AC 2010-711: CONSTRUCTION-RELATED ACTIVITIES FOR STUDENTS IN 1ST - 8TH GRADE

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Construction-Related Activities for Students in 1st - 8th Grade

Abstract

Three distinct programs Pittsburg State University uses to promote the understanding of the construction industry to children in grades 1st through 8th are Block Kids, If I Had a Hammer and Construct Your Future. These programs are ongoing activities aimed toward promoting the construction industry aided by the Construction Management/ Construction Engineering Technologies faculty and students at Pittsburg State University.

Block Kids

Block Kids is an event that is sponsored by the National Association of Women in Construction (NAWIC). This annual event is open to children that are currently enrolled in grades 1 through 6. Prior to the event, event staff solicit prizes from local merchants. These prizes are as closely related to construction as possible. For instance the local lumber company donates hammers, wrenches, and tool pouches. Some merchants donate gift cards so that the event staff can purchase prizes to their liking.

The day of the event every student is required to have an Official Registration/Entry form signed by a parent or legal guardian in order to participate (See registration form Appendix I). Students are assigned to groups that correspond to their grade level. Each student is given 100 regular sized Legos, a small rock, a piece of string no longer than 12", and a piece of aluminum foil no bigger than 18"x 18". The foil can be ripped into smaller pieces if desired by the student, but no scissors are allowed. Students are asked to build a construction project from the materials provided, and they are given one hour to construct their project. All parents or guardians are asked to leave the room while the students are constructing their projects. All building projects must in some way relate to the construction industry. (Examples include: bridges, houses, skyscrapers, retail shops, etc.) After the one-hour time limit, students are then judged by college students, industry persons and faculty volunteers. Each judge is given 3 to 4 students to review, usually in the same grade level. The judges are given a series of 7 questions to ask each contestant. These questions include[1]

1. Tell us about your project.
2. What were you thinking about when you decided to build this?
3. Who will use this? (What will people be doing when they use it?)
4. If you did this again, would you build it the same way, or are there parts you would want to change?
5. Do you know about different types of construction work? What kind do you think you would like best?
6. What would you like to be when you grow up?
7. Why did you come to the contest?

After these questions are asked, the contestant's project is then scored in 7 different areas including[2]

1. Originality/creativity (1-25 points)
2. Attention to detail (1-10 points)
3. Use of provided material(s) (1-10 points)
4. Oral presentation (1-25 points)
5. Enthusiasm (1-10 points)
6. Reason for participation (1-10 points)
7. Bonus points (Judge must state reason) (1-10 points)

Students constructing their projects

Each grade level is awarded prizes for first, second and third place. Prizes awarded include tool boxes, tools, toy construction equipment, hats, pizza coupons, and gift cards. Then all the first place winners are judged to determine first, second and third overall. The prizes for overall winners have been $100, $75, and $50 U. S. savings bonds.

If I Had a Hammer

The If I Had a Hammer program was started in 1987 by Perry Wilson. Mr. Wilson started out as a carpenter and found out that he could solve complex math problems on the job that he could never solve in the classroom. Mr. Wilson then decided to apply experience to education in order to help others learn from his experiences. This caused him to create a learning system devoted to developing programs and products to serve children who are in greatest need. If I Had a Hammer holds three basic beliefs regarding education:

1. Every child can learn if engaged properly
2. Success is available to every child
3. Children need to understand the value of education as a foundation for their life.

It is Mr. Wilson's belief that showing a child how math works in the real world will teach them in an engaging way that no conventional textbook can match. The program's goal is to create an atmosphere that welcomes mistakes and risks equally, that allows a child the freedom to ask questions and learn. Students should recognize that education is the key to personal growth and development and that success is available to anyone who is willing to make an effort and to make a commitment as part of their everyday life[3].

The entire program is a forty-two instructional hour program and is designed to "jump start" students who are struggling in mathematics. The fun, hands-on approach serves to reduce student anxiety while improving mathematic skills and attitude. All materials are aligned with the National Council for Teachers of Mathematics (NCTM). Major areas covered in this program include measurement, fractions, scaling, perimeters, areas, volumes, angles, patterns, and solving for the unknown[3].

A key element in the If I Had a Hammer program is the Hammer House. It consists of a free-standing, eight-foot-by-eleven-foot modular house that students assemble while on the Hammer field trip during the Hammer Math portion of the program.

A checklist for organizing the required material and equipment are followed to ensure all needed materials and equipment are present and functional before the students arrive. Materials needed include the walls, siding, windows, door, roof tin, porch posts, plywood subfloor, nail pouches, and screws. Required equipment includes charged cordless drills, screw driver bits for drills, ladders, hammers, tape measures, calculators, safety glasses, and nail pouches.

