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**Teaching 21st Century Skills to High School Students Utilizing a Project
Management Framework**

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**Teaching 21st Century Skills to High School Students Utilizing a Project
Management Framework**

by

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Dedication

This thesis is dedicated to my wife and to my two children. Thank you for allowing me to take this time out of our lives to fulfill a long-time dream of obtaining a graduate degree. I promise I will start on the “Things to Do” list that has been piling up at home.

I’m all yours.

Abstract

Teaching 21st Century Skills to High School Students Utilizing a Project Management Framework

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Educators, researchers, and government officials have concluded that today's students, at all levels of the educational system, are lacking in the skills needed to ensure their success in the workplace. This awareness is driving a movement to change educational curricula to include skills training in the areas of communication, collaboration, critical thinking, and creativity. Collectively, these areas make up what are called "21st Century Skills." The question becomes how to develop a program that effectively teaches these skills to students and how to get that program implemented into a usable curriculum. This thesis asserts that the direct study and application of the framework and specifically identified processes of project management (i.e. the key fundamental elements) is an effective methodology for building a foundation upon which to teach students "21st Century Skills". Using the term "direct study" means that students

are explicitly taught key terms, concepts, and processes of project management and then instructed to implement them in a project. The distinction being made here is the belief that, whereas some types of skills are better learned by simply doing, introduction to 21st century skills should be prefaced with some amount of theory and discussion and then reinforced with practical application. Several of the student project management programs discussed in Chapter 3 offer data that backs up this assertion. Additionally, a course outline for a proposed high school curriculum to teach students the key fundamental elements of project management is included in *Appendix A*.

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INTRODUCTION

Susan Evans is a twenty-five year old project engineer working for a major aerospace engineering company in Houston, Texas. She has been in this position for three years and this is her first job fresh out of college. Her short-term goal is to continue supporting her current project team by supplying the services and products required by the project manager to move the project towards implementation and successful completion. Long-term, however, Susan would like to move up into a project management (PM) position of her own. Her line-management asked her recently if she had considered PM as a long-term career goal. Honestly, Susan did not even know what PM was until she took this job. Her first encounter with the concept was during the initial job interview when the hiring manager asked her if she had any PM experience or had taken any project-related courses in college. She felt awkward confessing that she had not had any formal exposure to PM but she had some “hands-on” experience working project-like assignments in high school (i.e. science fair and term papers) and college in the form of her senior design project.

Thinking back on the previous encounters with those “projects” Susan remembered the struggle she had with each. Traditionally, her instructors would hand out a project assignment sheet with few guidelines and a deadline for final submittal. Susan would immediately feel overwhelmed and struggle with the issue of how to begin. She spent a lot of time thinking about what she wanted to do which, most often, resulted in procrastinating due to her inability to organize and develop a plan for attacking the

assignment. She always wound up performing adequately but felt as though her efforts could have been more successful if she knew how to better coordinate her thoughts and a plan of action.

Having reflected back on her previous experiences with these project assignments and the struggles she encountered, Susan began to rethink whether or not her goal of becoming a project manager was realistic. She knew that she lacked the skills and experience needed to manage complex schedules, budgets, risks, and human capital resources. She wondered how she could gain those skills and wished that there had been an opportunity in college or even in high school to learn how to plan, organize, execute, and close out a project. She wondered why the public education system does not teach these vital skills that students could use not only in their professional careers but in their daily lives.

Thesis Overview

This paper analyzes Susan's questions about the public education system's lack of project management skills training and makes a determination as to whether utilizing the framework and processes of project management to teach high school students important skills such as collaboration, creativity, communication and critical thinking is feasible. In the course of this analysis, this paper reviews the history of education and discusses how it was developed into the institution it is today. We consider the concept called project based learning (PBL) that is beginning to gain acceptance in school districts across the country and also describe what "21st Century Skills" are and how they are being introduced into the classroom. The formal practice of project management is analyzed and its key elements are identified and defined to determine if they might be

used as tools to help students in secondary education to be better prepared to face the challenges of higher education and/or their chosen career field. A few real-world applications of Project Management (PM) programs are reviewed along with preliminary results that researchers and educators have documented to date from these programs. Chapter 4 offers suggestions for developing a PM program and discusses the benefits that students will gain from PM skills training. Chapter 4 also discusses some of the challenges to implementing a curriculum like this and what forward work would need to be done to answer those challenges and convince the stakeholders that this is a worthwhile undertaking. Finally, we look at where Susan Evans is today in her PM career and how she has chosen to help students in her community to understand how to plan, organize, execute, and close out projects of their own.

CHAPTER 1 Overview of Education

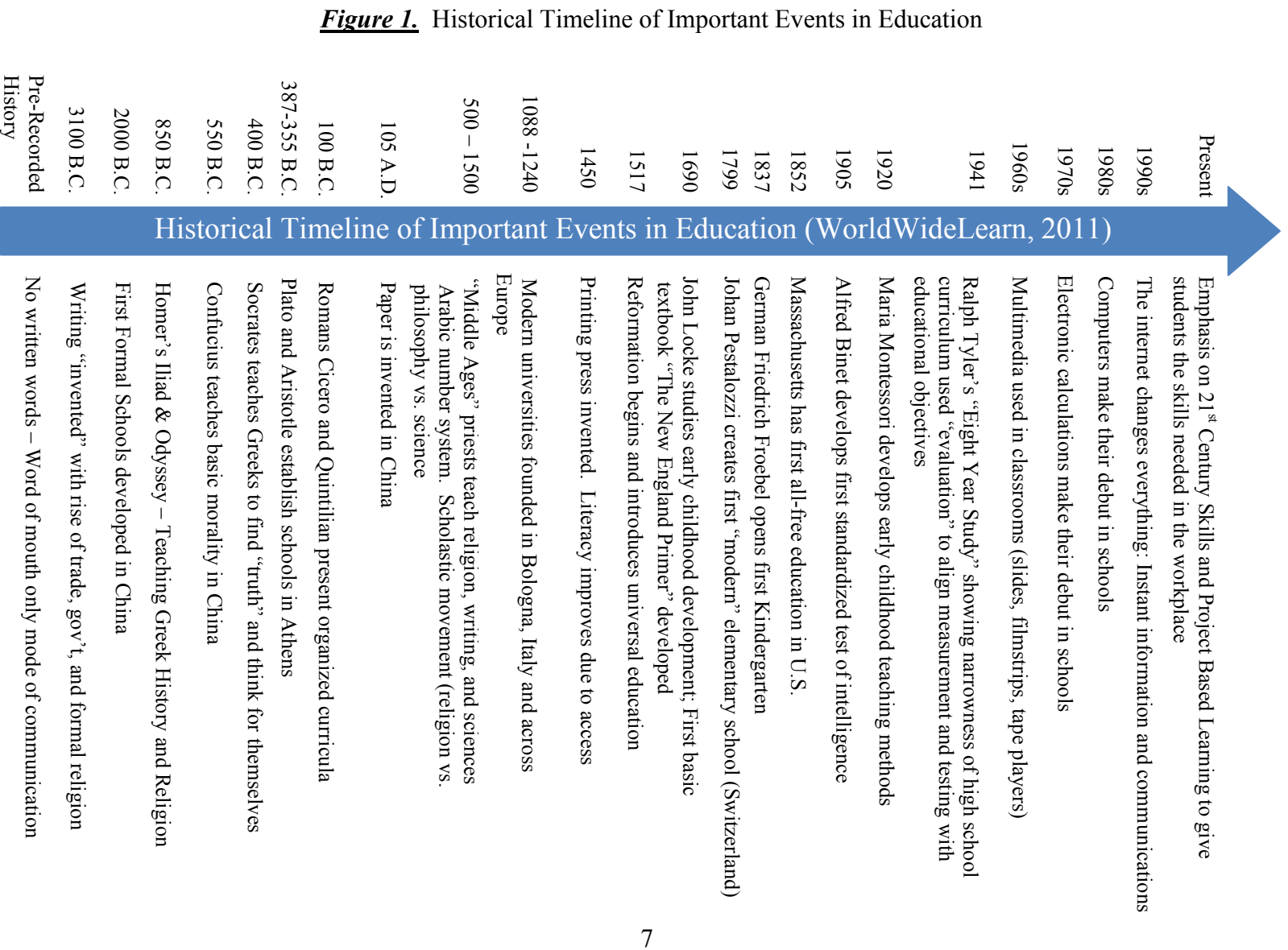
The concept of education goes back thousands of years. We review the history of education from the time when words were first written down, through the Greek and Roman eras, and then discuss the education system of today. The purpose for reviewing this historical timeline is to get a sense for the educational tools, techniques, and philosophies that have been employed since earliest recorded times and to understand how those elements brought us to where we are today with regards to education. With this historical perspective, a different methodology will be discussed regarding the way learning is presented with the goal of changing educational policy from teaching students to take standardized tests to teaching students skills they can use to be successful in whatever challenges they face in and beyond high school. Taking on the established educational system is not without challenges however. As Byrne points out (Byrne et.al., 2008), the biggest obstacles are: 1) identifying champions in school districts to accept and take on new teaching approaches [a project management based approach in his case]; 2) finding qualified instructors/mentors; 3) conflict with standardized curricula/testing; and 4) obtaining resources for implementing alternative curricula (i.e. references, supplies, workspace). These obstacles and ways to address them will be discussed later in the paper.

