design element of knuckles, which are not always included on 3D-printed prosthetics. Created by Open Bionics, the prosthetic hand uses steel cables that act as tendons to curl the fingers. The cables are attached to motors that act as muscles. The Dextrus design is quite advanced. Most other 3D-printed prosthetics use low-tech systems of cords to pull the fingers.

Because the Open Bionics hand is 3D-printed, each one can be specifically designed for its wearer. Before printing, the Open Bionics team scans the arm where the hand will be fitted and uses the resulting measurements as a basis for the print. The printing process takes about forty hours. So far, the Open Bionics team has worked through ten prototypes. They plan to start selling the hand in 2016, although everyone will have access to the open-source materials.


Most 3D printers can only print using one material at a time to build an object. The 3D printing process is slow and often requires additional assembly of pieces printed in different materials. Multi-material 3D printing exists, but to date it has been extremely expensive. Current printers capable of 3D multi-material printing sell for approximately $250,000. One of the reasons multi-material printing is so difficult is because different materials require different pressures and temperatures for printing.

MIT’s Computer Science and Artificial Intelligence Lab’s (CSAIL) MultiFab printer may overcome those 3D printing limitations. It is able to print using ten different materials on the same creation. Because CSAIL’s MultiFab is made from off-the-shelf components, its cost is only about $7,000. Unlike most 3D printers, MultiFab does not melt down plastic filaments and squirt them out. Instead, it mixes microscopic droplets of photopolymers and sprays them out using inkjet printheads. This enables MultiFab to print all pieces at the same time, rather than separate pieces that require additional assembly. In addition to printing with multiple materials, MultiFab is self-correcting to increase overall precision. CSAIL’s creators expect MultiFab to be a rapid prototyping tool for designers and manufacturers in the future.


Trove is a new platform that lets consumers personalize 3D printed jewelry. To date, 3D printing has not been a viable way to manufacture most consumer goods. That is because most 3D printed parts are currently being manufactured in plastic. Plastic is not an ideal material for many products, including high-end jewelry. Trove is helping to change all that. It enables users to print jewelry made of metals, including stainless steel and 18-carat gold.

With the Trove platform, a 3D printer creates a mold for a specific item of jewelry. Then, precious metal is poured inside the printer to create a one-of-a-kind piece. Trove is launching with thirty designs on its platform. Users are able to customize each design. As a result, Trove estimates that hundreds of thousands of customizations can be made to create unique, personalized items. For those who are wary of immediately printing jewelry with expensive materials, the company ships free 3D printed plastic versions of jewelry creations for them to test. Historically, jewelry customization has been an expensive luxury reserved for the rich and famous. That is expected to change as 3D printing continues to mature.


For her graduate project at Shenkar, an art and design school in Israel, student Danit Peleg took a unique approach. She designed a fashion collection of five pieces that can all be produced at home using a 3-D printer. Peleg experimented with a number of textiles before she found the right one for her project. She ultimately chose FilaFlex. It is a strong, flexible variety of plastic filament. With FilaFlex, Peleg was able to print “lace-like textiles” that she can work with just like cloth. She printed the entire fashion line using a $1,800 Witbox printer.

Today, many designers use 3-D printed fashions in their work. Dutch designer Iris van Herpen has been featuring 3-D printed clothing on runways for years. In 2014, a designing duo in Massachusetts printed a plastic dress that flowed like it was made out of cloth. Peleg’s collection is noted for being both cutting-edge and conventional. In public, some of the pieces might not stand out among regular street clothes. That is an impressive accomplishment in the field of 3-D printed fashions. The at-home fashion revolution is not here quite yet. Peleg reports that it takes approximately twenty hours to print a textile the size of a sheet of paper. In total, each piece in her collection took about 400 hours to print.


**XYZprinting and Barnes & Noble partner for educator week to bring 3D printers to stores nationwide.** (2015, October 16). *MarketWatch.*

XYZprinting is partnering with Barnes & Noble to showcase its new 3D printer, the da Vinci Junior 1.0, during educator appreciation week, which runs from October 10-18. Displays will be set up at Barnes & Noble stores across the nation. Throughout the week, employees of Barnes & Noble and XYZprinting will demonstrate how to engage students in learning with 3D printing. They will also provide tips on incorporating 3D printing into lesson plans.

The da Vinci Junior 1.0 is described as an “exciting and affordable product” for schools and libraries that are investing in Maker Spaces. It is easy to use and extremely quiet. Those qualities make it a welcome addition to any classroom. It is also safe for even the youngest of innovators. XYZprinting’s new printer was recently awarded *Tech & Learning* magazine’s Best of ISTE 2015 as well as *PC Mag*’s Best of CES.


Voodoo Manufacturing is a Brooklyn-based commercial 3D printing service for small to mid-size companies. It was founded by 23-year-old Max Friefeld and launched on October 6. Voodoo Manufacturing is a spin-off of the 3D printer manufacturer MakerBot. Friefeld formerly worked at MakerBot. Several of the individuals Friefeld met at MakerBot helped to play a role in co-founding Voodoo Manufacturing. Friefeld established the company after identifying a gap in the outsourcing marketplace for 3D printed goods.

Voodoo Manufacturing seeks to bridge the gap between larger printing services and local providers. The company aims to offer services to those who require 3D printing but do not want or need to buy a 3D printer. Although Voodoo is offering services that already exist, the company claims that it can fill orders in less time and at a lower cost. For example, Voodoo guarantees that orders of fewer than twelve units will be 30% cheaper on average compared to the prices of its competitors. In addition, such items will ship the next day.


The reasons companies use 3D printing change and increase every day. Until recently, most companies viewed 3D printing as a technology solution. Now, they are starting to regard 3D printing as a business solution. Stratasys Direct Manufacturing (commonly known as SDM) recently analyzed survey responses from more than 700 designers, engineers, and business executives in the aerospace, automotive, energy, and medical industries. All of the respondents already use 3D printing in their manufacturing or plan to do so within the next three years.

The resulting report predicts that 3D printing will soon play a major role in the end products that many manufacturing companies produce. One example is Airbus, a company that manufactures civil aircraft. Airbus is now using advanced 3D printers to print parts for its A350 XWB airplane. In 2014, the plane already contained a thousand 3D printed parts. As the use of 3D printing increases, manufacturing companies will have to train more workers to run the printers. They will also need to buy more 3D printers and increase the use of additive manufacturing with metals, such as aluminum and titanium.

19 People Become victims of Identity Theft each minute
Terms and Definitions

biometric authentication: the verification of identity based on a person’s unique characteristics such as facial features, fingerprints, voice, or retinal scans

encrypt: the process of converting information into a code to prevent unauthorized access or to hide the information’s meaning

Europay-MasterCard-Visa (EMV): a feature on credit cards where data is stored on integrated circuits (a chip) rather than on a magnetic stripe; sometimes called “chip and PIN”

familiar fraud: a type of fraud that happens when the victim whose information was compromised knows the person who commits fraud in his or her name

Federal Trade Commission (FTC): an independent agency of the United States government established in 1914 by the Federal Trade Commission Act to promote consumer protection and work toward the elimination and prevention of anticompetitive business practices

fraud: the wrongful or criminal deception intended to result in financial or personal gain for the person committing the act

fraud alert: a warning that can be placed on a credit report to flag that a person may be a victim of identity theft

fraudster: a person who engages in criminal activity using dishonest methods to gain something valuable from another person

hack: to gain unauthorized access

hacker: a person who uses computers to gain unauthorized access to data

identity theft: the fraudulent acquisition and use of a person’s private information, like a social security number, usually for financial gain

Internal Revenue Service (IRS): the United States government agency responsible for tax collection and tax law enforcement

cyberspace: the place where communication over computer networks happens

dark web: a group of websites that are publicly available but make illegal activity and information sharing possible by hiding who owns the websites and where the websites are hosted

criminal: a person who breaks the law

cybercrime: an illegal activity conducted on the internet or some other computer network

cybersecurity: the measures taken to protect a computer or computer system (like the internet) against unauthorized access or attacks

cyber hygiene: the steps that computer users can take to improve their cybersecurity and better protect themselves online

credit history: a record of a borrower’s paid and owed debts

credit report: a detailed document of a person’s credit history from a number of sources including banks, credit card companies, and collection agencies that is often used to determine the credit worthiness of a person applying for a loan

consumer: a person who purchases goods and services for personal use

compromised: when systems or information are exposed to unauthorized individuals

breach: an incident where personally identifiable information is put at risk because of exposure to unauthorized individuals

Encrypt: the process of converting information into a code to prevent unauthorized access or to hide the information’s meaning

Europay-MasterCard-Visa (EMV): a feature on credit cards where data is stored on integrated circuits (a chip) rather than on a magnetic stripe; sometimes called “chip and PIN”
liability: the state of being responsible for something, especially by law

malware: software that is intended to damage or disable computers and computer systems

merchants: the stores, restaurants, and businesses where people make purchases

password manager: a software application that stores and organizes encrypted passwords for a user and is accessed using a single, strong master password

personal identification number (PIN): a numerical code used to validate many electronic financial transactions

phishing: the activity of defrauding an online account holder to gain financial information by pretending to be a legitimate company

social engineering: in regards to information security, the psychological manipulation of people so that they perform actions or divulge confidential information

social network: a dedicated website or other application that enables users to communicate with each other by posting information, comments, messages, images, etc.

Social Security number: a unique number for each United States citizen that is used for identification purposes and to track Social Security benefits

spam: the irrelevant or inappropriate messages sent on the internet to a large number of recipients

spyware: software that enables a user to obtain hidden information about another person’s computer activities by transmitting data secretly from their hard drive

two-factor authentication (2FA): a security process that requires two means of identification from separate categories of credentials; usually one form of identification is a physical token (a credit card) while the other is memorized (a PIN)

Radio Frequency Identification (RFID): the wireless use of electromagnetic fields to transfer data and identify objects, animals, or people

scammer: a person who cheats or defrauds with a scheme, especially to make a quick profit

skimmer: a device used to illegally collect data from the magnetic stripe of a credit, debit/ATM card
OVERVIEW

Identity theft is the world’s fastest growing crime. Sometimes described as the “the invisible crime,” identity theft occurs digitally and can go undiscovered for long periods. Victims of identity theft can be held responsible for the crimes committed by others using their identity and may have to fight for many years to clear their name. The process is often long and frustrating, as it can be extremely tough to find and prosecute identity thieves since they often have no connection to the individuals whose identities they have stolen.

Thieves use a variety of technological methods and techniques to gain access to sensitive information. Some of the time, this means stealing information from business and government databases that are not secure. At other times, it means stealing information directly from a victim. Most often, identity thieves try to steal personal and financial information such as birthdates, full legal names, banking account details, and identification numbers. With personal and financial information, identity thieves can make purchases for their own gain. Stolen identities can also be used to fund activities such as illegal immigration, terrorism, or drug crimes.

Phishing is one of the methods identity thieves use to gain access to personal information. Phishing is a tactic where a hacker creates and sends emails that appear to be authentic communication from well-known companies. Each email contains a link that when clicked downloads malware or spyware onto the individual’s personal device. Malware monitors and captures information such as passwords and Social Security numbers when people enter them into their devices.

Another way hackers gain unauthorized access to sensitive information is through public WiFi connections. It is relatively easy for identity thieves to steal personal credentials while people are surfing the internet from public hotspots. Because public WiFi is typically not secure, hackers can steal significant amounts of personal information from thousands of people at a time. Colleges tend to be gold mines for hackers looking for information that is easy to access. On the typical college campus, there are large numbers of students, staff, and visitors accessing public WiFi simultaneously. In addition to being connected to unsecure public WiFi networks, students are frequently asked to provide a great deal of sensitive information as part of enrollment. Forms with phone numbers, email addresses, residential addresses, family contact information, and even Social Security numbers must be submitted. When not protected properly, this information is easy for hackers to use to take out loans, open new credit cards, and even impersonate the enrolling college students. College students are learning tough lessons about identity theft. People ages 20-29 make up 18% of all identity theft complaints, according to the Federal Trade Commission (FTC).

Identity thieves are smart and sophisticated with their methods. In addition to using advanced technological approaches to gain access to information, they also target vulnerable groups. In fact, research shows that some groups of people are more likely to be victims of identity theft than others. For example, data has shown that affluent, wealthy, and educated individuals tend to be the target of identity theft more often than blue-collar workers. The elderly are often identity theft victims because they tend to have more contact with medical establishments, medical specialists, and other people such as caretakers who are frequently in their homes. Children are also targets of identity theft because parents and guardians rarely monitor credit reports of young children in the same way they would for adults who use credit more regularly.
As identity thieves' methods become more sophisticated, identity theft protection methods must evolve. Many banks have chosen to move towards EMV, or chip and PIN technology, as a means of making payment transactions more secure. By the end of 2015, all merchants in the United States were required to have chip and PIN capabilities for accepting payments or they would be faced with liability if hackers stole any consumer data. Transitioning to terminals capable of reading chip and PIN technology was a burden for many retailers. By 2018, credit and debit cards using chip-and-PIN technology will be widely used around the world. Experts anticipate that even with chipped cards, fraud will continue. In fact, most experts predict other types of identity theft will increase as it becomes more challenging for thieves to steal credit card data.