After being outfitted with safety glasses, a nail pouch, hammer and a calculator, the students are gathered in front of the leader who introduces him or herself as the boss. The boss explains the difference between a boss and a teacher. The boss explains that a good boss is a good teacher, but could fire you if you do not meet his or her expectations. Next the boss explains the importance of safety. The boss demonstrates the proper use of safety glasses, how to use a hammer safely, and how to wear the hammer on the nail pouch to avoid injuries. Then the boss directs the students through a few muscle stretching and breathing exercises.

Next, the boss discusses floor joists and measurements taken with a tape measure. He measures and discusses the distances between the floor joists, plywood and the markings on the tape measure itself. Then a sheet of plywood is laid down on the floor joists to create the subfloor. Before the sheet is attached to the joists, the safe use of cordless drills is discussed along with the importance of knowing how and when to use the drill. Then a few students take turns in using the drills to attach the plywood to the floor joists. During that time the importance of planning ahead on the job is discussed to make the students aware of how to manage their time so that they can be productive.

Measuring floor joists

After the subfloor is completely attached, the students are assigned to four groups. Each group consists of five or six students. Groups are assigned a portion of the house based on four colors: red, green, yellow and blue. All the building members of the house are painted with one of four colors to reflect which team installs which piece of the house. The boss then reminds each group about how to handle the preframed walls in a safe and orderly manner, telling them never to walk backward when carrying wall sections. The individual groups lift and secure the walls into place one at a time until the entire outside wall frame is constructed. The walls are then screwed together at each corner with the importance of securing the walls together being explained to the students.

Installing wall framing

When the wall framing is in place, the students are gathered in front of the house by the boss. The boss asks questions of the students about the size of the house and how big they think it is. Using a white board the boss explains the area of a house by drawing it on the white board. Dimensions of the house are discussed in regard to its length, width, perimeter and area. The students along with the boss figure the perimeter of the house as well as its area. Then the boss gives the students the area of a sheet of plywood and the students are ask to figure how many sheets of plywood will be required for the area that they just figured. After the number of sheets is determined, the students are given a cost per sheet of plywood and are asked to figure the total cost of the plywood needed.

Discussion of house measurements

After the cost of the plywood is determined, the installation of the wood trusses begins. The boss explains how the trusses are to be installed as well as the proper use of ladders. As the green team brings in the first truss, the other groups are asked to move to the side to give the group the room they need to maneuver the truss being installed. The teams are asked to describe what they think teamwork means. The the rest of the groups will watch as each team gathers the ladders and the trusses and works with the boss to set the trusses safely in place.

The students are then gathered in front of the house to discuss the importance of math as it relates to construction. The tape measure and its markings are discussed with the students, showing the different fractions of an inch. The boss shows the differing fractions that together add up to one inch and how to read the fractions on the tape measure.

Next, the groups are asked to bring the siding pieces to the front of their particular wall frame to be installed. Again safety is emphasized so that the pieces do not drop onto someone's toes. The use of safety glasses is also reinforced. The process of setting the siding in place is explained to the students so that the inside of the siding will be flush with the window or door openings. The installation of the siding requires the aid of the boss and three adult volunteers. After the wall siding is installed, everyone gathers to install the siding on the gable ends of the house.

The students are then gathered to the front of the house for another question-and-answer session with the boss. Students are asked if they would do math for a penny, then for a quarter. How about for five dollars? The use of mathematics in the real world is explained to the students showing them that most jobs involve the use of math in some way. The students are then asked what they want to be when they are out of school.

The boss asks for three volunteers who would like to work for him. He conducts interviews with the three students asking them questions about their skills and educational background. He explains the importance of first impressions, how to look the interviewer in the eyes, using a good handshake, and being able to tell the interviewer why they should be hired. He also has them tell about their good qualities. After interviewing three or four students, the top candidate is given five dollars and told that they have the job.

Job interview

Windows and the front door are the next items to be installed. Each team gets either a window or a door. After these are installed, the porch posts along with corner trim and porch fascia are installed by the teams. To install the roof, adult volunteers and the boss install the corrugated metal roof panels. These panels have sharp edges, and for safety concerns the student teams just watch as the roof is installed.

After the roof installation the students are asked to push on the corners of the house to see if the structure is sturdy. The students are then asked why they think the house is so strong. The importance of planning is again mentioned. The students are all invited inside the house to see the interior and look at how all the framing members tie together.

The students then return all the tools and materials issued to them prior to leaving the assembly area. After all the students have left the assembly area and headed off to another activity the adult volunteers and boss disassemble the house and stack the pieces in areas according to their color in preparation for the next group of student builders. The structure is designed to be assembled and disassembled one hundred times before a new kit is required.