History

Up until 3100 B.C., when writing was “invented” learning was carried out by word of mouth and by demonstration. Due to the rise in trade, government, and formal religion the written word became essential for archiving and passing along information from person to person and generation to generation. At that time in Egypt, education was

mainly carried out by priests who taught religion, writing, and science. Learning was done by memorization and often harsh physical discipline was used to keep students focused. As evidence of this, archaeologists discovered an ancient clay tablet inscribed with the words “Thou didst beat me and knowledge entered my head” (History World International, 2006). The first formal schools were created in China around 2000 B.C. Around 850 B.C. Homer wrote the *Iliad* and *Odyssey* which both became Greek national epic poems that were used in the education of their youth. Education in Greece during this period was mainly for free men (non-slaves) and the goal was to produce well-rounded citizens. Schools were established in Athens where Plato’s “Academy” focused on truth and creating a “perfect society and education based on social standing” (History World International, 2006). The Romans made their mark on education around 100 B.C. with the development of an organized curriculum centered on creating great orators. For the Romans, science, philosophy, and music were not highly regarded as useful elements of their education system (History World International, 2006). Educational progress was relatively slow during the next 1000 years, but a few important educational tools such as paper and the Arabic number system were introduced. In 1088 A.D. the first “modern” university was founded in Bologna, Italy followed by universities in Paris, Oxford, Cambridge and other cities throughout Europe (WorldWideLearn, 2011). In Paris, St. Thomas Aquinas began working with the concept of scholasticism, which up to that point, was unprecedented. Scholasticism involves the organizing, sorting, and classifying of educational materials in order to make them accessible for teaching and learning (Mizii, Inc., 1999). The next few hundred years brought an increase in literacy with the invention of the printing press in 1450. The Reformation started circa 1517 and brought with it universal education which provided instruction for rich and poor alike (WorldWideLearn, 2011). America makes its first contribution to education in 1690 in

the form of “The New England Primer” which was the first basic textbook (History World International, 2006). The first “modern” elementary schools were established throughout Switzerland and Germany in 1799 and the first kindergarten was opened by Friedrich Froebel in 1837 (History World International, 2006). The early 1900’s saw the introduction of the first standardized test of intelligence and the emphasis on early childhood learning (WorldWideLearn, 2011). From 1933 to 1941, Ralph Tyler, an American educator working in curriculum development and evaluation, embarked on his “Eight Year Study” that resulted in the high school curricula of the day being characterized as “narrow”. Tyler introduced an innovative testing method where evaluation was used to align testing with educational objectives. In 1949, Tyler published “Basic Principles of Curriculum and Instruction” which is still used today in shaping curriculum and instruction design (Tyler, 1949). The latter half of the twentieth century brought the introduction of technology into the classroom such as calculators, computers, and ultimately the internet. Students now have instant access to information and communication with others worldwide. See *Figure 1* for an overview of the important events in history from pre-recorded history to modern times.



It is obvious in reviewing the history of education over the last five thousand years that the teaching techniques, philosophies, tools, and even the teachers and students themselves have undergone many cycles of change since the time when humans first began to try and understand the world around them. Even after all this time there is still vast disagreement with regards to the transfer of knowledge to the society's youth. There are those who believe in Educational Perennialism which follows the belief that one should teach principles and not facts. Under this philosophy, it is rationalized that the details of facts constantly change and therefore are not considered as important to the development of a person. Rather, it is liberal topics such as reasoning that should be taught instead of vocational instruction (Bayla, 2007). Educational Essentialism is a philosophy that says children should learn the traditional basic subjects such as reading, writing, and arithmetic in a rigorous curriculum. This curriculum should teach these subjects in a manner that increases the level of complexity as the student progresses through their education (Bayla, 2007). A third philosophy, called Educational Progressivism, puts forth the notion that humans are social beings who learn best in activities with other people. This philosophy sees children as scientists who learn by the scientific method of discovering a problem, defining it, proposing a hypothesis, using past experience to find solutions, and testing those solutions to solve the problem (Bayla, 2007).

The point in describing just three of what is sure to be hundreds of different educational philosophies is that even after five thousand years, humans still have notsettled on one single methodology for instilling the knowledge and skills in our youth that they need to thrive in a world that grows vastly more complex every day. Seemingly one element that Federal and State education agencies have agreed upon is the prominent role that standardized testing should take in the primary and secondary curricula across

the country. Students are being prepared to take standardized exams rather than being prepared with the appropriate knowledge and skills they need to face the challenges of higher education, the real world, and the workforce. As will be seen in the next section, educators at some community colleges are starting to see the effects of focusing on standardized tests and they are beginning to look to education policy makers to find solutions for resolving the issue of under-prepared students.

Current State of Education in the U.S.

According to the U.S. Department of Education Institute of Educational Sciences, 50 million students attended one of 99,000 public elementary and secondary schools in the Fall of 2009. An estimated \$543 billion was to be spent on education related costs for those students. Additionally, during that time, 18.4 million students were expected to attend two and four-year colleges across the nation. This is an increase of about 3.1 million students since the Fall of 2000 (NCES, 2009). Whereas these statistics indicate more students are seeking higher education, a recent article in the *Houston Chronicle* reveals that over 50% of these college students require developmental education in order to perform at a basic college level. The report also notes that 7.6% of “students who need the [developmental education] classes go on to earn a degree.” For Texas alone, the cost of this remedial instruction is \$200 million per year (Chron, 2010).

In response to demands for change and a push to ensure that students succeed in graduating or earning a certificate, legislators and educators are searching for new strategies to better prepare students for the rigors of college level courses. Most of the strategies outlined in the *Houston Chronicle* report are aimed at making changes at the community college level and include strategies such as: shorter-term developmental classes, allowing some students to begin college level work sooner; required classes

teaching study skills, time management and other keys to college success; new teaching methods and class content; changing from semester-long classes to four and eight-week classes, coupled with intensive tutoring; and adding “**courses to help students transition to college, focusing on study skills, time management, career choices...**” (Chron, 2010).

A subset of the strategies discussed in the article target high school students with the goal of improving their skills before applying for and entering college. Charles Cook, Vice Chancellor for Academic Instruction at Houston Community College, and Donetta Goodall, Vice Chancellor of Academic Affairs and Student Success at Lone Star College, both “expect the more rigorous high school curriculum will help in coming years” (Chron, 2010).

Just as in the case with Susan Evans, the aerospace project engineer seeking a PM position in her company and wondering why she had not been exposed to these skills previously in her educational career, the question to be asked and investigated is why wait until a student enters college, two or four-year, to teach them the knowledge and learning skills that some educators are suggesting should start at the community college level. Furthermore, what skills would benefit students most in their preparation for college, and beyond, and how should these skills be taught to them?

In 2006, the United States Congress passed the Carl D. Perkins Career and Technical Education Act. The most recent in a series of Perkins Acts, Perkins Title IV, was designed to “provide an increased focus on the academic achievement of career and technical education students, strengthen the connections between secondary and postsecondary education, and improve state and local accountability” (U.S. Department of Education, 2011). The Perkins Act only provides funding and basic requirements but

does not provide specific guidance on how schools are to implement a curriculum to impart these skills to students. It was left up to local school districts to define and implement a program that meets the stated requirements. One methodology that some schools have implemented to build student skill sets is project based learning.

Project Based Learning (PBL)

Project based learning (PBL) is a teaching methodology whereby the teacher acts as a facilitator while students take an active role in the education process. The project assignments are usually in the form of “real-world problems, questions, issues or challenges” (Trilling, 2006). Students, working individually or in groups, perform an in-depth study of the subject matter by formulating their own sets of questions. Often, this initial set of questions leads the students into further inquiry that leads to a deeper understanding. During the life of the project, the students’ work is often critiqued by their peers and evaluated by the teacher through the use of a rubric. According to Goodrich, a rubrics expert, a rubric is a “scoring tool that lists the criteria for a piece of work or ‘what counts’” (ALTEC, 2008). A rubric will specify the performance expected for several levels of quality and can be characterized by different types of ratings. One type of rating may range from “excellent” to “good” to “needs improvement.” Another type of rating may be a numerical score which is then totaled to formulate a specific letter grade. At the end of their inquiry, the students analyze their results and draw meaningful conclusions. Students may even be asked to develop their own innovative solutions to a given problem.

An initial analysis of this approach shows that it is a good framework for providing students hands-on experience with working in teams and exposure to some skills such as collaboration and problem solving. When looked at more closely however, analysis shows that PBL relies on students learning these skills incidentally through the course of working through pre-defined projects. Often, students are limited to learning only what they are exposed to because of the role they play in the project. Some students may learn critical thinking skills because they are solving project related problems while others may learn organization skills because they are assigned to make and keep a schedule of project activities. A better system would be one that teaches the entire skill set required to complete a project successfully. This skill set includes the entire range of knowledge and abilities that a student needs to carry out their own project, such as effective verbal and written communications, collaboration/teamwork, critical thinking/problem solving, and creative thinking/innovating. Collectively, these skills are called 21st century skills. The next section takes a closer look at these skills by defining them and discussing why it is important for students to acquire them.

21st Century Skills

As a result of legislation like the Perkins Act and in cooperation with public, private, and government entities, numerous organizations have stood up to take on the challenge of creating and implementing changes to the current education system. These organizations recognize, just as the Perkins Act concludes, that education of our youth must change in order to instill the knowledge and skills in students that they will need to compete locally, nationally, and globally in the 21st century workforce. So, why is it

critical that students learn 21st century skills? According to the Partnership for 21st Century Skills (P21, 2011), one of the previously mentioned organizations that advocates for educational policy changes at the local, state and national level, teaching 21st century skills to US students is necessary because:

- 1.) Education is changing. We can no longer claim that the US educational results are unparalleled. Students around the world outperform American students on assessments that measure 21st century skills. Today's teachers need better tools to address this growing problem.
- 2.) Competition is changing internationally. Innovation and creativity no longer set US education apart. Innovators around the world rival Americans in breakthroughs that fuel economic competitiveness.
- 3) The workplace, jobs and skill demands are changing. Today every student, whether he/she plans to go on to a 4-year college, trade school or entry-level job, requires 21st century skills to succeed. We need to ensure that all students are qualified to succeed in work and life in this new global economy.