Some start-up companies are matching hackers' creative criminal techniques with creative solutions to tackle the problem of identity theft. One company created denim jeans that prevent credit card information from being stolen when the card is stored in the pocket of the jeans. After being a victim of identity theft herself, Jessamyn Lovell, a photographer, used images to portray a story about her impersonator. To highlight the predictability of the generation process for new credit card numbers, Samy Kamkar developed a $10 device that accurately predicts the card number that will be issued for new American Express cards.

Experts recommend a number of best practices for individuals to use in order to protect their identities, but people must consistently use those tools and tricks to ensure their information is continuously protected. In truth, it seems no one is safe from identity theft. What is shocking is that very few people take an active role in protecting their information, despite the best practices shared by experts. In particular, millennials exhibit what is called “millennial malaise,” or a disinterest in data protection, despite the rise in identity theft crimes.

Identity theft is almost the perfect crime. It is rare that thieves are arrested or prosecuted, the payoff can be enormous, and it’s easy for the thieves to work in groups and share their knowledge. The trickiest aspect of identity crimes is that they may not involve physical theft, and, therefore, may not be discovered until long after damage has been done. These offenses can mean months of inconvenience and time spent correcting the problem, in addition to significant financial costs to the victims and the businesses involved. More collaboration between global governments and organizations is desperately needed to combat identity theft in the years to come. Individuals and businesses will also need more sophisticated systems to protect themselves. Governments and justice systems have a long way to go before they can truly discourage and protect against identity crimes.

What global strategies are needed to address the challenges of identity theft? What are the best ways an individual can protect his or her identity and how do governments and organizations convince them to take those steps? What role should businesses play in helping to combat identity theft? If there is a hack, should the businesses be held responsible? What personal information will be the most valuable to thieves in the coming years and decades? Most importantly, has your identity been hacked?
1. Why is identity theft sometimes called the “invisible crime”?

2. Former secretary of the US Department of Homeland Security, Michael Chertoff, promotes what he calls “cyber hygiene.” Explain what Chertoff means when he encourages “cyber hygiene”. In what ways does someone maintain good “cyber hygiene”?

3. Should individuals be solely responsible for protecting their own identities or should governments and businesses play a role as well? Why?

4. Even though millennials tend to be extremely tech-savvy, they have poor behavior when it comes to protecting their personal information. Describe the phenomenon known as “millennial malaise.” Does “millennial malaise” contribute to good or bad behavior when it comes to identity theft prevention?

5. What types of information are of value to identity thieves? How can different types of information be used to commit different types of crimes?

6. Some groups of people tend to be the victims of identity theft more often than others. What are some of the habits, characteristics, or life events that increase the likelihood of a person being a target for identity theft?

7. Why is medical identity theft such a serious concern? What are some precautions people should take to protect themselves and their loved ones from medical identity theft?

8. Why should businesses feel motivated to protect their consumers’ sensitive information?

9. Define a breach. What type of personal information may be compromised when large companies have breaches?

10. Why are social media platforms valuable to identity thieves?

11. Research shows that identity thieves have predictable spending habits after stealing someone’s identity. What types of purchases do they typically make? Why might this be the case?
Below are three major themes for understanding the topic “Identity Theft.” Because most of the articles contain important information on more than one theme, the articles have not been arranged by themes and are presented as one group.

- The Identity Theft Landscape
- Identity Theft Techniques
- Prevention of Identity Theft & Legal Responses

A Structured Overview (found in the Appendix) can strengthen understanding of the various themes and help to organize facts on the topic.

**Adamczyk, A. (2015, December 03). These states are most vulnerable to identity theft and fraud. Money.**

Identity theft is happening everywhere in the world. A few states in the United States are at higher risk than others. According to an analysis of the total number of theft reports per 100,000 residents, the states with the highest risk are Nevada, Florida, and the District of Columbia. The least vulnerable states are South Dakota, Hawaii, and Maine. According to a report by the Identity Theft Resource Center, there were already 717 breaches throughout the United States by December 2015. The breaches exposed more than 176 million personal records.

Matthew D. Green of Johns Hopkins Information Security Institute believes that many people are bound to have their personal information compromised, as everyone is vulnerable to identity theft. Individuals need to actively monitor their accounts for suspicious transactions instead of waiting for their banks to notify them. WalletHub encourages users to increase the security on their personal accounts with a secure password and two-step authentication. WalletHub also recommends using the available account alerts for all financial accounts.


**Aginam, E. (2015, November 29). Nigeria: NSA, Microsoft team up to tackle cybercrime in Nigeria. All Africa.**

Microsoft Nigeria has joined forces with the Office of the National Security Adviser (ONSA) and other stakeholders to tackle cybercrime in Nigeria. Between 2000 and 2013, Nigerians lost over N159 billion in online scams and identity theft. During the same time, more than 2,175 websites were compromised. Nigeria's National Security Adviser acknowledges that cyberspace is improving commerce, and believes there are opportunities to improve the general welfare of citizens.

Cybersecurity is quickly becoming a global phenomenon requiring efforts from both the public and private sectors. At a workshop in Abuja, representatives from Microsoft and ONSA agreed that security and law enforcement agencies need more education concerning the safety of Nigerian cyberspace. The Nigerian Federal Government promises to address the threats that exist in a way that respects individuals’ rights to privacy.


In 2013, Mark Kim’s personal information was compromised as part of a breach at Target. Kim immediately signed up for credit monitoring so he would know if someone used his identity to commit fraud. Soon, identity thieves opened accounts in Kim’s name at department stores. More than $7,000 in charges took place. Kim spent the next seven months filing reports with the police department and sending documents to banks and credit reporting agencies to correct his credit history. Although banks often cover the cost of fraudulent charges, it is up to victims to clear their credit records. This means that even though individuals do not owe money for fraudulent charges, the fraudulent behavior negatively impacts their credit scores. The process to clear credit history is long and frustrating.

It is rare that an identity thief is held accountable for his or her crime(s). Identity theft is a global problem, and it is difficult to measure losses worldwide. One Department of Justice study estimates that identity theft was responsible for losses of $24.7 billion in 2012. Experts estimate that the average loss when a credit card is exposed at $1,251. When a Social Security number is exposed, the average loss increases to $2,330.


Practicing smart password habits and using caution online is essential to keeping accounts secure. Two-factor authentication (2FA) is one way to add an extra layer of protection for online users. 2FA requires a user to confirm two different characteristics, or factors, of their identity. For example, it is standard for automated teller machines (ATMs) to use 2FA. ATMs require a bank-issued credit or debit card and PIN number that is unique to the card’s owner before money can be withdrawn. 2FA uses many forms of authentication including passwords, PIN numbers, email addresses, cell phone numbers, and security questions.

The benefit of 2FA is that fraudsters are less likely to obtain both characteristics of identity that are required to access sensitive information. If an identity thief gains access to a PIN number, it does not necessarily mean that he or she has the corresponding bank-issued credit or debit card as well. Without both pieces of information, 2FA prevents access to sensitive information. Many online platforms and companies are using 2FA. It is quickly becoming a popular way of ensuring online security and protecting personal information.


In 2012 Google began notifying users when it believed those people’s computers or accounts were at risk of state-sponsored attacks. State-sponsored attacks are attacks carried out by hackers working on behalf of governments. In 2015, Facebook launched its version of an alert system for state-sponsored attacks. According to Facebook’s Chief Security Officer, state-sponsored attacks tend to be more advanced and dangerous than other attacks on accounts.

People can take protective measures by turning on Login Approvals (Facebook’s version of two-factor authentication). In the event of a confirmed attack, people might want to replace their computers altogether. Facebook and Google were the first major companies to offer such alerts. Facebook’s move to warn users of potential state-sponsored attacks is part of a larger effort to help users protect their privacy and security.


Blakeley, K. (2015, September 27). Identity theft keeps rising: One in 14 Americans was victim last year, with women, the elderly and workers earning more than $75,000 a year targeted most. *Daily Mail*.

Data from the U.S. Justice Department reveals that one in every fourteen Americans was the victim of identity theft in 2014. In total, an estimated 17.6 million people, or 7% of the population older than sixteen, experienced at least one incident of identity theft. The most common form of identity theft was fraudulent use of a credit card, with 8.6 million victims affected. For 9% of victims, it took more than a month to resolve identity theft issues. Not surprisingly, the longer it takes to resolve the challenges that result from identity theft, the more likely individuals are to suffer from problems with work and social relationships. In 2014, women were more likely to be identity theft victims than men. Additionally, the number of elderly victims rose from 2.1 million in 2012 to 2.6 million in 2014. Data from 2014 also reveals that people with an annual income of $75,000 have a higher likelihood of being victims of financial fraud than individuals who earn less.

When victims spend more than six months attempting to resolve fraud problems, 29% report severe emotional distress. Most victims choose to reach out to their financial institution, rather than law enforcement officials. Research shows that 87% of identity theft victims reach out to credit card companies or banks, while just 10% contact police.


Law enforcement agencies will soon be able to identify people of interest by searching millions of facial images filed within Australia from driver's licenses, visas, and passports. Australia's Minister for Justice, Michael Keenan, plans to spend A$1.8 million establishing the National Facial Biometric Matching Capability (NFBMC). Facial recognition systems that use unique features such as the shape of the eye, mouth, or jaw will automatically identify someone from an image.

Keenan says facial matching will help bring justice to terror suspects, murderers, and armed robbers. He anticipates that facial recognition capabilities will help address the issue of identity theft in Australia. According to the Attorney-General's Department, more than 50,000 fraud and deception reports from 2013-2014 involved identity crime. A senior lecturer at RMIT University wants to know more about how the facial information will be used. He is asking questions about the privacy implications of facial recognition technology and where data will be stored.

This is not the first biometric measure that the Australian government has been cleared to use. As of August 2015, the government also has the power to collect one or more personal identifiers from Australians and non-citizens at the country's border. Personal identifiers are a person's unique physical characteristics such as facial images, fingerprints, and irises. There is an ongoing debate about whether it is ethical for the Australian government to access and use such information for law enforcement.


In early 2015, the Federal Trade Commission (FTC) released the list of top complaints received by its Consumer Sentinel Data Network. At the top of the list for the 15th consecutive year was identity theft. According to the report, 12.7 million US consumers were victimized for almost $16 billion in losses in 2014.

Identity theft crimes are classified in two ways: hassle and heinous. Hassle crimes, such as a stolen debit or credit card, are frustrating, but can be resolved. If someone uses a stolen card to make purchases, the victim can get his or her money back. Heinous crimes involve new account fraud, where a thief uses their victim's identity to take out a loan or get a line of credit. Heinous crimes are much more difficult to resolve.

Credit monitoring can help people keep an eye on their credit, but does not prevent identity theft altogether. The FTC reports that impersonation crimes are on the rise. Impersonation crimes take place when strangers pretending to be from important government agencies contact individuals. Usually, impersonation crimes happen over the phone. Victims are told they owe taxes or penalties and are asked to make payments or give out sensitive information.

Experts agree the easiest way to prevent identity theft is to be cautious of what you do with your information. Technology is quickly changing, but so are the methods hackers use to obtain information. Even though they are tech-savvy, millennials tend to engage in “bad social network behavior” that exposes their personal information. Millennials are five times more likely than others to become victims of familiar fraud. Familiar fraud happens when a victim's identity is compromised by a spouse, neighbor, sibling, coworker, or another person they know.


Is identity theft protection a good investment? Each year, people spend billions of dollars on software that helps monitor and protect them from identity theft. Most identity theft products offer three key services: credit monitoring, resolution services, and insurance. Most protection software costs about $20 per month or more.

Startup CreditKarma provides credit-monitoring services for free. Credit reports are monitored daily, and users are informed if and when there are any changes. CreditKarma does not offer credit monitoring for all three of the big credit bureaus. It also does not include issue resolution services.

Zander is a service that focuses on the painful resolution process that happens after someone becomes a victim of identity theft. For $75 per year Zander guarantees a personal caseworker who assists victims in managing the recovery process from start to finish. Zander also offers clients a $1 million insurance policy.

For those seeking three-bureau credit monitoring, insurance, and recovery services, BillGuard may be the best option. For about $84 per year BillGuard Ultimate monitors all three credit bureaus daily, helps victims through the recovery process, and guarantees a $1 million insurance policy. BillGuard offers some innovative services not offered by other identity theft protection plans. Users can link their credit and debit cards to the BillGuard app for transaction monitoring. Clients also benefit from monitoring based on geolocation data from cell phones. If a customer has his geolocation tracking enabled, BillGuard can monitor the location where transactions take place. If there is an attempted transaction from a location other than where the client appears to be, BillGuard sends out an alert immediately.