An independent third-party evaluation of students participating in a Hammer Math program revealed the following changes in math attitude:

85% have a better understanding of why math is important
60% are more confident that "I can learn math"
65% understand math in my regular class is easier
85% see math as being useful in solving real-life problems
95% think other kids my age would like to be in Hammer Math[3]

Construct Your Future

Construct Your Future is a week-long, half-day summer workshop program developed by the Pittsburg State University faculty for students in grades one through eight. This program is designed to introduce young students to the practices and principle of the construction industry. The program provides students with basic engineering and construction practices as well as giving them hands-on experiences relating to the principle, and practices learned.

Students are first given an overview of differing types of construction. These areas include residential, commercial, industrial and civil/heavy construction. They are shown visual examples of each of these types of construction via a PowerPoint presentation.

Common construction industry roles are presented to the students with explanations regarding what each individual's responsibility is and how it relates to completing a construction project. The roles presented to the students include that of an owner, general contractor, architect, engineer, specialty contractor, and material supplier.

Construction safety and its importance are discussed with the students. Personal protective equipment and their required use are explained. Students are required to wear a hard hat, safety glasses, and proper shoes for all hands-on activities that they participate in throughout the week. Also covered are areas of construction that require hearing protection, breathing protection, fall protection, and trench safety. The importance of a safe jobsite and wearing proper personal protective equipment is stressed before beginning all hands-on construction activities.

The basics of construction design are explored with the students. First, the effects of weight and gravity are discussed. Units of measure for weight are explained in pounds and kilograms. Next, the density of differing construction materials is explained. Structural and building loads are discussed. Differing load characteristics are presented, including live, dead, wind, and earthquake and the effects they have on a structure. Using two sets of bathroom scales with a board placed between the scales, a student is asked to stand on the center of the board, and a reading from each scale is taken. Then the student is asked to move closer to one of the scales, and a reading on each scale is again taken. This shows the students load reactions based on the position of the load. Four sets of bathroom scales are used to simulate four columns of a building. Concrete blocks are placed on each scale with a plywood sheet over the blocks to simulate the floors of the structure. Weight is placed in several locations on the plywood floor to show the students the differing reactions on each column based on the position of the load being applied. Pushing on the structure to simulate wind loads shows the students how the load is transferred to the columns in differing amounts. Rocking the structure back and forth to simulate earthquake conditions is also done so the students can see how drastic the load reactions can fluctuate depending on the severity of the loads being applied.

Pressure or weight per area is the next area of exploration. Students are asked to weigh themselves and estimate the pressure that their weight exerts on the concrete floor in pounds per square foot. They are then asked to determine the pressure on each column base of the building model. Lateral pressure is discussed by placing PVC pipe standing upright. The pipe has small holes drilled in the sides at six inch intervals. Each hole is plugged before the pipe is filled with water. The students are asked to calculate the weight of the water and the pressure at each level of the pipe and try to determine which hole in the pipe will squirt out the longest stream of water.

Compression verses tension is presented with examples of compression being demonstrated such as stepping on a can. Tension loads are presented by letting students pull on a hanging scale while sitting in a chair to see how much tension is required to pull them forward. The properties of differing materials are discussed with special attention given to which loads, tension or compression, each material is capable of holding.

The properties of concrete material are explored along with the ingredients that make up concrete. Students then go into the materials laboratory and mix up the proportions of rock, sand, cement and water to make up a concrete mix. The students then make a test cylinder using a plastic mold. Their test specimen is then tested in compression in a later session so they can see how the strength of their mix is performing.

Students are then taken to the computer lab to use AutoCAD Revit Architectural to design their dream house. They are shown the basic steps of using the Revit Architectural program and then are given the freedom to design the house of their choice.

The basic concepts of bridge design are shown to the students as well as the differing types of bridge designs. A diagram is shown to the students showing the structural members of a bridge and which members are in tension and which members are in compression. The students are then introduced to the computer program WestPoint Bridge. This program allows the students to select a bridge to design. The program allows the students to select the shape and size of the

members they use in their bridge as well to as keep a total cost of the bridge as the members are selected. After members are chosen, a load test is then preformed on the bridge to check its stability. A simulated truck is shown driving over the bridge with the bridge structural members highlighted red or blue to show which members are in tension and which ones are in compression. If any structural member is too weak, the graphic will show the bridge collapsing and in some cases show the truck falling through the bridge structure. If the truck makes it completely across the bridge the student can go back and alter the design using smaller structural members and then load test the bridge again. Each time structural members are changed the cost of the bridge is updated to reflect the change. The object of this exercise is to complete a bridge that will withstand the load test and achieve the lowest cost.

Specialty contractors are the next topic presented to the students. Differing specialty contractors are discussed and the students are given examples of these contractors and how they relate to the overall construction of a building project. Specialty contractors discussed include electrical, mechanical, site work, paving, roofing, masonry, and interior finishes.