The “4Cs” that are often referred to when discussing 21st century skills are communication, collaboration, critical thinking (problem solving), and creativity.

Table 1 describes each of the “4Cs” and gives guidelines to assist in proper assessment of each skill.

Table 1. The “4 Cs” of 21st Century Skills (P21, 2011)

21 st Century Skill	Description / Assessment Criteria
Communication	Articulate thoughts and ideas effectively using oral, written and non-verbal communication skills in a variety of forms and contexts
	Listen effectively to decipher meaning, including knowledge, values, attitudes and intentions

Table 1. cont.

21 st Century Skill	Description / Assessment Criteria
	Use communication for a range of purposes (e.g. to inform, instruct, motivate and persuade)
	Utilize multiple media and technologies, and know how to judge their effectiveness a priori as well as assess their impact
	Communicate effectively in diverse environments (including multi-lingual)
Collaboration	Demonstrate ability to work effectively and respectfully with diverse teams
	Exercise flexibility and willingness to be helpful in making necessary compromises to accomplish a common goal
	Assume shared responsibility for collaborative work, and value the individual contributions made by each team member
Critical Thinking	Reason Effectively - Use various types of reasoning (inductive, deductive, etc.) as appropriate to the situation
	Use Systems Thinking - Analyze how parts of a whole interact with each other to produce overall outcomes in complex systems
	Make Judgments and Decisions - • Effectively analyze and evaluate evidence, arguments, claims and beliefs • Analyze and evaluate major alternative points of view • Synthesize and make connections between information and arguments • Interpret information and draw conclusions based on the best analysis • Reflect critically on learning experiences and processes
	Solve Problems - • Solve different kinds of non-familiar problems in both conventional and innovative ways • Identify and ask significant questions that clarify various points of view and lead to better solutions

Table 1. cont.

21 st Century Skill	Description / Assessment Criteria
Creativity	Think Creatively - • Use a wide range of idea creation techniques (such as brainstorming) • Create new and worthwhile ideas (both incremental and radical concepts) • Elaborate, refine, analyze and evaluate their own ideas in order to improve and maximize creative efforts
	Work Creatively with Others - • Develop, implement and communicate new ideas to others effectively • Be open and responsive to new and diverse perspectives; incorporate group input and feedback into the work • Demonstrate originality and inventiveness in work and understand the real world limits to adopting new ideas • View failure as an opportunity to learn; understand that creativity and innovation is a long-term, cyclical process of small successes and frequent mistakes
	Implement Innovations - Act on creative ideas to make a tangible and useful contribution to the field in which the innovation will occur

Also in 2006, the same year as Perkins Title IV, a consortium of various business, individual, and research organizations (including Partnership for 21st Century Skills) performed a workforce skills and knowledge requirements study to determine how to prepare students to be successful in the workplace (Byrne, et al, 2008). Fortune 500 companies were asked to list the knowledge or skills they believed were critical for today's workforce to possess and the results are documented in *Table 2* (Byrne, et al, 2008). Reviewing the list of applied skills that were identified by the Fortune 500 companies shows a good, but not complete, correlation to 21st century skills. The items missing from the 21st century skills list are collaboration and critical thinking. Teamwork and leadership are directly relatable to collaboration, however. The purpose for pointing

out these discrepancies will become apparent in Chapter 4 in the correlation (mapping) analysis of project management elements and 21st century skills.

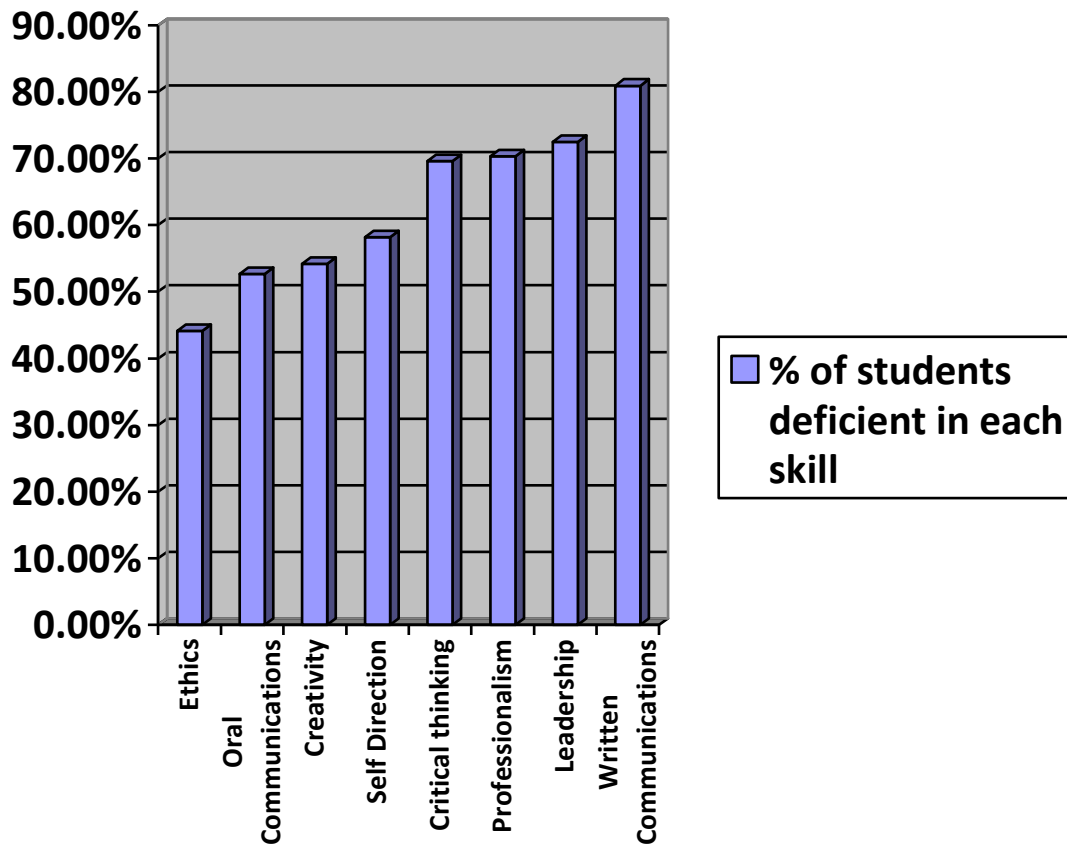
Table 2. Top Knowledge and Applied Skill Needs from Fortune 500 Survey (Byrne, et al, 2008).

KNOWLEDGE AREAS	APPLIED SKILLS
Reading Comprehension	Professionalism
English	Teamwork
Mathematics	Oral Communications
Foreign Languages	Ethics
Science	Information/Technology
	Written Communications
	Diversity
	Self Direction
	Creativity
	Leadership

The second part of the survey asked the Fortune 500 companies to assess how good the current education system is at teaching students the knowledge and skills listed in *Table 2*. Ratings of “deficient”, “adequate”, and “excellent” were used to assess each of these areas. None of the areas were deemed to be “excellent” with regards to student

preparedness. Students were found to be adequately prepared in all knowledge areas and the applied skill areas of information technology, teamwork, and diversity. The percentage of students deemed to be deficient for each applied skill is depicted in *Figure 2*.

Figure 2. Applied Skill Deficiencies in Today's Students (Byrne et al., 2008)

