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Motivation to Train for Creativity

Nina Sacco

University of Connecticut - Storrs, Nina.Sacco@gmail.com

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Nina Sacco

University of Connecticut- Storrs, Nina.Sacco@gmail.com

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**Nina Sacco
University of Connecticut**

**Thesis submitted in partial fulfillment of the
requirements for the Honor's Program at the
University of Connecticut.**

**Connecticut
May 2011**

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1. ACKNOWLEDGEMENTS

I have always considered myself a creative person. When I was younger I loved constructing arts and crafts, and finding solutions to futuristic problems. My passion for ingenuity led me to pursue a degree in Management with a concentration on Entrepreneurship at the University of Connecticut, in hopes of one day opening up my own business. During my senior year I was offered the opportunity to work with a non-profit organization, the Connecticut Invention Convention (CIC), which promotes creativity in elementary, middle school, and high school students. I knew this was the perfect chance to help this organization implement creative skills in children across Connecticut. After careful analysis it became evident that the CIC needed to uncover how to effectively motivate teachers to train their students to think and act creatively. I decided to use this thesis as an opportunity to help this organization grow, while simultaneously adding to my knowledge of the creative process.

My thesis would not have been possible without the help from my thesis advisor, Nora Madjar. Thank you for allowing me the unique opportunity to work with this non-profit organization, as well as dedicating your time and wealth of knowledge to assist me. I would also like to thank Neda Ahmaripour, Nikolay Kolev, Shana Mueller, and Charlotte Thomas, for their insights and advice on this topic. Additionally, I want to extend my gratitude's to my family and friends whose patience, love, and support helped motivate me each day throughout my four years at UConn. Finally, I am forever grateful to the University of Connecticut School of Business, and the Honor's Program, for giving me the

chance to explore a topic I believe deserves attention.

2. ABSTRACT

Creativity among United States citizens is on a steady decline despite the overwhelming evidence that creativity is a crucial skill in the professional world (Zacko-Smith, Puccio, Mance, 2010). Educational organizations, such as the Connecticut Invention Convention (CIC) and other non-profit educational organizations, have been dedicated to increase the presence of creative problem solving and innovation through STEM-based learning and inventions in various schools in Connecticut. To promote the existence of these organizations in hopes of countering the current nation's lack of focus on creativity, this thesis examines teacher's motivation to be involved in their programs and to train their students on how to think and act creatively, and how to make inventions.

3. INTRODUCTION

In a country where the amount of technical information is doubling every two years, teachers are not able to teach students the exact skills they will be using upon their entrance in the workforce in twenty years (Peter, 2010). Due to this fact, it is essential for teachers to foster the development of essential skills such as creativity and innovation that will prepare the students for their future careers and challenges, in addition to training them in the specific vocational skills (carpentry, and information technology) and basic functional skills (writing, and mathematics). Creativity is defined as “the tendency to generate or recognize ideas, alternatives, or possibilities that may be useful in solving problems, communicating with others and entertaining others” (Amabile, 1996; Franken, 2007). Innovation is defined as “the process of creating new ideas and putting them into practice” (Wiley, 2009). Performance of these behavioral skills (creativity and innovation) is necessary across all professions and is relatively timeless.

Corporations also recognize the importance of these skills and IBM recently polled 1,500 CEO’s of large corporations and found that creativity is seen as the number one “leadership competency” of the future (2005). Since so much value is placed on this skill, organizations not only seek candidates who already possess this talent, but additionally train their employees to improve their problem solving abilities. However, value is not only placed on creativity at the corporate level. There is a societal trend to implement these skills in

students while in school in order to potentially help them in their professional careers.

Creativity is helpful to students not only for their long-term future but for their current development as well, as a recent study of 1,500 middle schools found that students with high creative self-efficacy, had more confidence in themselves, and in their ability to succeed in all facets of life (Bronson & Merryman, 2010). Therefore teaching lessons in innovation will actually make students more comfortable with confronting problems where there are more than one possible answer, or situations where there are alternative choices. As noticed by these statistics, creativity is a necessary component in individual's lives both for personal self-esteem, as well as professional career skills. Now that one can identify these skills as essential, one can look at the importance placed on them at both the international and national level.

A. CREATIVITY IN THE UNITED STATES

In the United States, unfortunately, not enough importance is currently placed on these critical skills according to Kyung Hee Kim, a researcher at the College of William and Mary (2010). Kim states that creativity in American children has been steadily decreasing since 1990. As seen in "Education in China v. America: The Question of Standardized Tests" by Huffpost Education many believe that this decline of creativity is due to the shift in focus of the education system to increasing standardized test scores to meet school and

national levels (2011). Other experts indicate this decrease is in part due to a teacher's lack of knowledge as to what practices encourage the development of creativity. Whatever the cause may be, the problem is still pertinent, and it is important to identify the factors that motivate teachers to train for creativity. Various research studies have been conducted on this subject, however this relationship is quite complicated, and demands further investigation.

Richard Florida, author of *The Rise of the Creative Class*, recently ranked the United States second in the world in creative ability based upon three factors: talent, technology, and tolerance (2002). Additionally, the United States ranked low in the growth of creative capacities. This indicates that although they are historically known for their emphasis on creativity, the U.S. has not made tremendous efforts recently to increase creativity at a national level. Although it is important to analyze creativity at the national level, one can also break creativity down by state, as some regions have more resources available to them to promote the discovery of new ideas and processes.

B. CREATIVITY IN CONNECTICUT

Forbes recently created a list of "The 15 Most Creative States" based upon number of patents per capita (2011). Connecticut was ranked eighth, with 11% of patents issued to individual inventors, and 150 individual patents in 2008. Although this ranking is impressive based upon the geographical size of the state, and the number of technology based companies, it is important that the

state continues to support this coalition toward creativity by enforcing problem solving and the increase of innovative thinking through open-ended questions. Such methods of creative thinking need to be introduced and reinforced from the start, in both elementary and middle school levels via teacher to student interaction. By teaching creativity to young students it will be implanted in their primary set of skills and will be part of their nature to use them. Being creative since one is young could also influence individuals' ability to pass this skill on to future generations. To ensure that students are exposed to creative problem solving and trained in creativity and invention, it is very important to examine what motivates teachers to involve their students in these activities, especially when they are not currently part of standardized tests or requirements.

