

# Math & Construction: Curriculum, Community, & Career Connections

[www.tinyurl.com/Math-Construction](http://www.tinyurl.com/Math-Construction)

Created and Presented By:

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1. Connect to the community & utilize community resources
  - a. Learn from community resources & expose students to opportunities
    - Invite guest speakers/visitors to your classroom
      1. Professionals to share what they do in their career & how math is utilized
      2. Professionals answer student questions, hear student ideas, & provide feedback
        - MUSIC Model of Academic Motivation (Jones, 2009).
          - i. Students need to feel e**M**powered
          - ii. Students need to perceive what they are doing is **U**seful
          - iii. Students need to experience **S**uccess
          - iv. Student need to take an **I**nterest in a topic
          - v. Students need to believe that others **C**are about their work (Jones, 2009).
        - Examples: Habitat for Humanity, Project Library, Project DESTINE
    - Promote first-hand experiences
      1. Field Trips – Example at - [www.riverbender.com/articles/rockhill-fieldtrip/index.cfm](http://www.riverbender.com/articles/rockhill-fieldtrip/index.cfm)
      2. Carpenters' Training Center - [www.carpenters.org/training\\_centers/il/](http://www.carpenters.org/training_centers/il/)
      3. SIBA Career Expo – October 17-20, 2022
        - Contact Donna Richter @ [dmr@siba-agc.org](mailto:dmr@siba-agc.org)
      4. Manufacturing Day –September 2022
        - Contact Mark Bosworth @ [Mark.Bosworth@swic.edu](mailto:Mark.Bosworth@swic.edu)
      5. Other Opportunities
        - Contact your CTE System Director - [https://www.isbe.net/Documents/efe\\_directory.pdf](https://www.isbe.net/Documents/efe_directory.pdf)
      6. FREE Summer Camps and/or Internships
        - a. Ex - Around the country – Ts (<https://bit.ly/3yHZZIE>) & Ss (<https://bit.ly/3NJs1q4> )
        - b. Ex – E. St. Louis - Ss ([www.r3dev.org](http://www.r3dev.org)) & ([www.lansdowneup.org](http://www.lansdowneup.org))
  - b. Engage students in projects/problems/activities involving their community, potential careers, & pathways
    - Projects
      - Provide letters, videos, etc. from the community asking students for help with a project
        - Video on Lansdowne Up @ <https://www.bnd.com/news/local/article259402829.html>
      - Consider utilizing the engineering design process & allow students to take on career focused roles
        - Remijan, K. W. (2017). Project-Based Learning and Design-Focused Projects to Motivate Secondary Mathematics Students. Interdisciplinary Journal of Problem-Based Learning. <https://doi.org/10.7771/1541-5015.1520>
    - Problems/Activities
      - Incorporate other subjects, career connections, real-world terminology, & hands-on work
      - Calculate costs w/ real data (Quote sheet found as an additional doc @ <http://www.tinyurl.com/Math-Construction>)
- A. Architect or Drafting Technician
  - **Activity** – Create a floorplan & elevation for a house to be built in the new Lansdowne Development.
    - By hand using grid paper – Grid paper available @ <https://incompetech.com>
  - **Activity** – Use an architect (or drafting/architecture student) created design plan and build a 3d model.
  - **Activity** – Replicate your bedroom, the classroom, or a bedroom from a floor plan with Google Sketchup found at <http://edu.sketchup.com/> (ex @ [https://youtu.be/CiosiCO\\_oLU](https://youtu.be/CiosiCO_oLU) and <https://youtu.be/ziub5SbFzks>)
  - Community College Resource: <https://www.swic.edu/academics/career-degrees/computer-aided-design/>

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### B. Builder or Developer

- Review property lines & measurements using a known address or parcel number via the county’s mapping and platting office at <https://www.co.st-clair.il.us/departments/mapping-platting>
  - How to use Mapping & Platting County GIS software video @ <https://youtu.be/a7GKVI5iFMI>
- Understand zoning requirements and easement restrictions when considering development of lots
- ***Problem*** - A piece of property, parcel number 02170105020, was acquired by the Lansdowne LLC. What is the address? What are the dimensions of the lot? Will the home you designed or a home similar to the provided Habitat for Humanity plan fit on the lot?