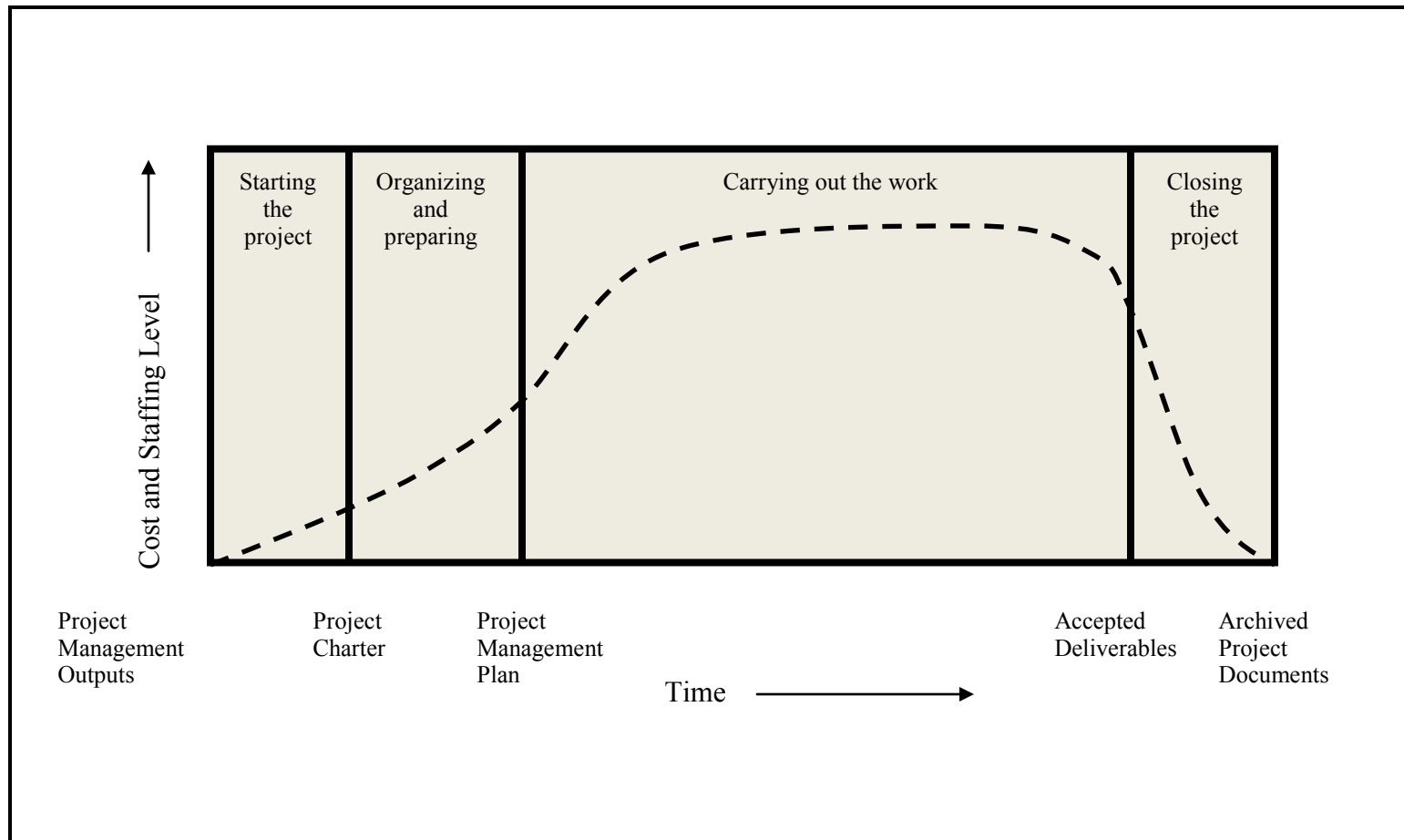


CHAPTER 2 Project Management

What Is Project Management?

Following the example set forth by the *Project Management Body of Knowledge (PMBOK Guide 4th Edition)* it is more appropriate to define what a project is before attempting to describe and define the concept of project management. In this context, the term “project” takes on a broader meaning. In the previous discussion of project based learning, the term “project” was used to refer strictly to an academic exercise. In this discussion, the term “project” is taken beyond academic. In regards to project management, the term has implications for scheduling, budgeting, resource allocation and a host of processes that will be discussed in more detail. According to *PMBOK*, a project is “a temporary endeavor undertaken to create a unique product, service, or result” and has “a definite beginning and an end” (PMI, 2008). Whereas *PMBOK* indicates that the beginning of a project is distinct, Verzuh indicates that “the date of the beginning maybe somewhat fuzzy, as an idea evolves into a project” (Verzuh, 2008). Both references, however, agree that projects must have a definite end and that the output or result of a project is a unique product or service. The time between the beginning and the end of the project is called the project life cycle. A generic project life cycle is depicted in *Figure 3*. This figure shows the changes in cost and staffing levels as a function of time throughout the life of a typical project. Costs and staffing are relatively low at the beginning stages and increase steadily until they reach their maximum when the bulk of the work is being carried out. Costs and staffing levels should then steadily fall to zero as the project winds down to a close.

Figure 3. Typical Cost and Staffing Levels across the Project Life Cycle (PMI, 2008)



Projects are generally undertaken in phases which are distinct divisions that have specific objectives or deliverables. The sequential staging of these phases from beginning to end creates a project life cycle. A simple project can have a single phase and conversely a complex project can be made up of many phases. *Table 3* gives an example of a project life cycle that is broken down into 8 distinct phases.

Table 3. Project Life Cycle Phases and Phase Deliverable Items (NASA, 2006)

Phase	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
Phase Name	Feasibility Assessment (FA)	Project Definition and Approval	Requirements Definition	Preliminary Design	Detailed Design	Flight Production And Certification	Deployment	Operations
Deliverable	FA Report / Project Approval	Project Management Plan	System Requirements Review	Preliminary Design Review	Critical Design Review	System Acceptance Review	Flight Readiness Review	End of Mission Review

This particular life cycle is a guideline for the development of government furnished equipment (GFE) in the Engineering Directorate at NASA's Johnson Space Center in Houston, Texas. Regardless of the complexity, each phase should be carried out with what *PMBOK* calls the five project management process groups. These process groups and their definitions are listed in *Table 4*.

Table 4. Project Management Process Groups (PMI, 2008)

Process Group	Definition
Initiating	Processes performed to define a new project or a new phase of an existing project by obtaining authorization to start the project or phase.
Planning	Processes required to establish the scope of the project, refine the objectives, and define the course of action required to attain the objectives that the project was undertaken to achieve.
Executing	Processes performed to complete the work defined in the project management plan to satisfy the project specifications.
Monitoring and Controlling	Processes required to track, review, and regulate the progress and performance of the project; identify any areas in which changes to the plan are required; and initiate the corresponding changes.
Closing	Processes performed to finalize all activities across all Process Groups to formally close the project or phase.

Now that the term “project” has been defined and we have a working knowledge of how they are structured, it is time to define project management. As defined by *PMBOK*, project management is “the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements” (PMI, 2008). More simply stated project management is the use of a combination of experience, standardized functions or processes, and often a software package, or other tools, to get a project defined, approved, and completed.

What are the Key Elements of Project Management?

As defined in (PMI, 2008), the key fundamental elements that are required in the successful conduct of project management and their purposes in the process are listed in *Table 5*. It should be noted that *Table 5* is an abbreviated list of key project management elements that, in the author's opinion, make up the foundation of a sound project management process. This opinion is based on more than 15 years of working as a project manager or as part of a project team while utilizing these elements to develop hardware and software systems for spaceflight.

Table 5. The Key Elements of Project Management (PMI, 2008)

Key Elements of Project Management	Purpose
Development of a Project Charter	Formal authorization of the project that bestows authority to the project manager to use resources to carry out the project.
Identification of Stakeholders	Person or group of people that has a vested interest in the project and may have influence over the project or the project's inputs and outputs. Stakeholders can include the customer, sponsor, manufacturer, end-user, sales/marketing rep, etc.
Document Stakeholder Needs/Goals/Objectives	Compilation of what needs the project's output has to fulfill in order to satisfy all parties that have a vested interest in the project. This list will be refined into formal requirements.
Develop a Project Management Plan (PMP)	The PMP is the primary source of information for how the project will be planned, executed, monitored and controlled, and closed

Table 5. cont.

Key Elements of Project Management	Purpose
Development of Valid Requirements	Formalizing and approving the stakeholders' needs that will meet the project objectives.
Define Scope of the Project	“The scope of the project constitutes the vision: the need to develop or procure a product; the goals and objectives of the customer and the company; information about the customers and users of the product, and how the product will be developed or purchased, tested, deployed, and used....The scope also includes the boundaries and the constraints of the project and product” (Hooks et al 2001). The scope can also explicitly state what is NOT an input or output of the project.
Create a Work Breakdown Structure	A subdivision of project deliverables and work into manageable components.
Identify and Sequence Activities	An ordered list of the specific actions to be performed to produce the project deliverables.
Estimate Activity Resources	The process of estimating the type and quantities of material, people, equipment, or supplies required to perform each activity.
Develop a schedule	The process of analyzing activity sequences, durations, resource requirements, and schedule constraints to create the project schedule.

Table 5. cont.

Key Elements of Project Management	Purpose
Estimate Costs and Create a Budget	Determining the monetary resources needed to complete project activities and aggregating them to establish an authorized cost baseline.
Define Project Constraints	Defining those internal or external restrictions or limitations of a project that will affect the performance of the project or a process. Constraints on a project can include scope, schedule, quality, budget, resources, and risk.
Balance Project Constraints	Determining how to address all constraints in such a way as to satisfy all project requirements thereby achieving the project objectives.
Acquire, Develop, and Manage a Project Team	Assemble the human resources (project team) required to complete the project assignments; improve the competencies, team interaction, and team dynamics to enhance project performance; track member performance, provide feedback, resolve issues, manage changes to optimize project performance.
Monitor Project Performance	Distribute information to project stakeholders, monitor and control project work, perform change control, control scope/schedule/costs/quality/risks, report performance.
Closeout the Project	Finalizing all activities to formally complete the project. Obtain acceptance by the customer or sponsor, document lessons learned; update processes as appropriate, archive relevant project documents.

A discussion of which of these elements are most appropriate to include in a high school curriculum is included in Chapter 4. Before that discussion, it is instructive to critically review previous efforts to teach project management in a high school setting.

CHAPTER 3 Real World Application of PM in Education

In this chapter we review examples of project management programs that have been implemented in different schools across the U.S. Some of these studies include preliminary statistics that indicate the introduction of project management concepts is successful in increasing students' proficiency in skills such as communication, organization, and teamwork.

Past and Present PM in the Classroom

Denver, Colorado

The Project Management Institute (PMI) chapter in Denver is currently working with two high schools (both Computer Magnet High Schools) to teach students project management fundamentals. The program is run by volunteers who introduce project management basics to students and then lead them in applying these principles on class projects. They utilize the curriculum found at www.pmihs.com which has the course agenda listed in *Table 6*.

Table 6. PMI Denver High School Curriculum (PMI Mile Hi Chapter, 2009)

Curriculum Item	Description
Course Syllabus	Generated by American Pathways University from their Bus 181 course in Project Management Systems
Introduction	Overview of the course and description of PMI and what it means to be a Project Management Professional (PMP)

Table 6. cont.