C. IMPORTANCE OF STEM EDUCATION

Davis and Bull (1978), Clapham (1997), and Greer and Levine (1991) have indicated that college students who have been taught and were able to demonstrate creative problem solving, tested as significantly more creative. It was also found by Kazerounian and Foley (2007) that subjects such as engineering and the biological sciences often stunted student's creativity as they limited solutions to one or two specific and correct answers, rather than allowing students to combine their knowledge, and their intuition to answer an open-ended question.

These findings were consistent with the 2007 “Are We Beginning to See the Light” survey conducted by the GE Foundation of 1,400 participants nationwide to identify where the disconnect is between children’s education, and performance on STEM (Science, Technology, Engineering, and Mathematics) related activities. The survey found that 90% of those surveyed said that science and math skills are needed even if one does not go into a STEM based career. This finding is critical, and should be taken into consideration by the Department of Education, as the 2007 ACT College Readiness Report has also found that only 43% of high school seniors are ready for college math, and 27% are ready for college science. Based on this information, our current elementary, middle school, and high school educational curriculum has not been the appropriate breeding ground for STEM related creativity. Foretelling this need, the survey also questioned what the most effective method to fix this disconnect is in education. In response, 80% of participants said a national curriculum in math is necessary, and 78% said a national curriculum in science is necessary.

As recently as November 23, 2009, President Obama announced the launch of a new campaign, “Educate to Innovate” which focuses on achieving and promoting excellence in science, technology, engineering, and math education. Stating that “Reaffirming and strengthening America’s role as the world’s engine of scientific discovery and technological innovation is essential to meeting the challenges of this century.” Obama stated that STEM education is his new “national priority”. In order to tackle this national problem, he created a

multi-phase plan to be implemented in the next ten years. This plan outlines partnerships with various corporate leaders to donate 260 million dollars of funds and in-kind gestures, as well as identifies the need to recruit famous individuals who hold STEM careers to raise awareness, and excitement. Finally, Obama instituted a “Day at the White House” where students from all over the country go to display STEM inventions and projects they partook in and meet politicians and various math and science professionals. This campaign will bring American focus on the importance of STEM education, and will reward schools that make a conscious effort to introduce these topics into their curriculum.

i. Creativity in STEM Education

The National Science Education Standards state that students “must appreciate the wonder of the natural world and understand the relationships between form and function” (2010). By introducing creativity into STEM lessons, it allows students the unique opportunity to demonstrate the real-world application of the science and math knowledge they have acquired. Integrating creativity into these subjects, allows teachers to provide their students with fundamental knowledge while simultaneously building upon their problem-solving skills by proposing analytical problems. Both this understanding of STEM and exposure to creative methods will benefit the student in any potential future careers.

ii. Programs that Support STEM Education

Based on this initiative, the United States Department of Education, and the National Science Foundation have come to endorse various STEM programs with the STEM Education Coalition. Due to the increase in interest in STEM Education various not-for-profit, and for-profit organizations have been created across the country. These organizations seek to provide children with multiple opportunities to express their creativity by participating in various activities ranging from building their own inventions to reading future scenarios and providing potential problems and solutions. Often times these associations provide lessons to students during the day in the classroom, but there has recently been a shift to after-school and camp programs.

A few prominent programs that support STEM education, and have penetrated the Connecticut market include: The Connecticut Science Fair, First Robotics, Future Problem Solving, and Junior Achievers. Although different in focus, as some center around critical thinking and problem solving skills and others around building entrepreneurial and marketing skills, these organizations strive for the same goal: to aid in educating students on the process of creativity. For a complete list of STEM related organizations as well as their primary offerings see Appendix 1A.

4. PROMOTING CREATIVITY

Now that these organizations and leaders have established a need for creativity in the classroom, it is pertinent that they implement practices to promote and drive the creative process. Since teachers are responsible for imparting knowledge on students by instructing and educating them throughout their schooling, it is natural that these individuals should be the driving forces behind this initiative. It is essential that we analyze the factors that motivate teachers while creating lessons and the obstacles that hinder elements of creative activities in the curricula. We can then leverage this knowledge to encourage teachers to institute lessons on creativity.

A. MOTIVATION TO CREATE

Motivation is an internal state or condition that activates behavior and gives it direction (Kleinginna & Kleinginna, 1981). Often motivation is dichotomized as either intrinsic or extrinsic. Intrinsic motivation is the process of arousal and satisfaction in which the rewards come from carrying out an activity rather than from a result of the activity. In this case the sense of achievement is satisfied by one's own feelings of happiness. Extrinsic motivation is when behavior is governed by sources of control originating from the respondent's environment (e.g., reward or punishment) (Beswick, 2011). There are various types of external rewards ranging from monetary awards, to tangible resources. Individuals can display different types of motivation based upon the varying situations they encounter. By examining the form of motivation

needed for teachers to administer lessons on creativity to their students, one can use this knowledge to motivate as many teachers as possible, therefore introducing creativity to the widest audience of students.

i. Previous Research on Intrinsic and Extrinsic Motivation

One thing most educational researchers agree on is that teachers are primarily intrinsically rather than extrinsically motivated. By placing values on such factors as the quality of performance of their duties rather than on their monetary rewards, teachers look inward for self-satisfaction. A revealing study by Pastor and Erlandson stated that there are three main factors which teachers strive to achieve, and act as motivational reinforcement, “experienced meaningfulness, responsibility for outcomes, and knowledge of results” (1982). Using these findings to motivate teachers to train for creativity, one must first demonstrate how creativity is meaningful by providing teachers with a task that will deliver measurable results. Secondly, one must indicate how influential their lessons are on their students, as well as the impact of delivering a lesson on creativity would be. Finally, one must provide the teachers with the results of the task allowing them to visually see the impact they made.

A common method to stimulate student learning and boost creative thinking and open-ended problem solving is to hold a science fair or similar educational program. These programs often challenge students to create an original invention or project which would solve a problem or answer a question proposed to them. Utilizing the methods of teacher motivation outlined by Pastor

and Erlandson, not only would students benefit from participating in a program that pushes them to discover new concepts and pair their imagination with their knowledge but it also would provide self-satisfaction for teachers. This intrinsic motivation would only be achieved if the teacher found meaning in the program, felt a sense of responsibility, and were able to see the results of the program. By choosing a program which attempts to increase creativity and innovative thinking among children, and then assessing why teachers had decided to implement such a program in their classroom, as well as analyzing the driving forces behind this decision, one may either support or refute Pastor and Erlandson's findings. Additionally, one can assess the aspect of psychological safety, how safe and comfortable teachers feel engaging students in creative activities.