Daly, R. (2015, August 06). Hackers can now steal fingerprints from Android phones. *Fortune*.

The days of using crime scene investigation techniques to steal fingerprints are long gone for hackers. Now hackers can steal fingerprints from Android devices using fingerprint scanners they access remotely. New research by FireEye Inc. has provided information about the methods hackers use to steal mobile fingerprints. FireEye Inc. first shared their findings in 2015 with a series of live demonstrations. The demos showed the process for hijacking information when making payments from mobile devices and stealing fingerprints from popular mobile devices.

The concern associated with hackers stealing fingerprints has been present since print scanners appeared on mobile devices. When a criminal is able to obtain a fingerprint and a user’s sensitive information, he or she can commit crimes for decades. Right now FireEye’s researchers believe the threat is confined to mostly Android devices with fingerprint sensors including the Samsung, Huawei, and HTC devices.


Australia and New Zealand recently agreed to a new information-sharing initiative. The agreement grants Australian and New Zealand authorities access to personal identity documents from either country. The goal is to combat identity crime while promoting cross-border travel, migration, and commerce. Authorities hope the information-sharing initiative will limit the number of identity theft victims each year. In New Zealand alone, 133,000 people fall victim to identity theft at a cost of $209 million each year.

The agreement gives Australia access to the New Zealand Confirmation Service where passport details, birth certificates, and citizenship certificates are stored. In return, New Zealand’s government agencies can use Australia's Document Verification Service (DVS). The service contains information on Australians’ passports, Medicare cards, visas, and driver's licenses.


Wearable gadgets are at the forefront of a technological revolution. By 2015, 20% of all US adults already owned at least one wearable. A Price Waterhouse Cooper study predicts there will be 50 billion newly connected devices by 2020. Wearables will reshape the way people live their lives, offering large and small conveniences as well as entertaining capabilities that were never available before. Most of the new functionalities will be possible because of the collection and processing of large amounts of data. Does that mean personal data is at risk?

Experts warn it is essential for consumers and manufacturers to make privacy and security priorities. Consumers have a general idea of what data their wearable fitness monitors and connected medical devices capture. What most consumers do not realize is how revealing and comprehensive that data can be to identity thieves and fraudsters. Access to intimately personal data such as location, physical activity, temperature, and heart rates are what make wearable devices valuable. If compromised, the risk to personal privacy and identity is serious.

Many experts feel smartphones are the weakest links. Most wearable devices sync to mobile phones using Bluetooth capabilities. When data from many sources is stored on a single device it is especially valuable to hackers. It is highly recommended that individuals choose wearables and mobile phones that have high security and privacy ratings. People should use biometric authentication such as fingerprints or facial recognition, whenever possible.

Dean, B. (2015, October 01). What you will pay for a more secure credit card. *Fortune*.

Experts worry that the benefits of switching to the Europay-MasterCard-Visa (EMV) chips may not reduce fraud outright. Though research shows that EMV-enabled technology results in a drop in fraud when thieves physically have a card, the decline is offset by an increase in fraud that takes place when using card number information without the card itself. EMV, or “chip and PIN” technology uses integrated circuits (the chip) instead of the magnetic stripes on credit cards. When paired with a personal identification number (PIN), payments happen successfully. France was one of the first countries to use EMV technology in 1992. Since then, more than 200 countries have also adopted the technology. A key reason for the US transition to EMV is a shift in liability.

As of 2015, retailers in the US are liable for any fraud that occurs in their stores if new EMV chip readers are not in use. Experts expect the cost of retailers transitioning to EMV to be $8.65 billion. EMV-enabled payments reduce fraud and use improved security features such as PIN authentication instead of signature-based authentication. Even though EMV-enabled payments are more secure, there are ways to hack EMV technology. For example, card-reader terminals can be hacked to accept any PIN that is entered. In a practice known as ATM-skimming, fraudsters can install fake PIN pads on ATMs to trick consumers into sharing their card information and PINs. RFID devices can steal the card number and expiration date of nearby cards. EMV-enabled payments are convenient and capitalize on technological advances. The true benefits, including reduced fraud, are not as secure as consumers have been led to believe.


Globally, billions of dollars are lost to cybercrime every year. In one year, 772,000 Australians were the victims of identity theft. A survey conducted by Veda reveals that one in every five Australians has had his personal information stolen at some point.

Fiona Long is Veda’s head of cybercrime. She reports that cybercrimes cost around $1.6 billion to the economy each year. Each incident costs about $4,000 and takes an average of eighteen man hours to resolve. Criminals use a mix of high- and low-tech methods to steal personal information. The methods include the use of spyware, malware, and social media monitoring to gather personal information from victims. Once information is collected, identity thieves piece together what they know about their victims.

Once they have recreated enough of a person’s identity, they can open accounts, buy phones, apply for loans, and even file tax returns under their victim’s name. Long says she has even seen the title deeds of houses transferred to other people. Veda urges people to protect themselves from identity theft by using secure mailboxes, shredding personal documents, and exercising caution when sharing information on social media.


The IRS plans to implement a new public awareness campaign to protect taxpayers from identity theft. IRS Commissioner, Jon Koskinen, urges the public to take the necessary steps to protect their personal and financial information online and at home. He claims criminals are evolving and developing advanced skills. As criminals become more sophisticated with their techniques, taxpayers must be even more regimented about protecting their data. Koskinen stresses the importance of making it difficult for criminals to access the massive amount of sensitive data that exists. Every person should take basic, common sense actions to protect themselves.

Over several months, the IRS will be promoting identity theft best practices. The efforts will include a weekly tax tip, YouTube videos, and resources on IRS.gov and other state websites. The IRS also vows to make every effort to convict those responsible for identity crimes.


Farzan, A. (2015, June 09). College students are not as worried as they should be about the threat of identity theft. *Business Insider*.

Typically, college students have very little money in their bank accounts. That does not mean they do not have something worth stealing. Students are often the targets of identity theft. Research suggests that students may be more likely to have their identities stolen than any other age group. Students are disproportionately unconcerned about the threat of identity theft. Experts say the reason college students are targets has a lot to do with their lack of concern with taking extra precautions to protect their personal information. In fact, sixty-four (64%) percent of students are “not very concerned” about fraud, reports Javelin Strategy & Research.

In 2014 18% of the people who experienced identity theft were between the ages of twenty and twenty-nine, reports the FTC’s Consumer Sentinel Network. Compared to the average identity theft victim, young people are only one-third as likely to discover fraud on their own. It isn’t until a debt collector contacts them or when they are denied credit that 22% of students learn their identity has been stolen. Interestingly, students are four times more likely to be victims of “familiar fraud,” or the hacking of personal information by friends, family members, or acquaintances.

Farzan, A. (2015, July 18). The habits and traits that make you susceptible to identity theft include nearly everyone. *Business Insider*.

Data from the identity theft protection company, Lifelock, helps consumers understand what habits and characteristics impact their likelihood of being identity theft victims. Wealthy, educated consumers are most likely to get their identities stolen. In fact, earning $100,000 or more per year increases a person’s risk by 51%. Having a four-year college degree increases an individual’s risk by 44%. Students and members of the military are particularly vulnerable to new account fraud.

New account fraud occurs when thieves open up accounts in another person’s name without the victim’s knowledge. Students are 45% more likely to be victims of new account fraud than non-students. Military personnel have 28% more money stolen on average than civilians. Major life changes such as buying a house, getting married, or having a child also increase a person’s risk of identity theft. Online habits are also factors. For example, a person that uses public WiFi networks are two times more likely to have his/her identity stolen. Using three or more social networks increases an individual’s likelihood by 73%.


The holiday season is an ideal time for cybercriminals to steal identities. During November and December, people are using their credit and debit cards online and at unsecure retailers. At the same time, people are traveling and using open WiFi connections. Retailers are too busy, distracted, and rushed to check their networks for possible attacks. Financial institutions have more difficulty in identifying suspicious behavior since many people are spending and traveling. The holidays present a perfect opportunity for cybercriminals to attack.

What should consumers do to protect themselves from identity theft? First, consumers should shop at retailers using Europay MasterCard Visa (EMV), or chip-and-pin, terminals. Cybercriminals are getting more advanced with their hacking tools and techniques, and non-EMV card readers are particularly vulnerable.

People also need to be wary of public WiFi connections. Experts warn that it is extremely easy to hack public WiFi connections at airports, hotels, and coffee shops. Even if someone does decide to use public WiFi, they should never make an online purchase or log in to a bank account or banking app.

Family computers are more prone to malware infection since so many individuals use them. It is important not to do online banking or log in to any sensitive accounts on devices that might have malware.

Finally, consumers need to avoid holiday spam. Cybercriminals know that shoppers want to save money and are more likely to donate to charities at that time of year. The phishing emails used by criminals are virtually identical to real emails from retailers. Consumers should exercise extreme caution by navigating directly to trusted sites rather than clicking links or attachments in emails.


In 2015 Samy Kamkar lost his American Express card and received a replacement card in the mail. When Kamkar saw the new card number, he thought he recognized a pattern and grew suspicious. He compared the new American Express card number to the numbers of his three previous cards. Sure enough, a clear pattern emerged. Kamkar enlisted the help of friends and soon found that the disturbing pattern applied to every American Express card he checked. Using the current card, Kamkar could predict the full number of the next credit card he or a friend would receive.

Kamkar immediately identified the possibility for a fraud scam. Any hacker who had compromised a card could predict the replacement card’s number and expiration date. In order to convince American Express to improve its process, Kamar built the MagSpoof to prove the danger of the number-predicting vulnerability. The $10 device uses an electromagnetic field to collect card details from nearby card scanners. If a criminal uses the MagSpoof and finds that a stolen card has been canceled, a button runs Kamkar’s number-predicting logic. After a week or so when the fraudster is fairly sure a new card has been activated, he or she could steal that card with the information from the number-predicting logic.

An American Express spokesperson pointed out that the chip-and-pin technology and the security codes on the back of cards still provide protections. Kamkar continues to argue that American Express needs to fix the problem to prevent real fraud.


Skimmers are the devices hackers use to illegally collect data from the magnetic stripe of a credit, debit, or ATM card. According to ATM Marketplace, skimmers cost consumers $2 billion in 2014. New York police report that skimming quadrupled throughout the state in 2015. A possible reason for the increased use of skimming devices is that they are extremely easy to access. Skimmers can be purchased on eBay for less than $100. Former FBI special agent, Tim Ryan, explains that in addition to being affordable, skimmers are smaller than most people expect. They can fit in the palm of a person’s hand.

Once installed, skimmers allow thieves to secretly record credit or debit card information and steal a person’s identity. When skimmers are in place, transactions still go through normally. As the transaction is being completed, the skimmer captures an individual’s credit card details. After a period of time, thieves collect the device or access the stolen data remotely. Officials are urging gas station owners to replace locks and use security seals on their gas pumps for additional protection. Customers are encouraged to avoid pumps that are out of an attendant’s view or pay with cash when buying gas.


A recent study in India by Symantec Corporation reveals the attitudes of millennials and baby boomers on the topic of cyber security. For the study, baby boomers are identified as those above 55 years of age, while millennials are defined as ages 24-54. The research shows that millennials are front-runners in adopting new technology, including social media, cloud capabilities, and wearable devices. Interestingly, while technology adoption is high among millennials, security insight is low. The millennial generation often uses multiple devices and expresses a constant need to stay connected. The desire for “always-on” connectivity makes it easier than ever for cybercriminals to attack.

Millennials should be more diligent in keeping their virtual identities secure. In general, younger generations are more likely to fall victim to financial fraud online, particularly through shopping portals. Older generations tend to be less informed about security “best practices,” leaving them vulnerable to email fraud, phishing schemes, and credit card fraud.

The report shows 54% of millennials have fallen prey to online crime over the last year, compared to just 28% of baby boomers. Millennials from India are more likely to share passwords, with 31% reporting such behavior, compared to just 16% of baby boomers. Finally, the report reveals that 40% of older people feel personally responsible when an online crime occurs, compared to just 25% of millennials.


Password managers might be the answer to growing concerns about identity theft. Consumers typically do a poor job of protecting their personally identifiable information. People usually select memorable passwords that rarely contain numbers or symbols. Hackers now have tools that can break most passwords, gaining access to information in just a matter of seconds. One hacking tool, Idict, proved it could break into a site in less than five seconds. Idict, and similar tools, store every word in the dictionary. It then uses those words, with and without numbers, in millions of combinations within a few seconds to secure access to a site. Industry experts call this type of hacking a “brute force attack.”

After Idict’s demonstration of quick and successful hacking, Apple has been progressive and has added additional safeguards to iCloud accounts. Most other sites have not yet done the same. To prevent hacking, consumers should have a unique, strong password for each site they use. The passwords should have random upper and lower case letters and include numbers and symbols. Ideally, people should change their password frequently.