Curriculum Item	Description
Scope	Definition, planning, measurement, verification, and control of project scope. Also creation of a work breakdown structure (WBS)
Time	Time management, activity sequencing, estimating duration, and schedule development
Cost	Cost management considerations: estimating, budgeting, and cost control
Quality	Quality management, planning, assurance, and quality control
Human Resources	People management skills; planning, acquiring and developing human resources
Communication	Communication management; planning, information distribution, performance reporting, and managing stakeholders
Procurement	Procurement management, planning purchases and acquisitions, source selection, contracts
Risk	Risk Management: identification, analysis, response planning, monitoring and control

Table 6., cont.

Curriculum Item	Description
Integration	Integration management, project charter, project management plan, change control
Professional Responsibility	No details available
Life Skills	No details available

This course curriculum also offers teacher resources and templates for students to use in planning their projects. The PMI Mile Hi Chapter website indicates that they have also implemented this program at the junior high school level and that two additional area high schools (Eaglecrest HS and Denver East HS) have expressed interest in having this program on their campuses as well. No information on the students' performance in these programs was available.

Philadelphia, Pennsylvania - “The Philadelphia Program” (Byrne et al, 2008)

In the summer of 2008, a pilot program was started in the Philadelphia School District through a partnership with the Project Management Institute Educational Foundation (PMIEF), DeVry University, and the Delaware Valley Chapter of PMI. The program “was designed to fill as many applied skill deficiencies as possible while combining project learning with Perkins Title IV requirements.” Included in the course curriculum were lessons on the elements of a project plan, project scope, organization, cost and schedule development, change management, risk analysis, human resource management,

leadership, and communicating effectively. The Philadelphia Program was completed in August of 2008 with the following results:

- 15 students participated in the program (originally 25 signed up but 10 did not attend)
- None of the 15 students passed the pre-test. The mean grade was 35.3%
- All 15 students passed the final project presentation
- The mean grade for the post-program test was 78.8%

The authors concluded that “these results reveal a statically [sic] significant difference between the pre-test and post-test at a .05 confidence level. This indicates the course was successful in addressing its student learning goals” (Byrne et al, 2008).

Rochester, New York – PM4Kids

PM4Kids is a project management training program developed by PM4Life, Inc. PM4Life is a 501(c)(3) not-for-profit corporation, established in 2001 and originally sponsored by the Project Management Institute’s Educational Foundation (PMIEF). The goal of PM4Kids is to establish “project management practices as life skills for elementary through high school students” (PM4Life, 2005). The specific objectives, as listed on www.pm4kids.org are to:

- Improve the organizational skills of the students
- Develop effective communication skills
- Develop teamwork skills
- Teach the importance of on-time completion of tasks and assignments
- Teach responsibility and accountability
- Develop coordination skills
- Teach students how to manage supporting resources

- Conduct a formal study to prove the concept that teaching project management to kids will improve their academic performance

From the years 2000 to 2006, PM4Kids reports to have participation from over 2000 students in the Rochester, New York area. During the 2004/2005 school year, a formal study involving 32 students from Nazareth Elementary School of Rochester was completed. The results of the study indicate that teaching project management to students led to a greater than 50% increase in all academic performance categories that were either directly measured or observed. The measured results include study and organization skills. The observed categories include time management, task completion, teamwork, and responsibility. The complete set of results is reported in *Figure 4*.

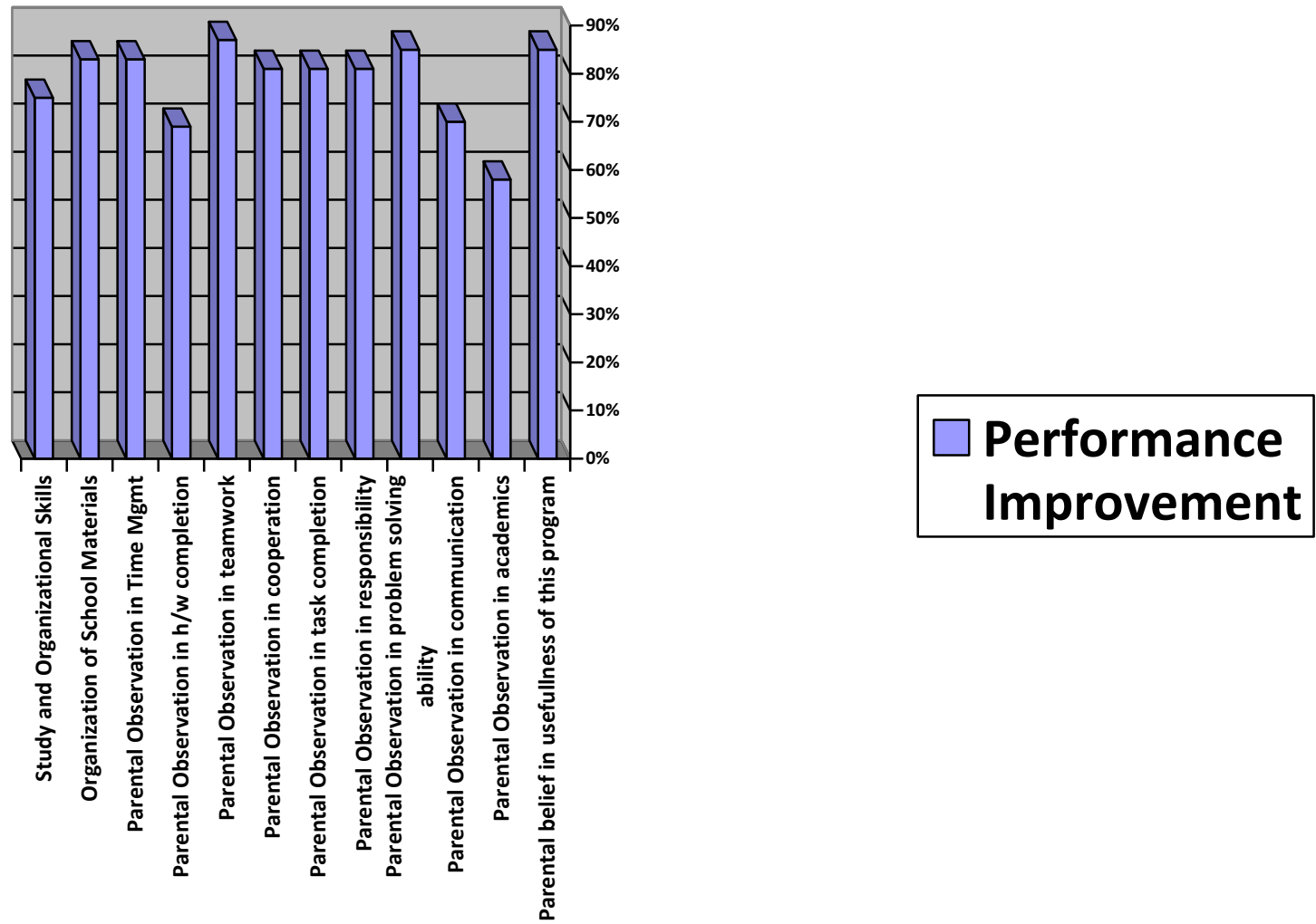
Hewlett-Packard's "Mission: Project Management" (Hewlett-Packard, 2004)

In 2004, Hewlett-Packard introduced an instructional module to teach students the fundamentals of project management. In the instructional kits sent out to requesting schools, Hewlett-Packard includes: information explaining what project management is and why it is important, lesson plans and examples to teach from, and a step-by-step process for designing and implementing a project using this tool set. The lesson plan for the curriculum is as follows:

- Project Management Overview – Includes a list of problems that this instructional module is expected to address. Also includes a definition of project management, an explanation of why it is important to teach it to students and the benefits that teachers and students will reap.
- Lesson Plans

- Lesson 1 – Definition Phase: Teaching students to manage a project to a successful completion using techniques utilized by employees at Hewlett-Packard.
- Lesson 2 – Planning Phase: Teaching students to manage a project by assigning roles, setting a due date, completing an objective statement, choosing criteria, developing a Project Task List and creating a Project Schedule (Gantt chart).
- Lesson 3 – Execution Phase: Teaching students to check the status of project and team tasks (half-way to project deadline).

Figure 4. PM4 Kids Performance Metrics (PM4Life, 2005)



- Lesson 4 – Analysis Phase: Teaching students to evaluate the success of group planning and individual contributions.

Project forms are provided to assist in the creation of critical project documentation. The forms include the project proposal, project task list/ schedule, project status update, project retrospective and personal retrospective. Also included is a glossary with definitions of many key project management terms. In a 2004 study (Hoyet, 2004) Hoyet used this curriculum to teach collaborative process skills to a group of forty-nine Paint Valley High School (Ross County, Ohio) ninth-grade English I students. A subset of the statistical analysis performed shows that the project management training increased the quality of the work, improved the project results, and indicated a better understanding of the project management process. In the abstract of her paper, Hoyet indicates that

Pre and post-tests, journal entries, peer and teacher assessments, self-assessments, and surveys support the author's finding that teaching the students the skills they need to succeed in collaborative teams results in increased cooperation, positive interdependence, and individual accountability (Hoyet, 2004).

A few key findings of Hoyet's research on improving collaborative skills using Hewlett-Packard's program are reported in *Figures 5* through *8*.

Figure 5 shows students' performance (i.e. letter grades) on projects that were completed prior to being taught the curriculum used in the HP instructional modules. The grades were collected by reviewing student records on project assignments.