In support of Pastor and Erlandson's findings, "conscious capitalism", a term coined by Dr. Raj Sisodia of Bentley University, is when passion is the singular factor that drives an individual to perform well (2007). He explains this concept in his book, Firms of Endearment, as he analyzed the shift in company's focuses to providing social value and employing individuals who are able to display a similar character of excitement and pure enthusiasm. His model would state that teachers should stray away from the typical command-and-control style of teaching and instead focus on counseling, inspiring, and motivating their students.

Recent empirical research by Jing and Shalley in *Handbook of Organizational Creativity* has also supported this need for intrinsic motivation

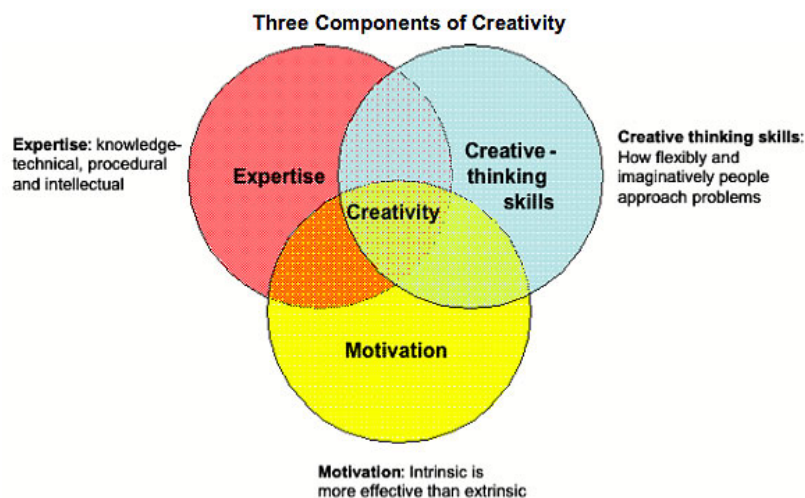
but has recognized the impact of pairing extrinsic rewards to reinforce the behaviors that were intrinsically instigated (2008). However, it is important to note that these extrinsic rewards act as aids rather than the sole motivating factor. Too much attention on a reward may cause the receiver's attention to be displaced to the end result rather than on the process leading up to the result. Therefore undermining the self-motivation one is striving to achieve, and having the opposite effect.

Paulo Freire's, a Brazilian educator, wrote the Pedagogy of the Oppressed based on Marxist critical theory which analyzes the relationship between a teacher, student, and the society (1972). The new relationship he proposes is one which debunks the "banking model" of education which claims that students are a clean state and "bank" the information fed to them by instructors. Freire cites that this model is flawed in its ideas that the teachers hold all of the information and the students know nothing, and because it assumes that humans just ape behaviors and merely adapt to situations they confront. He proposes that learning is instead a two-sided relationship that is fed and nurtured by both the teacher and the student that is centered on constant feedback and interactive learning. The student must be conscious of their incompleteness, and actively work to fill the knowledge gaps that exist. This problem-posing education views the world as a clean slate, which the student can discover by questioning the realities they perceive. The student could also be the driving force and the motivator for the teacher to engage in different activities.

As seen through this past research, although intrinsic motivation is necessary to stimulate creativity, the motivation to train for creativity may need to be coupled with extrinsic motivators such as time to grade creative projects, leeway in curriculum development, and recognition for creative encouragement. Doing so will maximize teachers motivation to train for creativity and not only to be creative themselves.

5. CURRENT CREATIVITY MODELS

Based on this empirical research, psychologists, educators, and businesspersons alike have created various models that incorporate motivation in an attempt to define and explain creativity. The Head of the Entrepreneurial Management Department at Harvard Business School, Teresa Amabile, created a three-part model for creativity (1996). As pictured below, this model stresses the importance of combining knowledge, creative thinking, and motivation.



First, one must contribute expertise. In order to produce unique and original ideas, one must first have the foundation to generate said ideas. This foundation is created through learning: a relatively permanent change in behavior or behavior potentiality that results from experience (Ormrod, 1999). Since each human encounters different experiences, every perspective is different, and is constantly being shaped and evolved with each passing day. Therefore, by providing students with occasions in which they build upon their pre-existing knowledge, and create new memories, and pockets of information, one is contributing to their creativity. These experiences, new and old, will later act as forms of inspiration, as students work to piece together what they know, and what they want to know to think about a topic critically.

Second, creative-thinking skills are necessary. These skills allow an individual to be adaptive and innovative while approaching problems. Although malleability is not a skill that can be taught, it is a skill that can be promoted. Teachers can allow students time specifically designated to the stimulation of ideas. By putting time aside, this instills in students that creativity is a process that must be worked toward. Teachers could also expose students to tasks that require thinking outside of the box and the generation of multiple ideas – activities, which promote creative-thinking skills and not just assignments with one correct answer. These kinds of open-ended projects may be harder to grade but have tremendous benefits for stimulating creative thinking skills. The third component of this model is motivation. As seen from the picture, the model

is centered on the need for intrinsic motivation to generate creativity and teachers could create and influence the atmosphere and context in the classroom to allow students to get intrinsically motivated.

Looking at the Venn diagram, where these three components meet is where creativity happens. Although the exact ratio of knowledge to creative thinking to motivation is not necessarily important, it is essential that there is some form of each component.

This model clearly conveys the message that creativity is a multi-faceted process that not only pulls from different areas, but also is unique to each individual. As found by K. Ferlic in *The Creativity Perspective* everyone needs time to find what their creativity looks like and how it desires to express itself for its expression will be different for each individual for we each are unique, infinitely creative being (2005). One individual may express creativity by putting together 10% knowledge, 50% creative thinking, and 40% motivation, and another may put together 50% knowledge, 20% creative thinking, and 30% motivation. Even if two individuals have the same ratio of each component, their expression of creativity will still be different as they have different encounters with knowledge and experiences.

Another model for creativity designed by Graham Wallas, a creativity strategist adds to this model focusing on the stages in the creative process (1926). As pictured below his model consists of five components that need to be followed consequentially.



First, immersion is the process where individuals gain interest in a topic and become engrossed in learning more about a subject or topic. After the initial curiosity is generated, incubation happens when one must suppress their “logical” thinking, and instead free their mind to produce unstructured and naturally occurring ideas. Once they have liberated their minds it is time for verification. During this step one tests their creative solutions. They evaluate the effectiveness of these ideas by identifying if the solutions could be applied in the real world. The final stage, application, is when the creative solution, which was positively evaluated, is implemented.