If passwords are truly strong and secure, they will be difficult to remember, which is why individuals should have password managers. A password manager keeps track of passwords on an individual's computer and is accessed through a master password. The password manager remembers passwords for sites the owner has already visited and automatically logs in the user. Password managers save time and offer greater security for those using random passwords. LastPass, Dashlane, and Qwertycards are all examples of password managers.


Travelers are especially susceptible to identity theft. Estimates suggest international travelers are as much as three times more likely to be victims of identity theft than non-travelers. Travelers are not actively checking their financial accounts, mail, email, or bills, so they do not catch discrepancies as quickly. When identity theft does happen, travelers frequently lack access to the account numbers, phone numbers, and statement histories that are stored at home. Should travelers purchase identity theft protection services?

Before buying any subscription plans, individuals should check their homeowner’s or renter’s insurance to understand what is covered. Some insurance plans include the option to add coverage that restores identity and credit. TrustedID, ProtectMyID, and Experian all offer identity theft protection plans that range in cost and security. Protection plans help cover the costs associated with restoring identities, travel expenses, fees to obtain new ID cards, and more. Travelers are encouraged to sign up for free fraud alerts from their credit card companies and banks. After traveling, it is a good idea to request a credit report for review. To reduce the risk of identity theft, international travelers should also avoid using geo-location apps and services that broadcast information about their whereabouts when they are far from home.


**IBM introduces new privacy tool Identity Mixer.** (2015, November 24). *Times of India.*

A new tool for protecting a consumer’s personally identifiable information is available on IBM Cloud. The tool is called Identity Mixer and was built using cryptography research. Using algorithms, Identity Mixer helps developers build apps that authenticate user identities without collecting sensitive personal information. The goal is that developers using IBM Cloud will be able to easily build user privacy technology into their apps.

As an example, imagine an online movie streaming service. The app requires users to verify that they have paid for the service and that they are old enough to make the purchase. Usually the user would enter his or her full date of birth and other personal details, such as name and location, to confirm his or her account. With Identity Mixer, the app can verify age and subscription status without the user entering any additional information. It authenticates user identity by asking the user to provide a public key that the user received when initiating the transaction. The technology also means that companies no longer have the burden of protecting and maintaining unnecessary personal details.

**Immigration New Zealand website scam - customers urged to take care.** (2015, July 30). *New Zealand Herald.*

Phishing scams can trick individuals into sharing sensitive, personal information such as passport details. A scam website has emerged that looks identical to the official Immigration New Zealand (INZ) website. Customers are urged to take special care in making sure they are accessing the legitimate site. The fake website has only a slight change from the real INZ website: the domain name (or URL) for the scam website varies slightly from the real website. When customers land on the fake website, which is a phishing scam, they are asked to enter personal information. INZ is investigating the situation and seeking to have the site removed.

In addition to the fake website phishing scam, INZ has been alerted to an increase in scam phone calls, mostly to Indian nationals living in New Zealand. The caller tells the individual on the phone that there is a problem with his or her visa. The caller then demands money and threatens serious consequences, such as deportation. So far, calls have been made using numbers that appear to be from the Immigration Contact Centre. Though the numbers are similar, INZ says it never asks for money over the phone.


NerdWallet, a personal finance website, completed an analysis of more than 300,000 identity theft complaints the FTC received in 2014, 15% more complaints than it received in 2013. NerdWallet reports the most common type of identity theft it uncovered was fraud involving government benefits or documents, such as passports, driver's licenses, and Social Security numbers. Other common fraud schemes involved banks, credit cards, and phone or utility accounts. Florida, Washington, Washington D.C., Oregon, and Missouri were reported to have the highest rates of identity theft complaints.


**Kane, K.** (2015, September 10). *This could be the year of the university hack.* *TechCrunch.*

Attacks on university networks and the students that use them are on the rise. In fact, Symantec's 2015 Internet Security Threat Report (ISTR) reports that education was the third most breached industry in 2014. In total, educational settings accounted for 10% of security breaches and that number is expected to rise in coming years.

As the number of targeted attacks on university networks grows, protecting those networks has become increasingly challenging. Education institutions have large and complex security needs. Universities have a continuous stream of new students, faculty, and staff. Many educational institutions also have open campuses where visitors and community members are invited to use facilities and WiFi. All of these factors increase data traffic and potential access for hackers. In addition, college students tend to freely share information on social media about their locations and personal details like birthdays.

The sensitive information stored on university networks is a data goldmine for hackers. Hackers can use financial, health, academic, and social information for a number of crimes. The sensitive data enables them to take over mobile devices and network accounts, max out credit cards, and steal student loan money.


What is the biggest mistake most people are making when it comes to protecting themselves from identity theft? It is not that they are using weak passwords. It is not that they are filling out suspicious forms or clicking on questionable emails. The biggest mistake most people are making is doing nothing at all to protect themselves. Executive Director, Neal O'Farrell of The Identity Theft Council, explains that a majority of people refuse to take even the most basic responsibility for their own protection. In fact, most consumers are not even taking simple actions such as checking credit reports, protecting their mail, and changing their passwords regularly.

O'Farrell feels cybercrime and identity theft are destroying consumer and business trust. In many ways, identity theft is the perfect crime. It is rare that thieves are arrested or prosecuted for their illegal activities. Thieves can easily work together and share knowledge and best practices. When successful, cybercriminals bring in a lot of money with their work. O'Farrell predicts the situation will get worse before it gets better. Improvement will depend on consumer security, law enforcement, banking, the IRS, and the Social Security Administration all doing a better job of preventing and prosecuting identity theft.


Passwords are not going away anytime soon. They are required to access bank information, social media platforms, and even apps. More and more often, people are using passwords to access the information and profiles that are important to them at home and at work. To avoid hacking, should information technology (IT) admins be automatically generating strong, secure passwords, or allow employees to choose their own? A benefit of employees choosing their own passwords is that they are easier to remember. In addition to password generators that automatically produce strong passwords, authentication technology also helps increase the security of personal information and profiles. Authentication technology can include sending an extra code to a person's phone that is required to complete a login or emailing that person to alert them of an account login from a new device.

Sean Sullivan, the security advisor at F-Secure, says that strong passwords are not being paired with username secrecy often enough. People know they should keep their passwords private, but they often do not use secure username credentials. It has been suggested that workplaces enforce password discipline and require employees to change passwords every few months to avoid obvious patterns. IT admins generally feel that machine-generated passwords are the best, even though they are said to be harder to remember. Typically, people memorize them faster than they expect, so this might be a good practice.

**Lemos, R. (2015, June 04). This startup aims to scour the Dark Web for data breaches. *Mashable.***

The time lapse between when a company’s information is compromised to when they notice that a problem exists is a significant problem. Terbium Labs is working to help companies reduce that amount of time. Two researchers from John Hopkins University’s Applied Physics Laboratory co-founded Terbium Labs. They use technology to help organizations detect leaked data to the Dark Web. The system monitors information to alert businesses if a hacker has published any of the company’s information.

Danny Rogers, co-founder and CEO of Terbium Labs, says that bringing breach detection time down from months to seconds gives businesses a huge advantage when it comes to managing a data breach. When detection time is short, companies can focus on minimizing damages and reducing the risk of the data leaked in the first place. Terbium Labs has already helped companies find thousands of credit card numbers that were available for sale on the internet.


**Levin, A. (2015, April 16). Why we need to kill the social security number. *Money.***

Social Security numbers were never intended to be a secure key to individuals’ data. Designed in 1936 by Frederick Happel, they track income made so benefit levels could be calculated. Before 1972, the cards even read, “For Social Security purposes. Not for Identification.” Social Security numbers were first used to identify federal employees in 1961, thanks to computer technology that made it possible to do so. The IRS might face fewer tax fraud challenges if it stops using Social Security numbers as the way taxpayers identify themselves.

To date, identity thieves have been remarkably successful in using Social Security numbers to steal tax refunds because the stolen Social Security numbers are plentiful. Between April 2011 and December 2014, the Internal Revenue Service (IRS) stopped more than 19 million suspicious tax returns, but it is estimated that as much as $5.8 billion in tax returns were paid out to identity thieves. By 2017, the Treasury Inspector General for Tax Administration predicts that fraudsters will receive $26 billion. Whether thieves are purchasing that information on the Dark Web or phishing for the information in email scams, they are successfully gaining access. The Anthem breach exposed more than 80 million Social Security numbers and the Premera breach exposed up to 11 million. Leading into the 2014 tax year, experts predicted the breaches would cause extreme difficulty for many US taxpayers.

There are a number of ways to possibly eliminate Social Security fraud problems. In 2010, India attempted to get all 1.2 billion of its nation’s citizens to use biometric authentication to verify identity. At least 160 similar biometric programs have been started in countries around the world. An alternative idea for traditional Social Security cards is to begin including chip-and-PIN technology.


Somewhere between 10 and 16 million Americans are victims of identity crimes each year. Fraudsters use a number of methods to steal identities. Their tactics include stealing the identities of children. Child identity theft is significantly more difficult to measure than identity crimes that target adults. A child’s Social Security number is pristine before first use. Minors have no reason to use credit with any financial institution until they are eighteen. At eighteen, minors become legally responsible for contracts they sign. Since children do not use their credit, there is no reason for parents to monitor their credit. If a skilled identity thief steals a brand new Social Security number, he or she might have fifteen years or more to use that number illegally before anyone notices. The number of personal loans, student loans, bank accounts, apartments, medical treatments, and prescriptions that could be secured is limitless. Estimates suggest between 140,000 and 400,000 children are victims of identity theft every year. The number is strictly an estimate since most child identity theft cases go undetected for years. Once a parent or child learns identity theft has happened, it sometimes takes years to undo the damage. While the credit is being repaired, finding jobs, apartments, and securing car or student loans are often difficult. Occasionally the child is even arrested for a crime he or she did not commit in a state in which he or she has never been. Parents and guardians are the first line of defense against child identity theft. Parents should be on the lookout for unexplained calls from debt collectors and pre-approved credit card offers in their child's name.


Identity thieves will not catch Michael Chertoff on public WiFi, using the same password on every site he uses, or clicking on questionable links. Chertoff is the former secretary of the US Department of Homeland Security. He says malicious cyber activity is happening at an unprecedented rate. According to Pew Research, 87% of American adults are online. The US Department of Justice reports that 11 million Americans were victims of identity theft in 2014.

Chertoff promotes what he calls “cyber hygiene.” He encourages people to use complex passwords and make up their own security questions when given the opportunity. Security questions that ask for answers that are opinions are preferable over questions that require fact-based answers. Chertoff strongly discourages the use of public WiFi, which he says opens the door to data theft since information transmitted on public WiFi can be easily intercepted. Chertoff does shop online, but with caution. He always goes directly to a shopping site, rather than clicking a link in an email. He also deals with only online vendors he trusts. Chertoff explains that no one can completely eliminate the risk of identity theft, but every individual can take precautions against obvious bad behaviors that cause problems.

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Most people have heard of the identity theft where someone steals personal information and uses it to get money or credit. What many people may not know about is medical identity theft. The Federal Trade Commission (FTC) warns that medical identity theft is a growing concern. Thieves can use a person's name and health insurance numbers to see doctors, get prescription drugs, and file claims. When a thief’s health information is mixed with their victim's information treatment, insurance and payment records can be affected. The Medical Identity Fraud Alliance (MIFA) estimates that 2.3 million Americans were victims of medical identity theft in 2014. The average cost of straightening out matters after medical identity theft occurred was $13,500 for 65% of victims. On average, victims spent about two hundred hours trying to resolve their cases. MIFA reports that just 10% of victims feel they reached a completely satisfactory conclusion.

To avoid being victimized, individuals should closely monitor their credit reports for any irregular activity. As a best practice, people should request a credit report from one of the three main reporting bureaus every four months. Since each bureau grants one free credit report per year, an every four-month strategy is the best way to monitor credit reports for free on a regular basis. It is also a good idea to work with healthcare providers to review electronic health records and check for errors. To protect against familiar fraud, it is important that people avoid giving out personal information to friends or family members as well. Finally, when people suspect they have been victimized, they should immediately report it to their health care provider, insurance company, and federal and state authorities.


The Internal Revenue Service (IRS) has a new team dedicated to investigating identity theft committed through hacking. The agency's unit is made up of twelve agents. The team will work from Washington and focus on cybercrimes related to tax fraud and data theft. According to the IRS, 1,000 cases of identity theft happened in 2014 through digital platforms. Between 2011 and 2014, the IRS prevented $63 billion in fraudulent tax refund transactions.