Figure 5. Grades of Students with Prior Project Experience
(Hoyet, 2004)

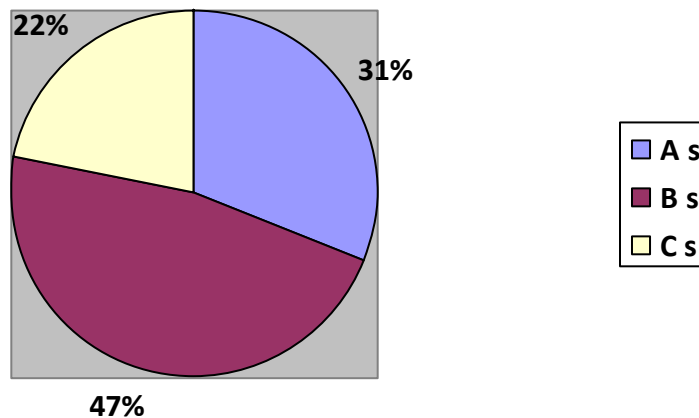


Figure 6 shows the students' results on projects after having completed the HP instructional modules. It is clear that the students performance was markedly improved based on the increase in the number of "A" grades and the absence of any "C" or lower grades. In her report, Hoyet notes that

...one encouraging finding is that the higher-functioning special needs students functioned well as part of regular teams, and one team of the lowest ability students, in a team of five students, received a B- on the project, with their assessment coming from the same rubric used for all teams. (Hoyet, 2004)

Figure 6. Grades of Students After Project Training (Hoyet, 2004)

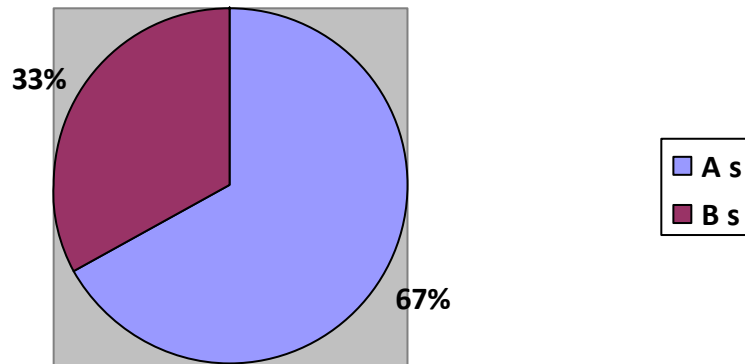


Figure 7 shows the results of a pretest that was given to assess the ability of students to define key project management terms and understand team member responsibilities. Two percent of the students received a “D” and ninety-eight percent received an “F”.

Figure 7. Grades of Students Prior to Exposure to Key Terms
(Hoyet, 2004)

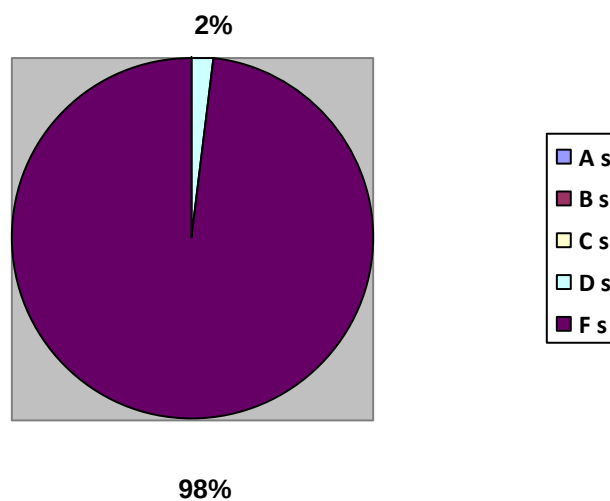
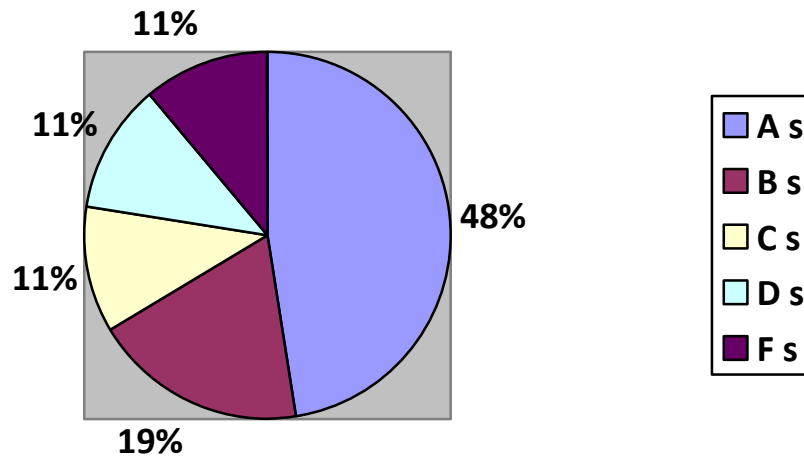


Figure 8 shows students' grade results after having completed the HP instructional modules. As with the pre- and post-project training grade results, it is clear that the project training made a big improvement in student performance with regards to defining key terms and understanding team member responsibilities.

Figure 8. Grades of Students after Exposure to Key Terms
(Hoyet, 2004)



Summary

An analysis of the results provided from the Philadelphia Program, PM4Kids, and Hoyet's research studies indicate that exposure to the terms, concepts, and processes of project management did improve student performance on subsequent project tasks or knowledge/skills assessments. The PM4Kids results showed an increase of proficiency in skills such as organization, time management, teamwork and cooperation, and problem solving. Hoyet's study resulted in student enthusiasm about their "increased understanding of both the way to work together successfully and the importance of learning these skills for school projects and future jobs" (Hoyet, 2004).

Combining the results of these studies with the previous discussions of 21st century skills and the elements of project management, the focus now changes to the synthesis of these concepts into a meaningful curriculum to teach high school students 21st century skills in a project management framework.

CHAPTER 4 Developing a PM Course for High School Students

This chapter takes the 21st century skills, applied skills, and knowledge areas that were introduced in Chapter 1 and maps them to the key project management elements that were defined in Chapter 2. Once this mapping is accomplished we will take another look at the list of key project management elements and choose the elements that are best suited for adoption into a high school project management class curriculum. The rationale for why each particular key element was or was not selected as a candidate subject for the curriculum is discussed.

Mapping Key Elements to Skills

It is useful to first take a look at 21st century and other applied skills described in Chapter 1 and determine if there is a correlation to the key elements of project management that were introduced and described in Chapter 2. *Table 7* shows the skills to project management element mapping. Note that what is listed in the “Key” in *Table 7* for “Applied Skills” is actually a modified list of the entries in *Table 2*. The difference is the addition of the skill “Critical Thinking” in order to make the list inclusive of all 21st century skills. “Collaboration” is not called out specifically in this list but is encompassed by “Leadership” and “Teamwork”.

The mapping shown in *Table 7* was created by taking an informal survey of present and former engineering project managers that are acquaintances and/or co-workers of the author. The collective project management experience of this group of professionals is greater than one hundred and twenty years in and around the field of project management. Each of them was asked to indicate which of the knowledges and skills listed in the key that a high school student would learn by performing each of the listed

key elements of project management. The results in the right hand column of *Table 7* are a compilation of that informal survey with the guideline that a knowledge area or applied skill was only listed if it was selected by 80% or more of the members of the group.

Analysis of the Mapping Results

Reviewing the results shows that “Reading Comprehension” and “Critical Thinking” show up in every one of the rows. This means that performing any one of the key elements of project management could benefit students by increasing their reading comprehension and critical thinking abilities. “Professionalism” and “Written Communications” are listed in all but one of the keys to PM, and “English” is left out of only two of the rows. Moving to the least selected knowledges and applied skills we see that “Ethics” and “Diversity” were selected by greater than 80% of the members of the group in only the key elements of “Balance Project Constraints” and “Acquire, Develop, and Manage a Project Team”. Recall that this does not mean that ethics and diversity are not important parts of project management but rather an 80% or greater consensus of the group did not believe that the other key elements of PM offered the opportunity to learn these applied skills.

Notice that “Foreign Language” does not show up at all in the right hand column. It was chosen by several of the project managers in the group with the notation that this was highly dependent on the scope of the project and/or the language spoken by the stakeholders.

Table 7. 21st Century Skills to Project Management Element Mapping

Key Elements of PM	Mapping to Applied / 21 st Century Skills and Knowledges
Development of a Project Charter	1,2,5,9,11,13,14,15
Identification of Stakeholders	1,2,5,7,9,11,12,15
Document Stakeholder Needs/Goals/Objectives	1,2,5,6,7,9,11,14,15
Develop a Project Management Plan (PMP)	1,2,5,9,11,13,14,15
Development of Valid Requirements	1,2,5,6,7,9,10,11,13,14
Define Scope of the Project	1,2,5,6,7,9,11,13,14
Create a Work Breakdown Structure	1,2,5,7,9,10,11,14
Identify and Sequence Activities	1,2,6,7,9,10,11,14
Estimate Activity Resources	3,5,6,7,9,10,11,13
Develop a schedule	1,3,5,6,7,9,10,11,13,15
Estimate Costs and Create a Budget	1,3,5,9,10,13
Define Project Constraints	1,2,9,10,13,14
Balance Project Constraints	1,2,5,6,7,8,9,10,11,13,14,15
Acquire, Develop, and Manage a Project Team	1,2,5,6,7,8,9,11,12,13,14,15
Monitor Project Performance	1,2,3,5,6,7,9,10,11,13,14,15
Closeout the Project	1,2,3,5,6,7,9,10,11,13

KEY

KNOWLEDGES

- 1 – Reading Comp
- 2 – English
- 3 – Mathematics
- 4 – Foreign Languages

APPLIED SKILLS

- 5 – Professionalism
- 6 – Teamwork
- 7 – Oral Communications
- 8 – Ethics
- 9 – Critical Thinking
- 10 – Information Technology
- 11 – Written Communications
- 12 - Diversity
- 13 - Self Direction
- 14 - Creativity
- 15 - Leadership

Which Key Elements Should (or Should Not) Be Adapted for a High School Curriculum?