Now, we can look at this model in terms of creativity generation in students. Based on this model, the teacher must allow the student to choose a topic, which they find interesting, and would like to research and think about critically. These topics may differ from student to student. To stimulate intrinsic motivation, it is important that the teacher does not provide the topic but instead

supports each student and their individual passions. Once the student has picked the appropriate topic, the teacher must encourage free thought, and discourage structured thinking. The teacher can do so by conducting classroom exercises to allow students to express personal opinions. Once resolutions are formed, the student should be encouraged to reflect on whether or not the solution could be viably applied in the real world. Teachers can tell them to self-reflect, as well as collaborate with others to talk about the potential application of their solution. Finally the student can actually test the solutions they created by applying them. If a teacher is having the student think of an invention, this is when the student would be asked to create the invention. Once created the student should then be told to analyze whether this was the most effective solution to the problem they were attempting to solve, or if hindsight has provided them with better insight into another solution.

I must reiterate that these are not the only two models of creativity. Looking at these models side by side it is also important to note that although they do not use similar vocabulary, and differ in the number and sequence of steps, the basis of both models is comparable. They state that creativity is an ongoing process that is affected by every event and experience an individual encounters. Therefore both models stress that creativity is unique to each individual. They also note that an initial knowledge base is critical, as one cannot construct ideas without a foundation available for comparison and derivation reasons. By looking at other creativity models in Richard Greene's meta-analysis *60 Models of Creativity*, it is apparent that these factors are consistent

throughout all models regardless of the profession of the creator, or the age of the model (2004).

6. Training for Creativity

These models establish creativity as a process that must be learned, applied, and continuously nurtured. Instructing students on this complicated process does not come easily, which is why teachers should be properly taught how to train for teaching creativity to their students. In order to assess what motivates teachers to train for creativity, common methods used, resources needed, problems one may encounter, and benefits, we will look at a current STEM related program, the Connecticut Invention Convention.

i. Connecticut Invention Convention

One of the most notable Connecticut based organizations dedicated to STEM education, is the Connecticut Invention Convention (CIC). This non-profit, educational organization has been promoting creativity and problem-solving skills for local children in grades kindergarten through eight grade for over 28 years. Children who participate in this program undertake real-life problems with their inventions and learn important skills that nurture interest in STEM (Science, Technology, Engineering, and Math) as well as interest in propriety rights, and business and entrepreneurship careers.

A. METHODS OF RESEARCH

I am attempting to use current research on creativity, and the documented need for creativity based organizations in Connecticut to understand how to motivate others, primary elementary and middle school teachers to train their students for creativity. This information is important, as creativity is a talent coveted in most businesses. Rather than waiting to receive this training on the job, teachers can provide students with this skill, to present to potential employers as part of the skill set they can provide upon their hiring.

Based on the literature for what is necessary for creativity, what makes teachers involved in STEM extracurricular activities, and what determines their motivation, I conducted semi-structured interviews with teachers participating in the CIC. Interviews for this research were held with teachers in different schools throughout the state. The teachers were either classified as those who were new to CIC, or those who had previously participated. Interviewees held various titles within the education system from kindergarten teacher, to enrichment teacher, and museum director. These teachers represent a diverse group of the population, as they had varying levels of experience, different experiences with CIC, and diverse views on the creative process.

B. WHAT MOTIVATES TEACHERS

After conducting ten, twenty-minute phone interviews with teachers who have participated in the CIC, as well as speaking to the president of the CIC, and conducting secondary research in the management, organizational behavior and education literatures, I identified various factors that contribute to teacher's motivation to train for creativity as summarized in Table 1 Appendix 1B.

i. Teachers' Own Previous Participation in Creative Programs

One major factor that influences teacher's motivation is their previous involvement in creative programs. Their participation, or lack of participation, aids in shaping their perceptions of the importance of these programs. A study by Hong, Hartzell, and Greene in 2006 recently found that teacher's beliefs structure how they format their classroom instruction. If a teacher has had a good experience as a program participant they are more likely to institute that particular program or the subject matter of the program into their own curriculum. If however, a teacher does not have a good experience with a program, they will not only stray from having their students participate in said program but will also place less value on the program subject. To supplement this research, of the teachers interviewed, half had participated in a science-related program as a student, which inspired them to integrate the CIC into their current curriculum. Additionally, a separate study of 178 elementary school teachers of third, fourth, and fifth graders, noted that teachers with advanced beliefs on knowledge, and high intrinsic motivation were most likely to include creativity instructions in their classroom lessons (Hong, Hartzel, & Greene,

2009). These advanced beliefs on knowledge were often attributed to past experience regarding the subject matter being taught.

ii. Teachers' Understanding of the Positive Effects on Students who had been Uninterested in STEM Activities

Once a teacher has successfully implemented a creative program, they are able to observe and measure the effects on their students. If a teacher witnesses a student they had labeled uninterested in STEM activities based upon past performance, thrive and become stimulated by the creative activity, they will be more likely to implement the lesson again in the future.

Women are often classified as students uninterested in STEM activities because of American societal norms that discourage them from entering into math, science, and engineering related fields. In a study designed to identify various ways to generate creative interest among women and other minority students, Kanter and Konstantopoulos discovered that the project-based method of teaching is more effective than simple instructions (2009).

Project-based science contains an inquiry aspect and a realization of the real-world utility of science and its relevance to everyday life, which should improve student's attitudes towards science as well as their achievement. Teachers who implemented more hands-on activity saw a higher rate in minority student's self-efficacy in regards to STEM-related activities.

iii. Teachers' Awareness of the Importance of Creativity in the Current Workforce

In various focus group interviews, teachers admitted the primary factor that motivated them to teach creativity to their students, was due to the country's current shift toward the promotion of innovation and team creativity. Two teachers felt it was their "duty" to properly prepare their students for the current workforce, and doing so required them to teach problem-solving skills in collaborative settings. Since teachers themselves saw a shift in their own professional roles toward more ingenuity and innovativeness, they found it essential to provide students the opportunity to develop these skills.

iv. A Mechanism to Establish Themselves as Teachers

Interestingly, Susan A. Hildebrant and Minhee Eom in a study entitled, *Teacher Professionalism: Motivational Factors and Influence of Age* uncovered that external factors of validation (i.e. receiving acknowledgement from their superiors) served as a driving force for teachers in their 30's (2009). These teachers are often labeled passionate, and proactive, and will engage in activities they believe will benefit their students while simultaneously publically demonstrating their effectiveness in the classroom. It is important to note that this specifically refers to teacher's age 30 and younger, as this external validation exists due to their novel position in the educational hierarchy, and their desire to have their voice heard and taken seriously among more elder teachers.

v. Influence from Other Teachers

Despite all of the other motivating factors, when it boils down to it, teachers are human beings who possess a psychological need to relate to their peers. Therefore, when teachers interact, if one is passionate enough about a creativity program they feel has positively impacted their student population, it will influence other teachers to implement a similar program. It has been found that, “Teacher collaboration is an integral part of teacher professional development” (Grant & Murray, 1999). By teaching a program that is also being taught by one’s peers they have the chance to meet and discuss the effectiveness of the program, as well as any challenges and opportunities that have arisen. Another study conducted by Ziempher and Rieger in 1988 portrayed the importance of mentors in influencing teachers to modify and strengthen their curriculum. This experienced figure could guide a teacher to implement a program by sheer suggestion alone.