When online users are not careful, they can easily become victims of phishing campaigns. Phishing is a cybercrime that entices victims to give their personal information online. Fraudsters can trick individuals into thinking they are receiving legitimate emails from banks, social media websites, or loan companies. The emails often include malicious attachments with malware or links to unsafe websites. When the attachments or links are clicked, individuals are at risk of having their information stolen. Malware spies on users, logging information about their keystrokes. When criminals access data collected using malware, they have access to passwords, account numbers, Social Security numbers, and passwords. When cybercriminals have access to Social Security numbers, they submit tax returns and collect returns in the name of their victim. Victims may not discover that their information has been stolen until they try to collect their refund and are told it has already been paid.


Experts say the internet is held together with Band-Aid fixes. Computer security is poorly regulated and enormous amounts of private, medical, and financial data are accessible to the world's hackers. The former defense secretary of the US once predicted that it would take a “cyber-Pearl Harbor” to make the nation fully understand its vulnerabilities in cyberspace. Only certain companies such as banks and hospitals are held accountable to government regulations when they are hacked.

Legal liability in the courts is still unclear at best, but computer security is finally gaining the national attention it needs. Consumers are demanding greater privacy protections. Businesses are elevating their security measures. A cyber security expert for the White House has claimed that prevention and detection technologies are broken. Even President Obama has called on Congress to pass a breach law outlining one clear, national standard for companies responding to data breaches.

Scott Borg is the head of the United States Cyber Consequences Unit. He believes the companies that are most prepared for cyber attacks are those that have identified their most valuable information and have chosen to store it separately from the rest of their network’s information. This strategy is called “defense in depth” and is being used more often in advanced security plans. Security experts agree that new protection strategies are a step in the right direction. Still, very little is preventing hackers from attempting to steal information. Rarely is an identity thief arrested or brought to justice.


Guarding customers’ personal information was a fairly easy task for information technology (IT) professionals of the past. It is just within the last few years that IT professionals have needed to be concerned with preventing identity theft. Experts argue that IT professionals are not yet thinking about security breaches or identity theft correctly. Increasingly, IT professionals are being encouraged to find innovative ways to protect information by studying what professionals are doing.

For example, meteorologists study past weather to forecast future weather conditions. They utilize large amounts of data to make educated guesses about storm systems. Could IT professionals begin to track historical data to better understand and predict data hacks? Another innovative approach might come from the pharmaceutical industry. Pharmaceutical companies use RFID chips to track drug shipments. Law enforcement agencies place the RFID chips in certain medication bottles and then monitor the signals to capture thieves. What if IT professionals used a similar model where they tagged and tracked data as it moves between people? Some credit-card companies in Europe offer “smart cards” with debit, credit, and phone-card features that self-destruct when stolen. Perhaps IT professionals could program sensitive data to self-destruct as well.


It is October 2015. Jihan Antoine, a social media publicist, has just learned that her data may be compromised in a T-Mobile security breach. Despite the hack and her own frustrations, Antoine decides not to change cell phone carriers. “Hacks are inevitable, so why bother?” she asks. Antoine is exhibiting what a recent survey identifies as “millennial malaise” about the dangers of identity theft.

Data shows that most millennials (ages 16-35) in the United Kingdom and United States do not trust governments or businesses to protect their identities online. In fact, 61% of millennials surveyed have little or no trust in data security on social media platforms. 25% of the respondents say they provide their personal credentials to sites because they believe governments and business access the data anyway. Instead of causing millennials to be more protective about their sensitive information, negative attitudes are contributing to even more relaxed behavior. Millennials tend to use the same password across a number of accounts and websites and to be more trusting of public WiFi. A common misconception among millennials is that they do not need to care about cyber security because they do not have valuable information to protect.

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Schiller, J. (2015, February 03). Photographer stalks the woman who stole her identity and turns her into art. *Wired.*

Anyone that has ever had a wallet stolen knows it is a frustrating experience. For most people, canceling a few cards and losing some cash is the end of the ordeal. But for Jessamyn Lovell, losing her wallet was the beginning of a long and unsettling process to recover what was taken: her identity. A thief stole Lovell’s wallet in San Francisco in 2010. It was not until 2011 that she learned someone had used her personal information to assume her identity and commit a series of small crimes.

Over the course of the next few years, Lovell, with the help of a private investigator, tracked down Erin Hart, the suspected identity thief. Lovell was not looking for revenge, but instead the answer as to why Hart had stolen her identity. Lovell, a photographer, decided to answer the question in the only way she knew how: through photos. Her project is known as *Dear Erin Hart* and portrays the struggles Hart has experienced since her release from prison. Lovell said she made peace with the incident during her project and that she wishes Hart the best. It is most important to Lovell that Hart knows her actions impacted a real person. Lovell’s work premiered in September 2014 at the SF Camerawork Gallery - the same place where her wallet was stolen in 2010.


Radio-Frequency Identification (RFID) is the technology that makes credit and debit cards, toll road transponders, and hotel room key cards work. To steal sensitive data, identity thieves just need to point a wireless RFID scanner at a wallet. The scanner gathers pertinent information such as credit card numbers and expiration dates. In this manner, tech-savvy thieves can pickpocket unsuspecting victims without actually stealing anything from a person's pocket. With an inexpensive RFID reader and relatively close proximity, thieves get enough information to steal someone's identity in just seconds. This crime is known as RFID-skimming.

San Francisco-based company, Betabrand, wants to stop thieves with its new RFID-blocking denim. The jeans are made in partnership with Norton, the Symantec cyber security company, best known for its anti-virus computer software. The jeans' pockets are lined with RFID-blocking fabric. The jeans cost $168 per pair. Betabrand also has a hooded blazer available with RFID-blocking technology that sells for $148.


Major health insurance companies are frequently the victims of significant data breaches. In 2015 at least 92 million records were compromised at insurance companies - Anthem, Premera, and Carefirst. The fifth annual Ponemon Institute Study on the privacy and security of health care data was released in 2014. The study reveals that in a twenty-four month period 91% of health care organizations reported at least one data breach. The Affordable Care Act of 2010 required that health care providers digitize their health information. Electronic information is easier for hackers to access than paper files. Some experts speculate that the health and medical industries are targets for cybercrimes because retail industries are more difficult to hack as they have taken so many precautions to prevent hacking. Health care organizations’ cybersecurity systems are new and less sophisticated, making them easy targets. Health care data is also more valuable to hackers.

Medical records contain payment and billing information which can leave credit card information exposed to fraudsters. The files also contain personal details like Social Security numbers that fraudsters can use to obtain medical services under their victim's identity. When medical information is mixed with a criminal's information, the victim's files are no longer accurate. Victims might receive medication they are allergic to or have incorrect blood type details in their files.

Criminals can benefit from medical identity theft in many ways. They can get health care themselves or sell the information to uninsured individuals that need care. The biggest profits can come from fake sales of medical equipment that are reported through Medicare or Medicaid to the government for reimbursement. Experts recommend a few best practices for protecting medical information. People should obtain a copy of their medical records and review them regularly. Social Security numbers should only be used when absolutely necessary.


By the end of 2015, an estimated 63% of payment cards in American wallets included new chip technology. Estimates suggest that 47% of United States payment terminals could read chip cards by the end of 2015. The transition to chip cards should be complete by the end of 2017. Chip technology is intended to better identify consumers and prevent payment card theft.

Counterfeit, or “cloned” cards, account for about two-thirds of in-store fraud. Card cloning happens when thieves make fake cards using information from data breaches or by skimmers on card reading devices. Instead of swiping cards with magnetic strips, for better protection consumers will insert their chip cards into card reading terminals and leave them in the machine until their purchases are complete. A survey by Visa indicates that 70% of business owners have already upgraded to chip terminals or scheduled plans to do so. As of October 2015, retailers that are unable to accept and process chipped cards may be held liable for fraud instead of the financial institutions. Chip cards represent the most significant change to US card security in decades.


Stoller, G. (2015, September 01). What hackers want more than your credit card number. Money.

Account takeover fraud happens when a cybercriminal gains unauthorized access to an account. According to an analysis by NuData Security, a Canadian-based cybersecurity company, account takeover fraud is increasing rapidly. In its analysis, NuData Security identified about 890,000 potential account takeovers in a two month period. “Account takeover is the new credit card fraud,” says the company’s director of customer success.

For identity thieves, account takeover fraud begins with obtaining a list of usernames and passwords, an act that is relatively easy for fraudsters. From dumpster diving to purchasing packages of identifying information off the Dark Web, a person’s information can quickly be stolen. The information is then used to open or access existing accounts. Fraudsters are moving beyond payment card details and are targeting Social Security numbers, addresses, and bank account information to force their way into accounts.


College students are especially vulnerable targets for identity thieves. Typically, college students are busy and distracted, rarely engaging in the management of their credit. At the beginning of school, they fill out a lot of documentation which asks for personal information such as Social Security numbers. They might apply for financial aid, complete rental forms, and many may complete a credit card application for the first time. Students are almost always online, operate on fairly unsecure college networks, and spend time with roommates and friends who can easily access their information. When young adults are victims of identity theft, they often do not know it until contacted by a debt collector or denied credit. In fact, a 2015 Javelin Strategy and Research study identifies that this is the case for 22% of the students who are victims of identity theft.

College students should practice good habits when it comes to protecting their identities, including leaving “foundational” paperwork such as birth certificates and Social Security cards at home. Students should also be cautious when using public WiFi. It is best to assume that data typed into a computer in a public lounge or cafe can be easily viewed and stolen. Avoiding sites that require logins and doing sensitive tasks, like online banking, is always best practice. It is also ideal to come up with a personal strategy for creating secure passwords, especially since accounts created in college often stay with a person well into adult life. Finally, students need to be aware of over-sharing on social media. Any information that a hacker could use to socially engineer their way into personal accounts is best left offline.


**The hidden dangers of free store WiFi.** (2015, November 30). *New Zealand Herald*.

Online fraud spikes during the holiday shopping season when people search for the perfect gifts online. It can be extremely tempting to log onto a store’s free WiFi to get a better signal while searching for the best deals. Using unsecure WiFi networks is exactly what identity thieves want their victims to do. It easily allows hackers to gain access to credit card and bank information.

During the holiday season, identity thieves also take advantage of fake emails and donation requests to steal personal information. Even though it is tempting to move fast with the hustle and bustle of the season, experts say the best way to prevent unauthorized access is to be cautious. If something sounds too good to be true, it probably is. Online retailers are on the lookout for fraudsters as well and may even delay transactions to make sure they are not fraudulent.


In a report dated November 10, 2015, Michael Horowitz of the Justice Department says that handling future cyber threats will be a challenge. One example of a cyber threat is a recent attack on the Office of Personnel Management (OPM). The OPM is responsible for providing classified personal information of prospective government employees. The attack left more than 22 million people vulnerable to identity theft.

Attacks like these demonstrate that not only are individuals at risk for identity fraud, but the United States government is also vulnerable. The government is taking additional precautions to ensure that individuals, organized groups, terrorists, and state employees cannot access the personal identification information stored in the government's database. The Attorney General also mentioned that she has met with corporate executives to spread the message of cyber-awareness to encourage strategic collaboration and to find new ways to protect American consumers.


Williams, D. (2015, November 23). 'Tis the season to prevent online identity theft. Huffington Post.

The holiday season brings out many online shoppers who hope to avoid long lines and enjoy the convenience of delivery to their front door. What customers do not always understand is that identity theft happens more often in online shopping markets. During the 2015 holiday season, 92% of consumers will go online to purchase or research products. While companies state that personal information is secure, hackers are determined to break through even the strongest of firewalls.

Experts recommend a few ways to ensure safe shopping online, one of which is looking out for spam emails. Hackers design these emails to link to sites while they automatically track your personal information. The experts recommend using PayPal or Google Wallet when possible, doing your online shopping on your personal computers or mobile devices, limiting your public WiFi usage when shopping, and avoiding sharing your passwords or personal information with other online users.


People enjoy spending during the holiday season. When there is more spending, there tends to be more identity theft and fraud. During the holiday season, consumers and retailers should be especially on guard against fraudsters. Unlike when they use cash, shoppers are incentivized with airline miles, cash back, and consumer protection when they use credit cards. Consumers assume some risk by using a credit card, but they are also protected by the Consumer Protection Act. The Consumer Protection Act guarantees that consumers are not responsible for any fraud they report within sixty days of receiving a credit card statement.

What should consumers be looking for as they monitor their accounts for fraud? What do identity thieves buy? According to MarketWatch research, identity thieves have fairly predictable buying habits. For example, luxury items are popular purchases with stolen credit card information. These purchases often include Louis Vuitton handbags, diamond rings, MacBooks, and Rolex watches. Red Bull, pizza, and hotel rooms are also common purchases made with stolen credit cards. World of Warcraft gold, website hosting services, search engine optimization, and coupons for Facebook ads are also routinely associated with fraudulent spending.