First and foremost, it should be emphasized that the intent of teaching key elements of project management to high school students is not an attempt to make them into formally trained, tested, and certified project managers. This is neither realistic as a goal nor practical due to the fact that education alone cannot create a successful project manager. In this profession, experience is one of the most valuable assets that a project manager relies on to define, plan, manage, execute, and close out even the least complex projects. Also, according to a pilot study conducted by Clarke and Howell, emotional intelligence has a direct correlation to project manager competence in teamwork and managing conflicts (Clarke and Howell, 2010). It is only a healthy, mature emotional intelligence, a solid foundation in the principles of project management, and a modest sense of humor that enables a good project manager to abide by and survive the tongue-in-cheek “Laws of Project Management” that Shtub et al. list (Shtub et al., 2005):

- 1.) No major project is ever installed on time, within budget, or with the same staff that started it. Yours will not be the first.
- 2.) Projects progress quickly until they become 90% complete, then they remain at 90% complete forever.
- 3.) One advantage of fuzzy project objectives is that they let you avoid the embarrassment of estimating the corresponding tasks.
- 4.) When things are going well, something will go wrong.
 - When things just cannot get any worse, they will.
 - When things seem to be going better, you have overlooked something.
- 5.) If project content is allowed to change freely, then the rate of change will exceed the rate of progress.
- 6.) No system is ever completely debugged. Attempts to debug a system inevitably introduce new bugs that are even harder to find.

- 7.) A carelessly planned project will take three times longer to complete than expected: a carefully planned project will take only twice as long.
- 8.) Project teams detest progress reporting because it vividly manifests their lack of progress.

It would be a tenuous argument, at best, to propose that high school students possess the emotional intelligence required at a professional level to manage a moderately complex project. Rather, the goal of teaching students these elements is to introduce them to the basic skills, techniques, processes, and tools that project managers use to help them solve similar problems that high school students face on a regular basis and will encounter later in their personal and professional lives.

Whether or not they realize it, high school students use rudimentary elements of project management in the course of their primary and secondary school careers. Science projects, book reports, and research papers all require some level of defining, planning, executing, communicating, re-planning, and re-work in order to successfully accomplish a given task and achieve a desired outcome (i.e. an acceptable grade on an assignment). How many of these students receive formal training in defining what exactly it is they are being asked to accomplish? How many students are taught to monitor the progress of their assignments and communicate with their instructors or classmates to seek clarification and modify their plans accordingly? How many are made aware that even the best plans get derailed and that planning for contingencies and employing measures to mitigate potential delays or failures (i.e. risk management) is a good thing to do when planning a one-off science experiment?

Even though, as has been shown from the programs already in place, teaching high school students project management key elements has proven to be beneficial, relatively few students have been given the opportunity to learn and use them explicitly. However,

students are assigned projects to undertake and left to figure out for themselves how to successfully manage them from definition through completion. As Hoyet points out (Hoyet, 2004):

It is critical for students to learn these working skills early in their academic careers, as many teachers in high school assign group projects without providing training in the skills to work successfully in teams. Learning how to plan task lists, task schedules, and how to manage a complex project are skills that students will use in academic and professional environments.

Teaching the fundamentals has always been a key approach to helping students succeed. Students do not start out in kindergarten reading books and writing reports. They have no ability to do algebra or calculus. They are first taught the alphabet and then taught how to sound out words. From there, they go on to learn how to read and write. The same is true in mathematics. They learn the numbers, how to count, how to add and subtract, and then how to do multiplication. Using these tools, students build on this foundation and learn algebra and other more complex mathematical concepts. As an extension of this argument, the question arises regarding which of the key elements of project management could benefit students and serve as a foundation for enabling them to successfully undertake increasingly more complex projects.

Table 8 revisits the key elements of project management that were introduced in *Table 5* and selects those that are the best candidates for a high school curriculum. A discussion of the criteria used to select or deselect the key elements is given in the “Why or why not” column.

Table 8. Selection of Key Elements of Project Management for a High School Curriculum

Key Elements of PM	HS Curriculum Candidate? Y/N	Why or Why Not
Development of a Project Charter	N	This element should be reserved for formal project management training. The product of this element is a document which does not further the goal of skills training through instruction and hands-on practical application. The skills and knowledge area learning potential for this key element are covered in many other key elements.
Identification of Stakeholders	Y	This concept is important at any level of project management training. For a student, the ultimate “customer” is the instructor but could also include fellow students or parents that may be involved in the inputs or outputs of the project.
Document Stakeholder Needs/Goals/Objectives	Y	Understanding what the instructor’s goals/objectives for the project are vital to ensuring a good outcome (i.e. grade).
Develop a Project Management Plan (PMP)	N	A science project may have a “pseudo” PMP that describes similar content as a PMP. This should be briefed to students but is not necessary to actually develop a PMP. As with the “Project Charter”, the product of this element is a document which does not further the goal of skills training through instruction and hands-on practical application. The skills and knowledge area learning potential for this key element are covered in many other key elements.
Development of Valid Requirements	Y	Knowing why they are undertaking a specific project and how to measure or assess if they have met the stakeholders expectations is key to success in a project.

Table 8. con't.

Key Elements of PM	HS Curriculum Candidate? Y/N	Why or Why Not
Define Scope of the Project	Y	It is important that students know and document the boundaries of the project. They should have a firm understanding of what they are allowed/required to do and what they are expressly prohibited from doing in the performance of the project. The timeframe for completing the project and any needed resources should also be documented.
Create a Work Breakdown Structure	Y	This is perhaps one of the most important elements that students should be taught in depth. Being able to breakdown a project/problem in to smaller, manageable components in a logical way is an extremely useful skill from which students will greatly benefit.
Identify and Sequence Activities	Y	Logically ordering the “WBS” elements of the project will enable students to see the activities that have to be done serially and which ones have independent start times.
Estimate Activity Resources	Y	Students should be able to put together a list of the things they will need to procure in order to get each of the tasks completed.
Develop a schedule	Y	This is also a crucial skill to teach to students, especially those prone to procrastinating. Once durations are added to the sequenced list of activities a schedule takes shape. A good schedule will show the minimum time needed to complete the project. Instructors should use this step to discuss what a critical path is, how it is affected by delays, and how to protect it.
Estimate Costs and Create a Budget	Y	Teaching students to put together and stick to a budget should be mandatory regardless of the context.

Table 8. con't.

Key Elements of PM	HS Curriculum Candidate? Y/N	Why or Why Not
Define Project Constraints	Y	As previously discussed in the “Define Scope of the Project Section” identifying and planning around constraints is also a critical skill that students should learn. They should be taught to identify risks to the project early in the planning phase and have a plan for dealing with them if they are encountered (i.e. purchasing extra consumable material in case a mistake is made in measuring and cutting).
Balance Project Constraints	Y	Students need to understand the concept of tradeoffs when faced with deciding how to proceed with a project. Can schedule be sacrificed to ensure quality? Can the budget be increased to meet schedule? If not, what are the alternatives?
Acquire, Develop, and Manage a Project Team	Y	This element can be used to teach students how to work in a team. Additionally, students will learn skills such as leadership, communication, and problem resolution.
Monitor Project Performance	Y	This element will give students experience in communicating project status to stakeholders as well as keeping track of performance metrics on scope, schedule, costs, quality, risk and other project parameters (PMI, 2008)
Closeout the Project	Y	This is probably the most neglected element but should be emphasized as an important part of the entire process. Students will learn how to obtain acceptance by the customer or sponsor, document lessons learned; update processes as appropriate, archive relevant project documents. (PMI, 2008)

Analysis of *Table 8* Key Element / Curriculum Selection

The selection criteria for “Y” or “N” in column two of *Table 8*, just as with the key element selection in *Table 5*, was determined with reliance on the author’s 15 years experience as a project manager or project team member and the familiarity with these key elements through development of hardware and software systems for spaceflight. After down-selecting two of the elements (Development of a Project Charter and Project Management Plan), fourteen are left with which to build a robust high school curriculum. Reviewing the mapping completed in *Table 7* for these key elements shows that there is plenty of overlap in knowledge area and skills training to account for the down-selection of these elements.

Developing a PM-Based Curriculum for High School Students

When determining how to develop a course to teach high school students 21st century skills utilizing a project management framework, one prominent consideration is that it must be relevant to their lives and their interests. In order to establish this relevance, the course should show how students can use the information provided to help them make their lives easier and to achieve the goals they have set for themselves. Whether it be how to better manage their time between school work and extracurricular activities, how to save for buying a car, or how to get into the college of their choice, the skills that will be gained in the study and practical application of these elements of project management will better prepare students in whatever personal or professional path they choose to pursue.

A high school curriculum outline was developed based on this research. The details of the curriculum outline are given in *Appendix A*. The intent of the curriculum is to teach the knowledge and skills in a project management framework while allowing students to choose a project to develop that is relevant to their own lives. Individual projects could include gaining admission to college, buying a car, getting an internship, or completing a scout project. In parallel, the students will have in-class 21st century skills lectures and will perform in-class team project activities that will allow students to practically apply those skills. Lecture materials would be developed by consulting learning science experts to assist in the design and presentation of the material. The author is not an expert in curriculum design and knows that this curriculum outline needs more detail and thought with regards to project design considerations, time-lining, scaling to appropriate grade level, and resource estimation. One element that the author would insist on however is that the students would be engaged in the lectures by ensuring that they actively participate in a dialog about why these skills are important and how they can be most effectively applied in their lives.