It is important to note, that although these factors of motivation have been identified, a teacher may be influenced to train for creativity by a combination of these factors, rather than one alone. Additionally, it may be the case that the motivational factor which once acted as a catalyst in their participation, has changed and adapted over time, causing them to identify a different factor as the root of their motivation.

B. METHODS OF TRAINING FOR CREATIVITY

Once I identified factors that determine what motivates teachers, the next step was to examine what are the methods that will allow the motivated teachers to in fact train for creativity in their classrooms.

i. Establishing a Knowledge Transfer

Thomas Edison's formula for creativity is one percent inspiration, and 99 percent perspiration. But is it as simple as that? Can one train for creativity by a small amount of inspiration, and a lot of hard work? The answer is no, creativity training must involve a knowledge transfer. This transfer according to Form, Cameron, and Dennis in *Creative Actions in Organizations* "occurs when an individual learns something in one context and applies it to another" (1995). This method of instilling knowledge into a student by exposing them to generic information, and then giving them the opportunity to solve a problem using this base knowledge and their own innovative ideas is an effective educational method. This technique is one that has been cultivated and practiced for years in various educational organizations.

ii. Providing Students with Appropriate Information

Another method of increasing creativity training in both the workplace and the classroom is providing the employee or the student with as much information as possible from all departments they will encounter. For example, to increase the creativity of a student and their performance on a task, the trainer can provide the student with the knowledge of the subject needed. Additionally, they can fine-tune the skills needed to answer said question, whether it be the ability to voice their idea with communication skills, or critically analyze their proposed solution. By allowing the students to practice their problem solving techniques, and therefore practice generating creative ideas, the students when faced with a new problem will be able to reflect back on previous solutions and become more confident in the creative process. This pre-existing database of creativity will act as the foundation for future creative ideas.

iii. Creativity in Teams

As mentioned earlier, businesses in the United States, are moving to a team model, in which all employees collaborate across departments on projects, bringing their departmental expertise, as well as their individual and personal opinions and ideas. Idea exchange is identified as “a cognitive process in which individuals share knowledge, perspectives, and beliefs which are based on their unique experiences and education.” (Zhou, Jing, & Shalley, 2008) Group brainstorming allows various ideas to be shared, and then after reflecting upon

ideas which one may not have thought of on their own, one may spawn another new idea. Often it allows an individual to view the task in another dimension they may not have previously considered, and this fresh perspective will allow them to take a new approach to the given situation.

As seen here there are various factors that can aid in creativity. But, which factors are most important? How do we determine these factors? In 1993, Woodman and colleagues tried to answer these questions by establishing a model that places importance on culture, resources, technology, strategy, and rewards to creativity. Researchers found that these factors, when manipulated properly, could help improve creativity. Although these factors are believed to be primary influencers independently they carry the most influence when they are strategically combined.

D. RESOURCES NEEDED

In addition to factors that stimulate motivation to train for creativity there are some that could actually present obstacles. In order to employ these methods, we must provide teachers with resources needed that will stimulate creativity among their students.

i. Space

To participate in a program that promotes creativity, teachers need the physical space to implement their lessons. Sarah Komendat of Buffalo State

College wrote, “Creative Classroom Designs”, which outlines various classroom designs to promote both learning and creativity among students (2010). Based on her research of classrooms in Lancaster, NY she outlined six classroom setups for students in grades 1-6. The designs included such elements as table shape, rug position, and the establishment of “creative centers” strategically positioned within the classroom. Although it is important to note that creativity can be derived anywhere, there are certain atmospheres which can facilitate this process.

ii. Training

In order to feel comfortable with the material they are instructing, teachers should receive proper training to promote creativity. This training should 1) Reiterate the importance of teaching creativity 2) Teach the instructor how to implement the curriculum to generate creative responses, 3) Provide the instructor with resources to aid in their lessons and the opportunity to ask questions, and 4) Give instructors the opportunity to be creative themselves, demonstrating the importance of the lesson. Since collaboration among teachers is a high motivational factor this training period would allow them to work with other instructors to bounce ideas off of one another, and build connections that they can later call upon if they have questions or want to share success stories.

iii. Outside Facilitator

In addition to training, the program can provide the instructor with a certified outside facilitator to aid in teaching the lessons. This facilitator would not be present for each lesson, but would instead act as a guide and mentor when needed. If the instructor has experience in the science, or engineering field, they may be called upon to explain any technical lessons the teacher may not be comfortable teaching.

iv. Developed Lesson Plans

One key finding from my research is that most teachers demand a curriculum that is grade-appropriate they can follow when instructing a course. A non-profit organization dedicated to educating youth, Junior Achievement, has created a five-unit curriculum plan concentrated on various topics from “Community and Economy” to “Business Management”. These units include various lessons as well as the concepts these lessons are trying to portray. *FIRST* also has targeted curriculum, which teachers are able to search based on the grade level, standards addressed (both national and state), number of lessons needed, and cost of supplies. Providing this variety of lessons allows the teacher to pick the appropriate lesson based on the needs of the students, while simultaneously satisfying the requirements of the school.

E. POTENTIAL PROBLEMS

Teachers also identify problems or issues that have prevented them from teaching creative lessons as seen in Table 1 Appendix 1B.

i. Lack of Knowledge on How to Assess Students

Since creativity varies from student to student, and is subjective in nature, teachers are often fearful and uncertain on how to properly assess performance. It is also difficult to compare grades of students when the subject matter of their project is drastically different. Teachers need to be properly trained to assess effort and technique in such a way that is fair across various genres of projects. Additionally, teachers must learn how to encourage students in their assessment to achieve higher levels of creativity in future projects rather than discourage them, which could potentially stunt their creativity.