Students are presented with an existing wood-framed wall that requires electrical and plumbing rough in to be installed. The students are assigned to teams, which include a project manager, electrical superintendent, plumbing superintendent, estimator, field engineer, and a safety manager. The responsibility of each position on the team is explained to the students so that each will know what their responsibilities are for the position they chose. The team is given a blueprint of the wall with all the required electrical and plumbing locations being shown. From there they have to figure out the quantity of materials needed and the best way to install them. They have to order the proper amount of materials and have them available so that they can all be installed in a timely manner. Each student assumes the responsibility for his or her position on the team to ensure the project is completed as shown on his or her blueprint.

A group planning/estimating exercise is the next scheduled activity. Students are split into groups of 3 to 5 and are ask to construct a tower out of large Legos. The tower consists of 27 blocks. A model of the completed tower is placed in an adjacent room and is the only thing the students have to go by to construct the tower. One member of each group is allowed to go into the adjacent room to look at the tower and then convey to the group how the tower is to be constructed. Each member of the group takes turns going into the adjacent room to look at the tower and then convey building instruction back to the group. This is done until the tower is finally completed. 10 seconds are added to a team's time for any pieces that are not in the exact location as the models. The group that completes the tower in the shortest amount of time after any penalties are accessed is the winner. After the towers are complete, problems with construction are discussed. Areas such as communication, making an accurate tower, and how to make the construction go easier are mentioned. Next a more complicated hotel project is given to the student groups. The hotel consists of 45 large Lego blocks. Each team is given 15 minutes to develop a plan of activities for the construction of the hotel. Each team develops an estimate of the time they think it will take to construct the hotel which is due five minutes after the review of the rules. Each team is given 1 minute to layout their work area after the 15-minute planning session. The team is not allowed to build the structure during the planning portion, but can layout each floor with the blocks properly arranged. During the planning exercise each group is given the plans to the hotel showing the block layout configuration for

each floor. After the planning session the clock starts and construction begins. A team is penalized 10 seconds for each second that they go over their estimated time and 10 seconds for each piece that is not in the proper location. The team that finishes in the least amount of time after penalty minutes are accessed is the winner. After the competition the students are asked, what difference did planning make on the success of the hotel project? And also, what differences occurred from the hotel project verses the tower project?

The last area students are introduced to in the Construct Your Future program is the use of global positioning systems (GPS). How GPS receivers obtain their signals from satellites and how coordinates are shown on the receivers is discussed with the students. Students are then shown examples of the uses of GPS in construction. Then students are instructed in the use of hand-held GPS receivers. Students are split into groups and given coordinates of objects that are located in the yard area outside. The students are then taken outside and instructed to find the objects with the use of their hand-held GPS receivers. The first group to retrieve all their objects is declared the winner

Bibliography

1. NAWIC Block Kids Building Program Official Oral Interview Questions/Revised March 2003
2. NAWIC Block Kids Building Program Judging Form/Revised March 2003
3. http.//www.ifihadahammer.com/

Appendix I

Official Registration/Entry Form

Please fill out all information requested. Please print legibly,

STUDENT'S NAME:

STUDENT'S SOCIAL SECURITY NUMBER*:

MAILING ADDRESS:

CITY, STATE, PROVINCE, ZIP:

PARENT/GUARDIAN NAME:

HOME PHONE NUMBER:

SCHOOL:
SCHOOL STREET ADDRESS:
TEACHER:
GRADE:
City, STATE, PROVINCE, ZIP:

*Required for U.S.Savings Bond

RELEASE

I hereby consent to the use of my child's name, photograph, entry, interview in promoting or publishing this program or the NAWIC Education Foundation now or at a future date. Further, I understand that this entry shall become the sole property of the NAWIC Education Foundation.

SPONSOR

(Sponsor/Region)

(Mailing Address)

(City/State/Zip)

(Signature Representative)

Must be received by:

(Signature of Parent or Guardian)

(This form must accompany entry at all levels of judging.)

ELIGIBILITY REOUIREMENTS/CONTEST-RULES

ELIGIBILITY

This contest is open to ALL children, currently enrolled in grades one (l) through six (6), except PRIVIOUNATIONAL WINNERS. Entry in contest must be through a RECOGNIZED SPONSOR,

RULES

l. All building projects must be completed where and when designated by Sponsor.
2. All building projects must be completed within the allotted time.
3. All building projects must be completed using approved materials only.
4. All building projects must be relevant to the construction industry. Projects which depict people or animals will not be allowed.
5. All building projects must be completed by entrant, with no outside assistance from parents, teachers, etc.
6. Every participant must submit the Official Registration/Entry Form, signed by a parent or Guardian.