According to a Consumer Federation of America (CFA) and the North American Consumer Protection Investigators (NACPI) survey, identity theft is the fastest growing consumer complaint. This is not surprising, considering 12.7 million Americans were victims of fraud in 2014. In total, the incidents contributed to $16 billion in losses. Impersonation theft, which usually involves a fraudster calling a consumer and claiming to be from the IRS, is on the rise. Unlike hassle crimes, which are primarily inconvenient, impersonation theft can result in serious credit issues and leave victims severely in debt.

Identity thieves are on the lookout for many types of information. They will hack social media accounts, steal airline miles, and even target medical information. Along with being cautious online, consumers should pay close attention to their personal assets. This means monitoring sensitive account information to make sure there are no suspicious charges or changes in personal information on their accounts.


Lifelock, an identity theft-protection company, is being criticized for failing to protect its users’ data. Lifelock promotes its services to businesses that experience data breaches. After a breach, Lifelock actively encourages merchants to purchase Lifelock subscriptions for their consumers.

A complaint issued by the Federal Trade Commission (FTC) claims Lifelock has not adhered to a 2010 order requiring it to establish improved security. The 2010 investigation found that Lifelock did not have sufficient security in place to prevent unauthorized access to the sensitive, personal information stored in its network. Lifelock stores birth dates, Social Security numbers, bank details, names, addresses, and other personal information. Lifelock’s measures fall short of truly protecting individuals from identity theft. The company places fraud alerts on credit accounts to prevent thieves from opening new accounts. While fraud alerts prevent new accounts from being opened in a victim’s name, they do not stop thieves from stealing and spending from existing accounts.

Appendix

THEMES AND CONCEPTS, USE OF CPS TOOLS, & PREVIOUS FUTURE SCENES
THEMES & CONCEPTS

Themes & Concepts serve as content organizers for each topic of study. Common themes are obvious in most subject matters or topics. Concepts represent mental images, constructs, or word pictures that help people to arrange and classify fragmented and isolated facts and information. Due to the vast amount of information available on each of the topics, the themes and concepts assist in organizing information into manageable threads or ideas, providing a complete picture or understanding of the subject.

Coaches may wish for younger students to utilize the provided Themes & Concepts for each topic as a reference and starting point in their research. Coaches of older and/or more advanced problem solvers may encourage students to take the research and develop their own Themes & Concepts for each topic.

CPS TOOLS APPLIED...

The appendix provides examples of creative problem solving tools applied to two of the current topics. The ALoU for the topic, It’s All in the Genes, assists with focusing on pros and cons within the topic. The Structured Overview for the topic, 3D Printing, assists with the organization of major themes for further research.

Extensive training of CPS tools can be obtained through the Center for Creative Learning LLC either through face to face workshops or Distance Learning Modules. Visit www.creativelearning.com for information.

A LOOK BACK...

Previous Future Problem Solving Future Scenes similar to themes found in Educational Disparities and It’s All in the Genes, two of the topics for the 2016-17 year, are provided. The Future Scenes serve as an additional research “source.” The situation in the Future Scenes for 2016-17 will be different, but some of the underlying themes may be the same. You may even want to use the Future Scenes in this section to complete a practice booklet.

Future Scenes put our changing world into perspective. Older Future Scenes were chosen so that changes that have taken place since the time the Future Scenes were written would be apparent. Read the scenarios and determine what technology is available now that may have been only a dream when the Future Scenes were written. What has changed? What has stayed the same? Predict changes for the future regarding each topic.
Educational Disparities
Themes & Concepts

Overview:
Educational disparity is the result of different learning results experienced by students coming from different groups. Statistics and research point to one overarching theme: great disparity in education still exists.

Theme #1: Family Background
In Harvard’s “Civil Rights Project”, Lee and Orfield identify family background as the most influential factor in student achievement. Unequal educational outcomes are attributed to several variables, including family of origin, gender, and social class.

Concepts:
Cultural Knowledge and Perception

- Parents from the middle-upper class and above have social networks that prove to be more beneficial than networks based in lower classes. These connections may help students gain access to the right schools and activities.
- Data from the British birth cohort studies has demonstrated the powerful influence of family socioeconomic background on children’s educational attainment. These differences emerge early in childhood and continue to grow throughout the school years.
- Family background influences cultural knowledge and perceptions. Middle class knowledge of norms and customs allows students of particular backgrounds to better navigate the school system.

Parents with academic success

- A correlation exists between the academic success of parents with the academic success of their children.
- Some home-lives are more supportive of educational success. This can mean students receive more at-home help, have more books in their home, attend more libraries, and engage in more intellectually intensive conversations.
- Students from disadvantaged families experience greater losses in academic skills during summer vacation.

Language

- When students come from families where the local language is not spoken at home, they often struggle with overcoming a language barrier in addition to simply learning subjects. They are more likely to lack assistance at home because it is common for the parents to not understand homework.
- Dr. Anne Fernald’s findings reveal income-based differences in children’s vocabulary starting as early as 18-months. Her research both confirms and extends what is understood how living in poverty impacts children’s language development.
- Psychological science examining second language acquisition has resulted in important findings about how linguistic minority children function; it has helped in identifying the resources those children need to perform commensurate with their cognitive abilities.
- An educational task force of the American Psychological Association recommends the expansion of access to high-quality bilingual education that would provide linguistically competent education to children.
Theme #2: Gender

Around the world, educational achievement varies by gender. The exact relationship differs across cultural and national contexts among men and women.

**The Female Disadvantage**
- Obstacles preventing females from receiving a quality education include traditional attitudes towards gender roles, poverty, geographical isolation, gender-based violence, and early marriage and pregnancy.
- Throughout the world, there are an estimated 7 million more girls than boys out of school. This “girls gap” is concentrated in several countries including Somalia, Afghanistan, Togo, the Central African Republic, and Democratic Republic of the Congo. In the Democratic Republic of the Congo girls are outnumbered in the classroom 2:1.
- In Nigeria children are socialized into their specific gender role as soon as their parents know their gender. Men are the preferred gender and are encouraged to engage in computer and scientific learning while the women learn domestic skills.

**The Male Disadvantage**
- Females outpace males in both high school and college graduation rates.
- Dropout rates for males has also increased over the years in all racial groups, especially in African Americans. For the past thirty years they have exceeded the number of high school and college dropout rates more than any other racial ethnicity.
- In general, males are much less prepared for schooling in kindergarten than females, creating a gap that continually increases over time into middle and high school.
- Boys are more likely to be disciplined than girls and are more likely to be identified as learning disabled.
- In the United States males of color, especially African American males, experience a high rate of disciplinary actions and suspensions. In 2012, 1 in 5 African American males received an out of school suspension.

**Women in the Workplace**
- With marginal variables between most countries, women have a lower employment rate, are unemployed longer, are paid less, and have less secure jobs.
- Young women are increasingly choosing typically “male” professions; still, they remain over-represented in traditionally female jobs such as secretaries and nurses and under-represented in jobs with responsibility and the professions.
- Males earn more than women at every educational level, in part because of their occupations. If both a male and female possess the same professional degree, the male will typically receive a larger salary than a female.

Theme #3: Race, Access, & Income Matter

Despite significant efforts across decades, there is still bias and differential treatment in educational systems around the world. Race and ethnicity, access to education, and family income continue to be predictors of educational success. Educational inequality between white students and minority students continues to perpetuate social and economic inequality. Educational inequality continues to be attributed to economic disparity that often falls along racial lines, making economics and race virtually inseparable.
Race & Ethnic Groups

- Developmental psychologists have identified how differences in early childhood education and childcare are associated with academic performance and school readiness for ethnic and racial minority children prior to their entry into K-12 schools.
- The organization of schools and how students are engaged in their learning are of critical importance for the educational achievement of students across ethnic and racial groups.
- In the United States, the high school dropout rate of Native students is about 12%, higher than that of blacks (8%) and of whites (5%). Only 39% of Native students who go to college complete a college degree in six years compared to 62% of whites and 69% of Asians.
- U.S. teachers in high-minority schools make about $2,251 less per year than teachers in other schools. For example, while Houston pays teachers in its high-minority schools an average of $2,549 per year more than their peers, Philadelphia pays them $14,699 less.

Access

- One U.S. study found that 29% of high-minority schools offered calculus, compared to 55% of schools with smaller black and Hispanic populations.
- When it is difficult to get to schools and universities, fewer students graduate. For example, many students on the St. Lawrence - a remnant of the land bridge that spanned the Bering Strait thousands of years ago - say they want to go to college, but half of them drop out of high school and only 2% complete college.
- Title VI of the U.S. Civil Rights Act of 1964 says that while states and school districts do not have to provide the exact same resources to all schools, all students must have equal access to educational opportunity.

Income

- An article in the journal *The Future of Children*, published by Princeton University and the Brookings Institution, suggests that income may have the biggest impact on a child’s development during their early years.
- Wealthier families have the means to spend significantly more on enrichment resources - books, computers, summer camps and private school - that can aid education.

**Figure 1. Rates of Kindergarten Proficiencies for Poor, Near Poor, and Middle-Class Children**

![Graph showing proficiency rates for different income levels](http://www.huffingtonpost.com/2014/06/12/early-childhood-poverty-report_n_5489862.html)
Overview:
Genes exist everywhere! Genes are in plants, animals, and people. As scientists continue to learn more about how genes work, controversy emerges. Many people refuse to consume genetically modified organisms and others fear that gene therapies may be unsafe for plants and animals.

Theme #1: Genetically Modified Organisms

Concepts:
Regulation of GMOs
- To address strong concerns around health, Vermont, Maine, and Connecticut have passed laws to require GMO labels.
- Most developed nations do not consider GMOs to be safe. In more than 60 countries around the world, including Australia, Japan, and all of the countries in the European Union, there are significant restrictions or outright bans on the production and sale of GMOs.
- Many Americans are taking matters into their own hands and choosing not to consume foods that contain GMOs.
- In the 1980s when deliberate releases of GMOs into the environment were beginning to occur, the US had very few regulations in place. Adherence to the guidelines provided by the NIH was voluntary for industry.

Are GMOs Safe?
- Chipotle reports that 300 scientists have “signed a statement rejecting the claim that there is a scientific consensus on the safety of GMOs for human consumption.” The company has chosen to avoid GMOs in their food since there is not agreement among experts.
- In 2014 a survey by the Pew Research Center found that 57% of Americans said it’s generally “unsafe to eat genetically modified foods.”
- The World Health Organization, the American Medical Association, the National Academy of Sciences, and the American Association for the Advancement of Science have all declared that there is no good evidence GMOs are unsafe.
- The United States government has approved GMOs based on studies conducted by the same corporations that created them and profit from their sale. For this reason, individuals continue to question the accuracy of the information and the overall safety of GMOs.

Food Labeling
- In the past five years companies have submitted more than 27,000 products to the Non-GMO Project which certifies goods that are free of genetically modified organisms.
- 64 countries, including the entire European Union, with over 40% of the world’s population already label genetically engineered foods.
- China labels genetically engineered foods.
- The same companies that fight GMO labeling in the United States reformulate or label GMOs in the foods they sell overseas. Why do they afford this transparency to some countries while spending over $100M to fight such transparency in the United States?
- Each country establishes its own food labeling laws. Within the United States, the government has established clear guidance with respect to labeling food products containing genetically modified ingredients.
Theme #2: Genetic Modification: Insects, Plants, & Animals

Concepts:

*Insects*
- Scientists in Britain say they have developed a way of genetically modifying and controlling an invasive species of moth that causes serious pest damage to cabbages, kale, and other similar crops worldwide.
- Three-quarters of the corn and cotton grown in the United States is engineered to resist insects.
- Millions of genetically modified mosquitoes could be released in the Florida Keys if British researchers win approval to use the bugs against two extremely painful viral diseases.

*Plants*
- Farmers have widely adopted GM technology. Between 1996 and 2013 the total surface area of land cultivated with GM crops increased by a factor of 100, from 17,000 square kilometers (4.2 million acres) to 1,750,000 km (432 million acres).
- 10% of the world’s croplands were planted with GM crops in 2010.
- By 2014 in the US, 94% of the planted area of soybeans, 96% of cotton, and 93% of corn were genetically modified varieties.
- In recent years, GM crops expanded rapidly in developing countries.
- In 2013 approximately 18 million farmers grew 54% of the world’s GM crops in developing countries.
- Scientists in Britain say they have developed a way of genetically modifying and controlling an invasive species of moth that causes serious pest damage to cabbages, kale, and other similar crops worldwide.

*Animals*
- Europe’s cows, pigs, and chickens are eating GMOs: their feed usually contains ingredients made from genetically modified plants.
- Animal feed often has additives and enzymes that are produced with genetically modified microorganisms.
- Although GM animal feed must be labeled, the end products of animal production such as milk, eggs, and meat do not require labeling.
- Sixteen years after it was invented, Golden Rice still isn’t commercially available.
- Enviropig, or “Frakenswine” as critics call it, is a pig that’s been genetically altered to better digest and process phosphorus.
Theme #3: Applications of Genetic Study

More than a decade ago, the US National Institutes of Health launched the Human Genome Project. Genetics, it was thought, would lead us to discover why we get sick and how to cure disease. Today, however, patients have little idea of how genetic testing works, what purpose tests may serve, and/or whether they should get tested for certain conditions. The largest debate is over the ethical, safety and potential for political and economic war over genetic modification in humans.