Despite the growing knowledge of creativity, there are still not proper national systems in place to assess student's efforts in creativity, as the range of ideas are too broad, and the assessments are currently based on opinions.

ii. Own Lack of Comfort with Creativity

Another limitation teachers may face is in their own comfort with creativity. If teachers have had very little instruction on creativity themselves, they may not feel adequately prepared to teach lessons that promote creativity. During CIC's teacher training workshop, teachers were given the opportunity to learn a lesson of creativity on their own called "Take Apart Lab". During this lesson they

were given ordinary technological household objects that no longer worked, and were told to think about the components that make up this invention. They then were given the opportunity to take the item a part using tools and talked about the mechanisms found in each object. Although the teachers seemed engaged and excited during the lab itself, afterwards when asked if they would feel comfortable teaching this lesson to their class, many seemed apprehensive. One teacher in particular said that he would not be replicating this session as he was fearful a student would ask him what a particular piece of an object was, and he would be unable to answer. Even though these teachers had identified this lesson as one that would be beneficial to their students, their own nervousness would prevent them from sharing it with their students.

F. BENEFITS

If teachers were able to overcome these problems, and successfully train their students, they would experience various personal and professional benefits.

i. Seeing their Students Succeed

By instilling creativity in their students, teachers will have the opportunity to watch their students succeed in various areas in life. Corporations recognize

the importance of this skill, as IBM recently polled 1,500 CEO's of large corporations and found that creativity is seen as the number one "leadership competency" of the future (2005). Since so much value is placed on this skill, organizations not only seek candidates who already possess this talent, but additionally train their employees to improve their problem solving abilities. However, value is not only placed on creativity at the corporate level.

Creativity is also helpful for student's current development as well, as a recent study of 1,500 middle schools found that students with high creative self-efficacy, had more confidence in themselves, and in their ability to succeed in all facets of life(Bronson & Merryman, 2010). Therefore teaching lessons in innovation will actually make students more comfortable with confronting problems where there are more than one possible answer, or situations where there are alternative choices. As noticed by these statistics, creativity is an essential component in individual's lives both for personal self-esteem, as well as professional career skills.

ii. Seeing their Students Engaged

Not only will creativity be beneficial in the long-run for their students, but also in implementing lessons that encourage brainstorming, open-ended thinking, and group work, their students will be more actively engaged. Project-based, hands on learning, has shown to have a higher rate in student's self-efficacy in regards to STEM-related activities.

iii. Using the Invention Process to Appeal to Minority Students

Women are often classified as students uninterested in STEM activities because of the American societal norms that discourage them from entering into math, science, and engineering related fields. In a study designed to identify various ways to generate creative interest among women and other minority students, Kanter and Konstantopoulos discovered that the project-based method of teaching is more effective than simple instructions (2009). Project-based science contains an inquiry aspect and a realization of the real-world utility of science and its relevance to everyday life, which should improve student's attitudes towards science as well as their achievement.

7. CONCLUSION

Based on my research, I have identified key factors in regards to motivating teachers to train for creativity. In brief, I found that teacher's participation in creative programs, their understanding of positive effects on students who had been uninterested in STEM activities, teacher's awareness of the importance of creativity in the current workforce, creativity as a mechanism to establish themselves as teachers, and the influence from other teachers are primary motivators of teachers. Although these factors can motivate teachers, obstacles are still present regarding lack of knowledge on how to assess students, and teachers own lack of comfort with creativity. These obstacles can be overcome

by providing teachers with various resources such as space, training, an outside facilitator, and developed lesson plans, to aid in their ability to train for creativity.

i. Creativity is Key to the Future

The amount of technical information is doubling every two years; teachers are not able to teach students the exact skills they will be using in the workforce upon their entrance in twenty years (Peter, 2010). Due to this fact, it is essential for teachers to foster the development of essential skills such as creativity and innovation that will prepare the students for their future careers and challenges, in addition to training them in the specific vocational skills (carpentry, and information technology) and basic functional skills (writing, and mathematics).

ii. We are in a Creativity Crisis

In the United States, unfortunately, not enough importance is currently placed on these critical problem-solving skills according to Kyung Hee Kim, a researcher at the College of William and Mary. Kim states that creativity in American children has been steadily decreasing since 1990 (2005). Richard Florida, author of *The Rise of the Creative Class*, recently ranked the United States second in the world in creative ability based upon three factors: talent, technology, and tolerance (2002). Additionally the United States ranked low in the growth of creative capacities. This indicates that although they are

historically known for their emphasis on creativity, the U.S. has not made tremendous efforts recently to increase creativity at a national level.

iii. Teachers are Intrinsically Motivated to Train for Creativity

Teachers are primarily intrinsically rather than extrinsically motivated in regards to long-term motivation to train for creativity. By placing values on such factors as the quality of performance of their duties rather than on their monetary rewards, teachers look inward for self-satisfaction. Extrinsic rewards, such as monetary compensation, although alluring, do not emphasize the value of creativity to the teacher. Without this realization of value, the teacher will not promote and institute creativity-centered lessons.

Teachers can be encouraged to teach, and develop their students' creativity by being shown the positive impact creativity will have on their student's academic and professional careers in the future. Additionally, teachers will be encouraged if they see the impact creative lessons can have on a student's perceptions of STEM-related activities. The creativity process will be made simpler for both student and teacher if resources such as space, training, outside facilitators, lesson plans are provided beforehand. These intrinsic motivators should be coupled with extrinsic rewards such as more time to grade assignments, and more leeway in planning curriculum to create the desired outcome.

iv. Various Methods to Train for Creativity

One can establish a knowledge transfer as a method to teach creativity. This method of instilling knowledge into a student by exposing them to generic information, and then giving them the opportunity to solve a problem using this base knowledge and their own innovative ideas is an effective educational method. This technique is one that has been cultivated and practiced for years in various educational organizations. Teachers can also provide the student with as much information as possible from all areas of education. This pre-existing database of creativity will act as the foundation for future creative ideas. Finally, one can promote creativity in teams. Group brainstorming allows various ideas to be shared, and then after reflecting upon ideas which one may not have thought of on their own, one may spawn another new idea. Often it allows an individual to view the task in another dimension they may not have previously considered, and this fresh perspective will allow them to take a new approach to the given situation.