CHAPTER 5 Thesis Conclusion and Forward Work

This thesis began by reviewing the history of education and showed how even after 5000 years of evolution, our educational policy is still missing opportunities to teach students critical skills they can take beyond the classroom and into the workforce. The concept of 21st century skills was introduced and the processes and key elements of project management were discussed. After reviewing some of the real-world applications of a project management curriculum in the classroom, an argument was made for teaching these “life skills” within the framework of a project management curriculum utilizing key elements of project management.

Assuming that one were inclined to accept the challenge of taking this argument forward and making it into a workable curriculum, how would they proceed?

Just as any project manager would suggest, the best way to get started on enacting this curriculum is to formulate a good plan. We do not have to look any farther than *Table 5* of this thesis to find that one of the first steps is to identify the people who matter most in this equation: the stakeholders. These are the people who have a vested interest in the benefits of learning 21st century skills and often have the power and influence to make it happen. In this case, the stakeholders would be parents, students, teachers, and local school board members. The stakeholders have to be made aware that project management has been around for a long time and it has proven to be a solid, reliable model for successfully performing tasks of all scales and all levels of complexity. It is this track record of performance and scalability that is the best selling point for using this framework as a new pedagogy for 21st century skills. Stakeholders should also be made

aware of the issues that Byrne outlines in his research (Byrne et.al., 2008) regarding the lack of available resources for introducing new courses and resistance to changing from the status quo. To overcome these obstacles, stakeholders should be provided with a detailed plan that demonstrates how teaching students 21st century skills in a project management framework makes their lives better and their communities better places to live in. Just as with a work breakdown structure, the major pieces of the plan to implement a new curriculum have to be parsed into manageable pieces and assigned to different members, maybe even stakeholders, to own and make sure they get carried through to completion. Bringing in people who have a stake in the problem and having them own part of the solution is often the key to a successful project.

Where to go from here? The first step is performing a more in-depth survey of teachers and education administrators to get their input on this idea and to help better design a curriculum like the one offered in *Appendix A*. Also, following the example of the curriculum that is offered by HP (Hewlett-Packard, 2004), a set of templates and standard project forms would be good additions to the curriculum to help students document their work and keep track of their progress. Taking it a step further, a software module that facilitates this training would strengthen the case for this curriculum as well. Once this information is gathered a proposal package should be put together and presented to a local high school for demonstration and further consideration.

The Case of Susan Evans Revisited

After exploring her options, Susan decided to pursue a career in project management. She talked with her supervisor and they laid out a training and career plan that would give

her the skills, knowledge, and experience she needed to move into a role as a project manager. She enrolled in a series of training courses that exposed her to topics such as business management, leadership development, process control, configuration management, and performance metrics. In addition, she was assigned to a mentor who had been a project manager on some of the company's major spaceflight projects. Susan transitioned into a position as her mentor's deputy project manager where she became recognized as a vital member of the company's project management staff. Today, as a project manager herself, Susan has successfully completed several major projects and is even teaching one of the training courses that she herself took when striving to achieve her goal as project manager. When she's not busy with the latest schedule or budget crisis Susan makes time to mentor new employees and to volunteer at a local high school where she works with students to make sure that they know how to properly scope and manage their assignments without the frustration and confusion that she experienced back in her high school days.

Of course Susan Evans is fictional character but her story is based on the experiences of a real person.

APPENDIX A - Proposed High School Curriculum to Teach 21st Century Skills to High School Students Utilizing a Project Management Framework

This curriculum is a prototype that is designed as an example set of lesson plans to demonstrate how 21st century skills can be taught in the framework of a project management type of learning structure. The author has no background in high school education and realizes that this proposal is most likely lacking the structure and adherence to educational policy guidelines that a certified curriculum would adhere to. Some of these individual lessons will probably take multiple sixty-minute class period to complete.

Lesson 1 – Course Introduction

Objective: To introduce students to 21st century skills, explain why they are important, and lay out how the course will use the project management framework and PM's key elements to teach them the principles and practical application of 21st century skills.

Outline:

- I. 21st Century Skills
 - a. Listing of 21st century skills and knowledge areas
 - b. Discussion of why they are important and how they are practically applied
- II. Project Management
 - a. What is a project?
 - b. What is a project objective statement?
 - c. What is project management
 - 1. Framework/lifecycle
 - 2. Process groups
 - 3. Key terms

Homework assignment: Students will be assigned the task of choosing a project that they will take through the project development process. The project should be a goal that is relevant to the student and should be an undertaking that the student actually wants to accomplish. Examples of an individual project include: a scouting project, gaining admission to a university, buying a car, getting a job, performing a community service like refurbishing a city park, etc. The student will develop a project objective statement (POS) that includes all of the elements of a POS discussed in class. The assignment will be due at the beginning of the next class period.

Lesson 2 – Skill Training “Communication” / PM Definition Phase

Objective: Skill - To understand the importance of effective use of verbal and written communication. Also to discuss the different types of communication media and what type is most appropriate in different situations. Students will learn how to avoid miscommunication. PM – Students will learn the definition phase in the project management life cycle.

Outline:

I. Communication

- a. Importance of effective communication (verbal and written)
- b. Different media and the appropriate usage of each
- c. Common types of miscommunication and how to avoid it

II. Project Management – Definition Phase

- a. Identification of Stakeholders
- b. Document Stakeholder Needs/Goals/Objectives
- c. Development of Valid Requirements
- d. Define the Scope of the Project

In class assignment: Students will be introduced to an in-class project assignment that will involve the project development of a multi-element hardware/ software system in teams of 4-5 members. Each team will be assigned a single element of the system and begin to develop a set of requirements given a set of stakeholder NGOs. Teams will not be chosen until the next lesson but until then, students should work individually to make a list of requirements based on the class discussion of what are valid requirements. Students should also write a project objective statement from the project description document they will be provided.

Homework assignment: Students will identify stakeholders in their personal projects (from the first homework assignment) and list at least one formal requirement for each of the stakeholders identified. Students should also develop a major milestone schedule identifying at least 4 milestones with target dates.

Lesson 3 – Skill Training “Collaboration” / PM Planning Phase

Objective: Skill - To understand roles and responsibilities of project team members and the importance of collaboration with a project team. Understand that people often have different perspectives, working styles, and ways of processing information and how these differences serve to make a team stronger. PM – To understand the deliverables of the planning phase and create them for their in-class and homework assignments.

Outline:

I. Collaboration

- a. Importance of working effectively and respectfully with others
- b. Ensuring that all members of a team are heard and their opinions are valued equally
- c. Being flexible and making compromises to achieve a common goal

II. Project Management – Planning Phase

- a. Creating a Work Breakdown Structure
- b. Identifying and Sequencing Activities
- c. Estimating Activity Resources
- d. Developing a schedule
- e. Estimate Costs and Create a Budget
- f. Define Project Constraints/ risks / external dependencies
- g. Balance Project Constraints/ risks / external dependencies

In class assignment: Students will be grouped into project teams for the multi-element hardware / software system project assignment. The teams will start out by choosing a project manager, a resource estimator, a scheduler, and a designer. The team should work together to review the individually developed deliverables from the definition phase and merge all of their inputs into a single project objective statement and a single list of valid requirements. The team will then work together to develop the planning phase deliverables (work breakdown structure, resource estimates, schedule, project constraints including a list of external interfaces). Interface information will have to be requested of other teams and should include mechanical, electrical, and human interface considerations.

Homework assignment: Students will create a WBS, schedule, and budget for their individual projects. Students will also identify any constraints, risks, and external dependencies that could affect the cost or schedule of the project.

Lesson 4 – Skill Training “Leadership” / PM Execution Phase

Objective: Skill - To understand what it means to be an effective team leader. Understand what situational leadership means. PM – To understand the deliverables of the execution phase and create them for their in-class and homework assignments.

Outline:

I. Leadership

- a. Common mistakes of leaders
- b. What it means to be an effective leader
- c. Situational leadership
- d. Conflict resolution
- e. How to provide feedback and motivation

II. Project Management – Execution Phase

- a. Acquire, Develop and Manage a Project Team
- b. Monitor Project Performance

In class assignment: Each project team will work to build a mockup of their assigned component of the multi-element hardware / software system. The teams will ensure that their system conforms to the set of requirements documented in the definition phase and will perform interface testing with other teams (as required) to ensure that all interface requirements are verified as well. Any discrepancies in conformance to requirements will either be corrected or documented as non-conformances in the final report.

Homework assignment: Students will compile all of the project phase deliverables into a report and submit it at the beginning of the next lesson. The report will contain an assessment of the likelihood that the student will carry out the plan as developed. The student will also include a statement regarding the usefulness of this exercise and the likelihood that the skills taught and the project management framework will help them to be successful with future projects.

Lesson 5 – Skill Training “Critical Thinking” / PM Closeout Phase

Objective: Skill – To understand and use different types of reasoning and systems thinking to solve complex problems. How to analyze, synthesize and interpret information. PM – To understand the deliverables of the closeout phase and create them for their in-class assignment.

Outline:

I. Critical Thinking

- a. Effective reasoning
- b. Systems thinking
- c. Analyze information and draw logical conclusions
- d. Innovation in design and problem solving

II. Project Management – Closeout Phase

- a. Final Acceptance from sponsor
- b. Reviewing lessons learned
- c. Updating processes accordingly and archiving project documentation.

In class assignment: Each project team will develop a final report on their part of the multi-element hardware / software system project and present it to the rest of the class. The final report will include an acceptance report showing verification compliance of all documented requirements (including interface requirements), any non-conformances, a list of lessons learned, and an overall assessment of their team’s performance.

Homework assignment: N/A

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