Concepts:

Genetic Modification & Research

- Researchers believe gene mechanism in fruit flies may point to new treatments for alcohol abuse
- Researchers are genetically modifying tobacco to make human collagen (a protein needed to build skin, tendons, and connective tissue), as well as vaccines and drugs for devastating diseases such as rabies and Ebola.
- Many industries stand to benefit from additional GMO research. For instance, a number of microorganisms are being considered as future clean fuel producers and biodegraders.

Recombinant DNA

- Recombinant DNA, the process of removing DNA from one organism and inserting it into the DNA of another organism, giving it new traits, is one of the core techniques of genetic engineering.
- Recombinant DNA can be used to make crops resistant to pests or disease and used to make livestock leaner or larger. In medicine this technique can be used to develop drugs and vaccines, and to reproduce important human hormones and proteins. Engineering human DNA into a host organism can turn that organism into a factory for important medical products.
- Insulin production is an example of the recombinant DNA process.
- Host organisms can range from bacteria like E. coli, to plants, to animals.

Genetic Modification in Humans

- Chinese scientists say they’ve genetically modified human embryos for the very first time. The team attempted to modify the gene responsible for beta-thalassaemia, a potentially fatal blood disorder, using a gene-editing technique known as CRISPR/Cas9.
- Gene editing is a recently developed type of genetic engineering in which DNA is inserted, replaced, or removed.
- A Chinese group used a genome editing procedure called Crispr to modify an aberrant gene that causes beta-thalassaemia, a life-threatening blood disorder, in faulty IVF embryos obtained from local fertility clinics.
- Genetically modified animals have been used to grow transplant tissues and human transplant organs through a concept called xenotransplantation.
Overview:
3D printing is an emerging technology that is spreading across the globe. With 3D printing, an object can be created in a series of layers that make up a three dimensional solid shape.

Theme #1: Multiple Process Required
There are a number of processes involved in 3D printing: first, objects must be modeled or conceptualized. Then, printing happens through one of many available processes. Even in the short amount of time that 3D printing has been available it has matured significantly.

Concepts:
Additive Processes & Alternative Printing Techniques
- In 3D printing additive processes are used in which successive layers of material are laid down under computer control until the entire object is created.
- Each of the layers can be seen as a thinly sliced horizontal cross-section of the eventual object.
- Technical standards generally use the term additive manufacturing to describe 3D printing; processes such as extrusion and sintering which represent more complex techniques are also becoming popular.
- Some methods use melting or softening material to produce the layers. Selective laser sintering (SLS) and fused deposition modeling (FDM) are the most common technologies using this type of printing.
- Another method of printing is curing a photo-reactive resin with a UV laser or other similar power source one layer at a time. The most common technology using this method is called stereolithography (SLA).

Scanning & Modeling Objects
- Creating a 3D object begins with modeling or developing the virtual design of the object that will be created.
- Most often the virtual design is made in a CAD (Computer Aided Design) file using a 3D modeling program (for the creation of a totally new object) or with the use of a 3D scanner (to copy an existing object).
- 3D scanners use different technologies to generate a 3D model; examples include time-of-flight, structured/modulated light, and volumetric scanning.
- Many IT companies like Microsoft and Google enable their hardware to perform 3D scanning; a great example is Microsoft’s Kinect.
- Engineers and product designers can scan an existing object or contour by shooting thousands of points of light at it and loading the “point cloud” - a 3D ghost image of the original - into a computer.
Evolution of 3D Printing Technology

- Over the years, digital design software has matured; scanners have become commonplace and affordable desktop printers have come within reach of self-starting entrepreneurs, schools and home tinkerers.
- Additive manufacturing would not have flowered without major advances in computer-directed modeling. A decade ago it took weeks to generate a digital 3-D model; now it takes only hours.
- Technologists believe that 3D printing will free the population from the dominance of mass manufacturing.
- Today objects can be of almost any shape and produced from a 3D model or other electronic data source.
- 3D printers can be classified as industrial robots.

Theme #2: Medical Applications

Some of the most promising applications of 3D printing are emerging in medicine, for humans and animals alike.

Concepts:

- Printing Organs
  - Is Superman’s bulletproof outfit becoming a reality? Yes, and so is the printing of human cells (including stem cells) into complex functional living tissues. These techniques are already being applied to address the need for tissues and organs suitable for transplantation. The ability to customize the materials used for organ production - even printing living tissue - promises to be truly transformative.
  - For years researchers have been building organs by hand, pipetting progenitor cells - which have the capacity to differentiate into specific types of cells - onto degradable scaffolds.
  - So far there has been mixed success in printing organs; some handmade bladders have been functioning in a handful of patients for many years and a miniature kidney implanted in a cow has successfully excreted urine. However, constructing organs by hand is laborious and plagued by human error.
  - While perfection remains a few years in the future, the printing of organs, cartilage, skin, and tissue holds great promise for transforming health care and extending longevity.
  - Kengla’s fellow scientists at the Wake Forest Baptist Medical Center’s Institute for Regenerative Medicine are developing in collaboration with other labs processes to systematically print muscle tissue, skin, kidneys, cartilage, and bones.
  - Transplanted organs created from a patient’s own tissues won’t be rejected, waiting times for kidneys and other donor organs will decrease, and organ traffickers could be put out of business (the World Health Organization estimates almost 11,000 organs were sold on the black market in 2010).

- Other Body Parts
  - Doctors are already using 3D printing to create knee replacements customized for each patient.
  - Entrepreneur Dr. Daniel Stolyarov is experimenting with 3D printing using Graphene (the substance that is quite flexible, transparent, and yet is 100 times stronger than steel) for applications in the human body.
  - Carlos Kengla has spent the last few years focusing on the production of ears which he prints using cells that are taken from human ear cartilage and then propagated in the lab.
● The Alfred DuPoint Hospital For Children works with engineers at the hospital to build a
durable “exoskeleton” using a 3D printer.
● Buttercup the duck was born with a backward left foot. Buttercup received a new silicon foot
that was created with a 3D printer.
● In 2013 medical researchers in Belgium and The Netherlands replaced the jaw of an 83-year-
old woman with a 3D printed model of her lower mandible. Doctors had to remove her jaw
due to a severe infection, but surgery would have been a major risk due to her age and several
other factors. The researchers worked with an implant company called Xilloc to replace the
jaw. The implant was made using a 3D printer with powdered titanium and a laser melting
process.

Medication & Healthcare
● Experts expect that 3D bio printing has the potential to completely reshape healthcare.
● Prescription drug companies are eager to test drugs and other therapies on rapidly prototyped
organs or tissue, rather than animals or human beings.

Theme #3: Continued Adoption
The world is already reacting to the possibilities of 3D printing; every day there are more devices,
more opportunities, and more innovation happening at the fingertips of ordinary individuals all
over the world - it is clear that 3D printing will not be limited to business applications only or
accessibility only to the wealthy.

Concepts:
Accessibility
● Future hand-held devices like smartphones will have integrated 3D scanners.
● Digitizing real objects into 3D models will become as easy as taking a picture. Prices of
3D scanners range from very expensive professional industrial devices to $30 DIY devices
anyone can make at home.
● Design software has become more accessible, and scanners, too, have become more powerful
and easier to use - even at home.

Business & Industry Applications
● While many people are only now hearing about the technology, engineers and designers have
been using large and expensive 3D printers for nearly three decades, making rapid prototypes
of parts for aerospace, defense, and automotive companies.
● Ford Motor Company uses 3D printing to make prototypes of many parts in their vehicles
cylinder heads, brake rotors, shift knobs and vents).
● NASA’s rocket engine injector made from a 3D printer passed a major hot fire test. In the test
the rocket engine injector generated 10 times more thrust than any injector made from 3D
printing in the past.
● Defense Distributed is a high tech gunsmith group that created the world’s first fully open-
sourced 3D printed gun called the “Liberator.” Fifteen of the gun’s parts were made out of
3D printed plastic and the body can be etched overnight.
● Yahoo! is teaching blind children to search the web using a machine called Hands On Search.
Hands On Search is shaped like a cloud and combines voice recognition technology with a
MakerBot 3D printer to turn voice queries into physical objects.
Nano printing

- It is predicted that Nano-3D Printing will be the next “Big Thing” in 3D printing. For example, non-printed batteries the size of a single grain of sand may power miniature medical devices, compact electronics, or even tiny robots.
- Applying 3D printing concepts to nanotechnology will make nanofabrication faster and more efficient, and therefore economically viable much sooner than most futurists envisioned.
- Princeton University scientists created a bionic ear using a 3D printer. The bionic ear can hear much better than what average human ears can detect. The purpose of the experiment was to explore an efficient method of merging electronics with tissues. The scientists created the bionic ear using the 3D printing of cells and nanoparticles.

A Glimpse at the Future

- Biz Stone, Twitter’s co-founder, recently predicted that Nike could be a pure software company in ten years by simply printing their product.
- In the future products will be at an individual’s disposal. Imagine a woman is at home when she realizes that one of the wheels on your dishwasher has broken. She simply looks up the part on the internet and then prints the part at home or at a neighborhood commercial 3D printer.
- When a child outgrows her 3D-printed custom shoes, the parent will be able to drop the old pair in the material recycler and print out a brand new pair, one size larger.
Identity Theft
Themes & Concepts

Overview:
Identity theft is a form of stealing someone’s identity in which someone pretends to be someone else by assuming that person’s identity, usually as a method to gain access to resources or obtain credit and other benefits in that person’s name.

Theme #1: The Identity Theft Landscape
Identity Theft is complex and transcends governmental and geographic boundaries.

Concepts:
Trends in Identity Theft
- In 2014 fewer U.S. consumers were victimized by identity theft than the previous year, but experts continue to warn that individuals should be on guard.
- Identity theft can be used to facilitate or fund other crimes, including illegal immigration, terrorism, phishing, and espionage. There are cases of identity cloning to attack payment systems, including online credit card processing and medical insurance.
- Common types of identity theft today include:
  - Criminal identity theft (posing as another person when apprehended for a crime)
  - Financial identity theft (using another’s identity to obtain credit, goods, and services)
  - Identity cloning (using another’s information to assume his or her identity in daily life)
  - Medical identity theft (using another’s identity to obtain medical care or drugs)
  - Child identity theft (using a minor’s identity for the impostor’s personal gain)
- In 2014 data theft reached record levels. According to the Identity Theft Resource Center, there were 783 data breaches that year, a substantial increase from 2013.
- All forms of fraud, including identity theft, cost Americans about $1.7 billion in 2014, or an average of more than $2,000 per incident.

Hassle v. Heinous
- ID Theft crimes can be categorized as hassle or heinous
- Card fraud, where someone steals a credit card or debit card number and uses it to make purchases, is classified as hassle: it’s a pain, but it can be shut down.
- Even if money is pulled out of a checking account with a hassle crime, it can be returned.
- New account fraud, where someone uses identifying info to take out a loan, is categorized as heinous.
- Javelin Strategy and Research (which is backed by LifeLock) found that victims are three times as likely to take a year or more to discover what’s going on when crimes are heinous.
- Heinous crimes give fraudsters the opportunity to use identities for illicit purposes like applying for a job (as their victim) or filing for the victim’s tax refund.
Who are the Victims?

- Child advocates say that foster youth are particularly vulnerable to identity theft because they bounce from one home to another, giving a number of adults access to their private information.
- A Los Angeles County study found that eight percent of 16 and 17 year old foster kids had fraudulent charges on their credit reports.
- Children are targets because their information is readily available when stored within a school system.
- The elderly are often victims because they tend to have more contact with medical establishments, with medical specialists, and with other people, such as caretakers, entering their homes often.
- Because almost no one monitors a child’s credit report, a child’s stolen identity can often be used for years before misuse is even detected.

Theme #2: How Does Identity Theft Happen?