A. SUGGESTIONS FOR FUTURE RESEARCH

Since this topic is a relatively new phenomenon in education, research is still needed to solidify the best methods of motivating teachers to train for creativity. Research should also be conducted on other motivational factors such as teacher's realization of the importance of training their students to be

creative, as well as teacher's belief that training for creativity could make a difference. Additionally, the development of fair and accurate creativity assessment criterion for teachers to use may ease their apprehensions when grading creativity, and may entice them to incorporate more problem solving lessons into their curriculum.

8. APPENDIX

1A. STEM RELATED PROGRAMS

Program Name	Mission/Niche
Connecticut Invention Convention Odyssey of the Mind	<p>“Imagination in Play”, Enhance a student’s critical thinking skills through stimulating hands-on activities.</p> <p>The Odyssey of the Mind teaches students to learn creative problem-solving methods while having fun in the process. For more than twenty-five years, this unique program has helped teachers generate excitement in their students. By tapping into creativity, and through encouraging imaginative paths to problem solving, students learn skills that will provide them with the ability to solve problems -- great and small -- for a lifetime. The Odyssey of the Mind teaches students how to think divergently by providing open-ended problems that appeal to a wide range of interests. Students learn how to identify challenges and to think creatively to solve those problems. They are free to express their ideas and suggestions without fear of criticism. The creative problem-solving process rewards thinking "outside of the box." While conventional thinking has an important place in a well-rounded education, students need to learn how to think creatively and productively.</p>
Connecticut Science Fair	<p>Interest young people in careers in science and engineering through recognition for their science achievements and by providing opportunities for them to interact with engineers and scientists.</p>
First Robotics	<p>Inspire young people to be science and technology leaders</p>
Destination ImagiNation, Inc.	<p>Foster creativity and critical thinking. Learn and apply creative problem solving tools and methods. Develop teamwork, collaboration and leadership skills.</p>
Project Lead The Way (PLTW)	<p>A leader in the U.S. for providing activities, projects, and problem-based programs for middle and high school STEM education w/ a curriculum emphasizing critical thinking, creativity, innovation, and real-world problem solving.</p>
Connecticut Science Challenge	<p>Nation's oldest and most highly regarded science fair.</p>
Connecticut Junior Science and Humanities Symposium	<p>Includes guest lectures/tours, where students present their original findings.</p>

STEM Education Coalition	Support and strengthen science, technology, engineering, and mathematics learning and programs at all levels .
National Science Teachers Association/Connecticut Science Teachers Association	Promoting excellence and innovation in science teaching and learning for all.
Connecticut Center for Advanced Technology	Offers services to manufacturers, high technology firms, small business, entrepreneurs, educators, public policy makers.
Future Problem Solving Program International	Stimulates critical and creative thinking skills, encourages students to develop a vision for the future.
New York State Invention Convention	Stimulate the development of students' creativity and imaginations, thereby building a new generation of American inventors.
Project Invention Convention	
Massachusetts State Science and Engineering Fair	Increasing awareness of, exposure to, participation in inquiry-based learning through the development of science and engineering projects.
Mills Lawn School Invention Convention	Designed to promote problem-solving and creative thinking skills.
eeSmarts	Energy efficiency and clean, renewable energy learning initiative funded by the Connecticut Energy Efficiency Fund.
Invent Now, Inc.	Looks for new and creative ways to spread the inventive spirit, developing a range of creative products, programs and innovative partnerships that emphasize the importance of invention in society.
Invent Now Kids – Camp Invention	Nationwide, week-long camp program for children led by local educators and hosted at local schools; student participate in modules involve hands-on work as well as a high degree of teamwork.
Invent Now Kids – Club Invention (Afterschool Program)	Afterschool program to supplement STEM related learning; concentration remains on building problem solving and critical thinking skills as well as teamwork through open-ended discovery.
Collegiate Inventors Competition- "CIC"	Encourages, recognizes, and rewards students enrolled in a college or university to share their inventive ideas with the world.
Young Inventors International, Inc	Not-for-profit group that helps engineering and science university students develop skills and networks to bring new ideas to the market and also aims to help students looking to increase visibility (publicity) of their ventures

as well as those seeking funding opportunities.

Northeast Science Bowl	Science education and academic event for high school and middle school students to encourage student involvement in math and science activities, improve awareness of career options in science and technology, and provide an avenue of enrichment and reward for academic science achievement.
High Touch High Tech (HTHT)	To expose children, at an early age, to the amazing world of science and nature by providing innovative, educational, hands-on programs that are presented in a fun manner that nurtures their budding young minds and stimulate both their imagination and curiosity.
Multiply Your Options (MYO)	One-day conference for 8th grade middle school girls aimed at exposing girls to female role models in the fields of science, mathematics, engineering, and technology.
Connecticut Pre-Engineering Program (CPEP)	Through innovative out-of-school programs, CPEP serves as a catalyst to significantly change under-represented students' knowledge, attitudes and behaviors relating to the pursuit of STEM careers.
Pre-Engineering Program (PEP) -Part of CPEP	Students participate in the same hands-on activities listed on the CPEP website.
Explore Engineering (E²)	Participants work in small groups alongside faculty and college students to explore the various engineering careers available, learn and demonstrate engineering concepts, and participate in the Young Engineering Science Scholars Program (YESS).
Kids Are Scientists Too (KAST)	Summer STEM-focused program for students entering 5th through 10th grade.
International Science and Engineering fair (Intel , DOD)	At Intel ISEF, students are encouraged to tackle challenging scientific questions using authentic research practices to create solutions to the problems of tomorrow. Global Science Fair.

Star Base

STARBASE emphasizes experiential applications, student interaction, and problem-solving experiments. Students and teachers attend visit military bases for 20 to 25 hours of instruction in 13 topics. They learn and apply knowledge in team inquiry, then add reasoning processes to build understanding of applied science, math and technology. Facilities, simulators, and trainers are made available. Collaboration between military bases, school districts, and communities ensures the integration of instruction with state and local science and math objectives. In 2008, there were 60 locations in 34 states, Washington, D.C. and Puerto Rico. There were also various outreach programs to American Indians in Missouri, Oklahoma and South Dakota. Program participants are primarily 5th graders from populations historically under-represented in STEM. These students may be disabled, socio-economically disadvantaged or come from inner cities, rural locations, or other areas with typically low academic performance.

Junior Science and Humanities Symposium

Students conduct an original research investigation in the sciences, engineering, or mathematics, and participate in a regional symposium sponsored by universities or other academic institutions. Scholarships are given to top contestants. The program develops students' oral presentation skills and emphasizes the ethical conduct of original research. Administered by AEOP, with funds from AEOP, ONR and AFOSR.