*Identity theft techniques are advanced and take people by surprise because they take place in unexpected places and in unexpected ways. Fraudsters use many strategies to gain access to sensitive information both financial and personal.*

Concepts:

**Bank Statements & Financial Information**

Bank statements and financial information is jeopardized in multiple ways:

- Fraudsters stealing bank or credit cards, identification cards, passports, authentication tokens ... typically by pickpocketing, housebreaking or mail theft
- Fraudsters skimming information from bank or credit cards using compromised or hand-held card readers and creating clone cards
- Fraudsters altering check to change the name (to deposit checks intended for payment to someone else) or the amount on the face of checks (Simple altering can change $100.00 into $100,000.00, although transactions of this value are subject to investigation as a precaution to prevent fraud.)
- Fraudsters seeking access to facilities which process checks in large numbers (mailrooms, post offices, offices of a tax authority, a corporate payroll or a social or veterans’ benefit office)
- Fraudsters attaching card stripe readers to publicly accessible ATMs to gain unauthorized access to the contents of the magnetic stripe, as well as hidden cameras to illegally record users’ authorization codes

**Misleading or Tricking Techniques & Schemes**

- Common-knowledge questioning schemes to access account verification and compromise: “What’s your mother’s maiden name?” or “What was your first car model?” or “What was your first pet’s name?”, etc.
- Advertising bogus job offers in order to accumulate resumes and applications typically disclosing applicants’ names, home and email addresses, telephone numbers, and sometimes banking details
- Impersonating trusted organizations in emails, SMS text messages, phone calls, or other forms of communication in order to dupe victims into disclosing their personal information or login credentials, typically on a fake corporate website or data collection form (phishing)
- Using false pretenses to trick individuals, customer service representatives, and help desk workers into disclosing personal information and login details or changing user passwords/access rights (pretexting)

**Technology Breeches**
- Using “contactless” credit card readers to acquire data wirelessly from RFID-enabled passports
- Hacking computer networks, systems, and databases to obtain personal data, often in large quantities
- Retrieving personal data from redundant IT equipment and storage media including PCs, servers, PDAs, mobile phones, USB memory sticks, and hard drives that have been disposed of carelessly at public dumpsites, given away, or sold on without having been properly sanitized
- Stealing personal information from computers using breaches in browser security or malware such as Trojan horse keystroke logging programs or other forms of spyware

**Taking Advantage of Social Media**
- Browsing social networking websites for personal details published by users, often using this information to appear more credible in subsequent social engineering activities
- Guessing Social Security numbers by using information found on internet social networks such as Facebook
- Befriending strangers on social media to take advantage of their trust until private information is provided

**Theme #3: Prevention & Legal Responses**
*Around the world, countries are addressing identity theft in a number of ways. Legal responses to identity theft are varied and result in mixed success. Individuals are strongly encouraged to be thoughtful about their online and offline behaviors to protect personal identity. At the same time, financial institutions and merchants bear the burden of trying to protect the data of others.*

**Concepts:**

**Individual Protection Strategies**
- It is recommended that individuals do not give out their personal information over phone, fax, or on social media platforms.
- It is good practice for people to use a shredder to destroy tax related documents after tax time is over (thieves can look through the trash), keeping the necessary ones in a safe.
- Individuals working with accountants should do their research on what methods the accountant uses to protect the client’s personal information.
- To protect themselves against electronic identity theft by phishing, hacking, or malware, individuals are well advised to maintain computer security by keeping their operating systems and web browser security fully patched against known security vulnerabilities, running antivirus software, and being cautious in their use of IT.

**Countermeasures**
- Chipped credit cards will be widely used by 2018; experts do not expect this to shut down all fraud, instead they expect other types of fraud to increase when thieves are unable to steal credit card data to print onto fake cards.
- Card issuers use fraud detection and prevention software that analyzes patterns of normal and unusual behavior, as well as individual transactions, in order to flag likely fraud.
• Merchants routinely request additional information such as a PIN, zip code, or Card Security Code as preventative measures to fraud and identity theft.
• Significant industry collaboration and information sharing about known fraudsters and emerging threat vectors currently exists.

Legal Action & Responses
• Prior to 1998, crimes that would now be considered identity theft were charged under “false personation” statutes, which go back to the late 19th century. False personation can be defined as “the crime of falsely assuming the identity of another to gain a benefit or avoid an expense.”
• Identity theft laws in place make it a crime to misuse another person’s personal or financial identifying information.
• In France a person convicted of identity theft can be sentenced up to five years in prison and fined up to €75,000.
• The FTC encourages consumers to file a complaint whenever they have been the victim of fraud, identity theft, or other unfair or deceptive business practices.
• The FTC compiles complaint data that it receives, along with data from other agencies, into the Consumer Sentinel Network, which is available to more than 1,800 law enforcement organizations in the United States, Canada, and Australia. The Consumer Sentinel Network allows members to spot emerging and long-term trends and helps U.S., Canadian, and Australian law enforcement agencies to combat fraud.
• In Australia, each state has enacted laws that deal with different aspects of identity or fraud issues. Some states have now amended relevant criminal laws to reflect crimes of identity theft, such as the Criminal Law Consolidation Act 1935 (SA), Crimes Amendment (Fraud, Identity and Forgery Offences) Act 2009, and also in Queensland under the Criminal Code 1899 (QLD).
• In Canada each province and territory has its own privacy law and privacy commissioners to limit the storage and use of personal data.
Example: A STRUCTURED OVERVIEW – Generating Tool

Directions:
From your research or the challenges generated, sort your ideas into focus areas. Use this example of focus areas for 3D Printing to organize facts about this topic, OR label each box of the structured overview on the blank Structured Overview with one of your own focus areas.
A STRUCTURED OVERVIEW – Generating Tool

Directions:
From your research or the challenges generated, sort your ideas into focus areas. Label each box of the structured overview with one of your own focus areas. Add additional boxes as you discover more facts.
### Example: ALoU - Focusing Tool

**Directions:**
From your research, choose one aspect of *It's All in the Genes* to examine options and ways to improve. In this sample ALoU is used to analyze an article for this topic “This salmon will likely be the first genetically modified animal you eat.”

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Limitations (including ways to Overcome)</th>
<th>Unique Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Genetically modified salmon grow quickly which lowers production cost.</td>
<td>- Modified fish may enter the wild and breed with wild fish altering the species. (Overcome by requiring the modified salmon to be raised in very secure fish farms.)</td>
<td>- Fish is usually more expensive and this salmon may be available to people with all levels of income.</td>
</tr>
</tbody>
</table>
ALoU - Focusing Tool

**Directions:**
From your research, choose one aspect to examine options and ways to improve.

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<td>(including ways to Overcome)</td>
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</tbody>
</table>
Junior Division Future Scene
Future Problem Solving Program  2001-02

Holographic mail sys.
3.25.2050
Acropolis, USA

Message from:
Commissioner of Education EP Torrance, III

To my compatriots:

As I appear before you today and see that our once great educational system is no longer effective, I do it with determination and not sadness, because I believe in the creative genius of children.

We are seeing the result of many years of criticizing a public educational system that has, during its best times, produced presidents, scholars, doctors, lawyers, writers, technology experts and, you, my wonderful creative thinkers. It is now your time.

For the past 50 years education in the United States has tried to “keep up with the changing times,” but there has never been much cooperation among the different ways to educate students. A combined, effective system was never put together because there were many who had different ideas of how education should be. In the early years of the 21st century, laws were made that said certain subjects would be taught in schools and students had to achieve certain levels of performance. Many thought teachers began “teaching to the test” and students learned only what the achievement test covered. It is believed this was one of the reasons that led to voucher systems and charter schools. With more students attending both private and charter schools, they began to have the same problems the public schools did. Homeschooling seemed to be successful for some students, but it was not very convenient for many others. Distance learning, cyberlearning and virtual classrooms were effective, but for only a part of the student population. There were good parts to all the different options to educate children, but no one put it altogether, and that, my friends, is why we are here today.

If the United States is to once again be among the nations who have successful educational programs, then it is necessary to put different options of education together. As we look to the future, I must remind you that what has happened in the past is often the beginning place for rebuilding. I believe this is true in this case. Virtual classrooms; holographic instruction; interactive, intelligent tutoring systems and cyberlearning; as well as the more traditional methods of instruction such as public, parochial and charter schools; the voucher system; distance learning and homeschooling all had positive things about them, but they could not be successful very long by themselves. As Future Problem Solvers who have researched all these educational approaches and know what worked and what didn’t, it is your time to put together an educational program for your district based on the positive parts of these educational options.

Use your problem solving skills to identify challenges that need to be considered, select an underlying problem and complete the problem solving process to arrive at an action plan.

Good luck, my friends.
Your future is a mystery! Do you want a clue as to what that future may be?

Few things give us clues to our future like genetic testing. Over the last thirty years, the public demand for genetic testing has grown a great deal, thanks to several breakthroughs in technology. Now in 2040, genetic tests have become very common to help identify issues of personality/intellectual development that may affect how people plan their future.

The Boddy Memorial Genetic Testing Lab is an independent laboratory dedicated to the advanced study of the human genotype. Located in the state of Oregon, USA, the Boddy Lab provides genetic tests throughout North America. Current technology requires a great deal of advanced knowledge; therefore, independently-owned labs often choose to specialize in the type of genes they study. The Boddy Lab is very well known for the study of genetic patterns that influence how a person's mind develops; it especially focuses on the gene combinations that influence personality/intellectual development. Although expensive, genetic testing reports from this lab can have many different applications . . .

Mr. Green stood before a judge waiting to be sentenced for murder. Miss Scarlet, Green's lawyer, argued that the results from the Boddy Lab indicated Green had inherited a combination of genes linked to violent behavior. Therefore, Miss Scarlet maintained that his sentence should be reduced on the grounds of a mental disability. Police records often include genetic test results that show possible personality problems. Hoping to decrease future crime, police may also keep genetic testing records on a criminal's children as they also may exhibit violent tendencies.

Professor Plum from his private school in London examined Boddy Lab's genetic test results showing that a high percentage of the school's new applicants had a predisposition toward reading disorders. It is not unusual for exclusive private schools to require genetic testing for families who apply. The results are kept on file if the child is accepted as a student.

Mrs. Peacock from New South Wales contacted the Boddy Lab to have genetic testing done on her newborn. Many parents choose to have their children genetically tested at birth hoping to identify their children's possible hidden talents that may not be obvious at a young age.

Colonel Mustard, local military recruiter, discussed the Boddy Lab reports of recent potential recruits with other military officials. Genetic testing is often required for people who want to join the military or serve the public, like firefighters or police. Test results are most often used to forecast how a new recruit may react in a stressful situation.

The Boddy Lab can only provide clues about how a person's personality and intellectual development is influenced genetically. Your assistance is required to anticipate the major challenges entailed in attempting to forecast a person's future through genetic testing. Work through the six-step problem solving process to create an action plan that addresses the work of the Boddy Lab's genetic testing for personality/intellectual development.
The Creative Problem Solving Process

Research and Analyze the Situation
(community issue, Future Scene, events in a story, historical event, etc.)

1. Identify Challenges

2. Select an Underlying Problem

3. Produce Solution Ideas

4. Select Criteria

5. Apply Criteria to Top Solutions

6. Develop an Action Plan
**Topic Specific Publications**

**Readings, Research, and Resources (R, R, & R)**
Summaries of articles on current year topics, questions for discussion, and terms and definitions

**Questions and Answers for Readings, Research, and Resources**
Over 600 questions and answers on cardstock or electronic; a useful supplement for R, R, & R

**Topic Activity Units**
Lessons focusing on the FPS model, research, thinking tools; practice Future Scenes

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**Curricular Publications**

**The Problem Solving Experience: Classroom Curriculum**
Activities to provide direct instruction or cross curricular implementation to the creative problem solving process and provide practice through the application of problem solving in a variety of contexts; may be taught as a full semester course or spread across 1-4 years
Target audience grades 5-8
2011 Edition

**Problem Solving Across the Curriculum**
Future Scenes categorized by topic with an informative guide and background information
2007 Edition

**TIPPS - Terrific Ideas of Practices & Procedures For Success**
TIPPS to celebrate creative thinking ideas - a collection of activities by FPS coaches
2008 Edition

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**Global Issues Problem Solving**

**Coach’s Handbook**
A comprehensive overview of Future Problem Solving with the problem solving model, tips for teaching, and information on evaluation in a binder-ready format
2011 Edition

**Student Guide Workbook**
For use with the Coach’s Handbook Explains each of the six steps involved in the problem solving model; includes generating and focusing tools

**Problem Solving Process Pointers for Students**
A more comprehensive workbook for practice in the problem solving process
2010 Edition

**Evaluation Primer for Global Issues Problem Solving**
A step-by-step evaluation guide for Global Issues Problem Solving component; a useful tool for FPSPI newcomers, seasoned evaluators, coaches, and students
2011 Edition

**Global Issues Problem Solving Team and Individual Champions 2016**
IC champion booklets and evaluations - teams and individuals

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An introduction to creative problem solving and higher-level thinking skills for the classroom teacher and students; authentic learning situations engage students in meaningful work
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Scenario Writing Champions 2016
Top five scenarios from each division in FPSPI’s 2016 International Scenario Writing Competition; read the best of the scenarios from around the world and see what makes them champions

Essential Publications

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Creative problem solving tools specifically designed for most FPS components (Global Issues Problem Solving, Community Problem Solving, and Scenario Writing)
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A guide to help middle and high school students effectively use future studies concepts
2007 Edition