Army Educational Outreach Programs

Central office for Army-sponsored research, education, competitions, internships and practical experiences to engage and guide students and teachers in STEM. Students of all proficiency levels, interests, ethnic, economic and academic backgrounds participate in real world STEM experiences. Involves interactive activities and community science fairs. / Central office for Army-sponsored research, education, competitions, internships and practical experiences to engage and guide students and teacher in STEM. Students of all proficiency levels, interests, ethnic, economic and academic backgrounds participate in real world STEM experiences. Involves interactive activities and community science fairs.

Junior Solar Sprint (AEOP)	A national competition in which students explore concepts and technology to address global climate change, reduce air and water pollution, and reduce foreign fuel dependence. Focuses on the design, construction and racing of solar electric cars. Conducted by the Northeast Sustainable Energy Association and partially supported by AEOP.
E-Cybermision (AEOP)	Web-based competition promotes self-discovery and real-life applications of STEM. Teams propose a solution to a real-world problem in their communities and compete for regional and national awards. Encourages the pursuit of advanced education and careers, and increases the number of technologically literate citizens and future Army employees. Administered by RDECOM.
Fast Track Science	A high-energy after-school and summer camp program featuring remote controlled racing. Components include a racing kit, 33 or more hour curriculum, and training. Action focused on team-based challenges using the real process of science and mathematics.
Discovery Academy	An interdisciplinary (science, math, language arts and social studies) 60 hour web platform for teachers nationwide to incorporate into summer camps, the classrooms, or after-school programs. The current program is on rainforests.
JROTC Math and Science Program	Provides hands-on activities/kits 16 hours in length and focused on math and science problem solving (basic electronics) that involve “learning by doing.” Available as a summer camp (JCLC) or as an in-school program.
Leadership and Academic Bowl	Three-phase one-year mandatory competition focused on academics and leadership using a state-of-the-art Internet game. In level 1, cadets form teams and compete using the game. Level 2 takes place at select college campuses (potentially on campuses with strong STEM programs, internships and facilities). The program develops high-stakes test-taking skills (i.e., SAT/ACT) in science, math, history, English, literature, and select JROTC subjects. Involves Senior ROTC.
West Point Bridge Design Contest	Web-based engineering design competition to stimulate interest and encourage advanced education in STEM among middle and high school students. Contestants learn about engineering and technology through a realistic, hands on problem-solving experience.

New York Science Olympiad

New York State Science Olympiad (NYSSO) is a 501(c)(3) non-profit organization dedicated to improving the quality of science education in grades 5-12, increasing male, female and minority interest in science, creating a technologically literate workforce and providing recognition for outstanding achievement in science and technology. These goals are achieved by providing opportunities for teams of students to participate in 22 regional and state Science Olympiad tournaments across New York State. NYSSO also promotes the inclusion of Science Olympiad activities in classroom curricula and provides teacher training at seminars and an annual coaches workshop.
National Level Olympiad.

**National Science Olympiad
Sea Perch Program**

SeaPerch provides students the opportunity to learn about robotics, engineering, science and math while building an underwater remotely operated vehicle (ROV) as part of a STEM curriculum. Students learn how to build a propulsion system, develop a controller, and investigate weight and buoyancy. This project teaches basic skills in ship and submarine design and encourages students to explore naval architecture and marine and ocean engineering concepts independently. Teacher training and curriculum/activities are provided, as well as the actual kits (3K kits cost \$450K). The program is currently in 18 states and more than 10,500 students have built SeaPerches. More than 275 teachers have been trained.

International Human Powered Submarine Race

Carderock NAVSEA laboratory is the annual host for the International Human- Powered Submarine Race. The competition is primarily a college-based competition, but included two high schools among 18 teams from U.S. and international schools in 2009

Patriots Technology Training Center

Robotics workshops and competitions are sponsored during the Annual Youth Summit on Technology. These events provide take-away robotics kits teaching robot-building and the application of engineering and scientific knowledge learned in school. Students pay to attend the camp. Patriots teams compete in an annual robotics competition at the Naval Academy. NAVSEA support also includes preparatory work such as the training of S&Es (14 in 2009), and can include Educational Partnership Agreements with sites where the activity is conducted. Bases participating in 2009 included Carderock, Indian Head and Dahlgren. NAVSEA

headquarters also participates.

Civil Air Patrol Cadet Program

Motivates youth to become responsible citizens through aviation-centered programs emphasizing aerospace education, leadership, physical fitness, and values. Supports the Air Force by communicating opportunities and careers in the Air Force. Cadets voluntarily enroll and renew their enrollment on an annual basis. AF partners with USAF organizations and aerospace organizations. Middle and high schools from 1,100 communities nationwide are represented.

Society Of American Military Engineers

One-week high-energy hands-on engineering camps for students from across the U.S. and the world who excel in math, science and technical courses and are interested in pursuing engineering in college. Camps are led by engineers from private industry and the military. Camps take place on a military base in the Colorado Rockies, Southern California, and the Mississippi Valley. Supported by the Department of Civil and Environmental Engineering

Spring Board

SpringBoard is a component of the Juneau Economic Development Council, a nonprofit corporation based in Alaska. SpringBoard and the Department of Defense are partners for this work. They Run all kinds of programs around Juno.

Base Outreach

Happens at various Air Force bases, Air Force research centers around the nation. Possibly includes most bases in populated areas. Possibly includes bases from the other branches and definably the NAVY and the submarine warfare bases. Programs provided vary by location, but it seems like the air force is most involved.

Society for science and the public

Society for Science & the Public (SSP) is a nonprofit 501(c)(3)-membership organization dedicated to public engagement in scientific research and education. Our vision is to promote the understanding and appreciation of science and the vital role it plays in human advancement: to inform, educate, and inspire. They hold several different very elite competitions. They are extremely well funded and members include even noble prize winners. They promote awareness of science.

1B. Table 1- MOTIVATORS AND OBSTACLES FOR TRAINING FOR CREATIVITY

Motivators and Methods	Obstacles and Needed Resources
<ul style="list-style-type: none">•Teachers previous participation in creative programs•Seeing the positive effects of students who have been uninterested in STEM•Realizing the importance of creativity in workforce•Establishing themselves as teachers•Influence from other teachers•Realizing the importance of training their students to be creative•Believing that training for creativity could make a difference•Establishing a knowledge transfer•Providing students with appropriate information•Creativity in teams	<ul style="list-style-type: none">•Unsure of how to assess students•Own lack of comfort with creativity•Space•Training•Outside facilitator•Developed lesson plans

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