### C. Surveyor

- Land Survey
  - ***Activity*** - “Stake out a lot” and/or position a house on a lot
  - Conduct an Impervious Land Survey - [https://digitalcommons.imsa.edu/pfs\\_tr/24/](https://digitalcommons.imsa.edu/pfs_tr/24/)
    - ***Problem:***
      - ✓ Find the area of the footprint for a building
      - ✓ Find the area of the tract of land that the building sits on
      - ✓ What is the impervious surface percentage for the square tract of land?
      - ✓ If the tract of land is zoned with a 15% impervious surface limit, how much area could still be covered with asphalt, concrete, etc. on this tract of land?
- Cell Tower Surveys - <https://tinyurl.com/yckh5uas>
- Tree Surveys
  - Resources
    - <https://extension.psu.edu/a-guide-to-preserving-trees-in-development-projects>
    - <https://www.deltalandsurveying.net/tree.htm>
      - Locate/map trees 8 inches in diameter
      - Allow engineers & architects to design plans in relation to the trees on the property
        - ✓ “...and allows the design of drainage, retention areas and utilities serving the project ... to determine which trees may need to be removed from the site”.
- Community College Resources/Opportunities
  - Parkland Community College (Champaign, IL) – Instructor Kory Allred - [kallred@parkland.edu](mailto:kallred@parkland.edu)
  - SWIC – ENGR 251 – Class held on Saturdays in Fall <https://www.swic.edu/academics/transfer-degrees/engineering/curriculum/>
- Research
  - Kory Allred from Parkland College explained that he measured heights of trees to help a researcher to determine whether drones were able to accurately measure tree height.
    - ***Problem*** - Find the height of a tree (NOTE: I recommend that teachers invite a surveyor to their school, talk w/ students about training/skills needed, show his/her Total Station/Drone, and then provide an accurate measurement to check student results.  
3 Methods:
      - a. Find the height of a person and use estimation and addition
      - b. Use a clinometer (angle of elevation) & trig (or isosceles triangles)
        - ✓ Handmade Clinometer- <https://bit.ly/3Aj85Zh>
        - ✓ Classroom Clinometer - <https://www.geopacks.com/products/clinometer>
      - c. Use a Smartphone App – <https://bit.ly/3ocOLV0>

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### D. Construction Project Manager

- Construction managers oversee all aspects of the building process
  - Drones are being used to monitor/communicate progress w/ clients, improve safety, & estimate inventory
  - Resource: <https://uavcoach.com/drones-in-construction/>
- 2-year College Resource - <https://www.swic.edu/academics/career-certificates/construction/construction-management-technology/>
- 4-year College Resource - <https://www.siue.edu/academics/undergraduate/degrees-and-programs/construction-management/>
- **Activity:** Fly a Quadro Copter and land at various assigned “ground control” or “wayward points”
- **Activity:** Use a drone image in Desmos to identify points, etc. Ex - <https://www.desmos.com/calculator/e0za6r74gj>
- **Activity:** Use a drone captured image in GeoGebra & find the area of the construction site. <https://www.geogebra.org/geometry/rhkvvdtf>

### E. Carpenter

- Walls are made up of studs and plates (<https://youtu.be/Wlg8LOHmbtw>)
  - Studs are vertical
    - Standard size is 2x4 (actual size is 1 ½ inches x 3 ½ inches)
    - Typically, placed 16 inches apart along the length of a wall
    - Studs can be hardwood or softwood timber, but are typically soft being Spruce, Pine, or Fir excellent strength to weight ratio...A LOT of wood comes from Canada
    - More studs are used at doors, corners, and windows for extra strength
    - Vertical framing must be “plumb”
      - ✓ Plumbness can be determined w/ a bubble level, laser level, or plum bob (<https://youtu.be/ZuRtD9ZOSSE>)
  - Plates are horizontal
    - Plates are basically studs on their back... Plates at the bottom and top of a wall
    - Horizontal framing must be “level”
      - ✓ Levelness can be determined w/ a bubble level, laser level, or plum bob
- **Problem:** Estimate the # of studs & cost for studs to frame a room, garage, or house given blueprints
  - Note: The number of studs can be estimated to equal the number of *linear feet* (one foot measurement along a line).. (Reference: A Blueprint for Geometry. Retrieved from <https://archive.org/details/blueprintforgeom0000fult> )
  - Cost per stud is \$4.48 (quote from Lowes 6.26.22)
- **Activity:** Build a wall with studs & plates laying down and then stand into place
- **Problem:** Walls & corners must be “square”. Using only a tape measure, how can be determine that the wall is square and corners are square?
  - Ans1 @ <https://youtu.be/NGXvnt6yFZw> & Ans2 @ <https://bit.ly/3Rc3G0h> & Speed Square
- Roof trusses are pre-engineered triangular framing that can be installed to form the roof of a building
  - Resource: <https://www.bestwaytoframe.com/roof-trusses>
  - **Problem:** Find the truss angles <https://www.mathgiraffe.com/blog/geometry-with-roof-trusses>

### F. Bricklayer

- **Problem:** If the front façade of a house is to contain brick, determine the area to be covered in brick, & the # of bricks needed. (Note: Mortar thickness is 3/8 inch (same as diameter of a piece of chalk.)
- Contact the Bricklayers about visiting the classroom to do a brick laying activity
  - Similar to the activity conducted at Career Expo: <https://youtu.be/L4abROfXFIk?t=44>
  - Union Resource: <https://bac8il.com/contact-us>

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### G. Roofing Contractor

- Estimators use a tape measure & trundle wheel to take measurements for replacing an existing roof
- Estimators use architectural rulers to take measurements from blueprints for new construction.
- Notes:
  - Shingles & felt create a protective barrier on a roof so that water does not leak into a building
  - 10% should be added to the roof's area for shingles as well as felt
    - Resource: <https://www.roofingcalc.com/how-to-measure-and-estimate-a-roof-like-a-pro/>
  - Shingles can be sold by the Square (100 sq ft) or the Bundle (33 1/3 sq ft)
  - A bundle of architectural shingles costs \$32 (quote from Home Depot, 6.26.22)
  - A Square of architectural shingles costs \$90 (research 6.26.22)
  - A roll of felt covers 2 Squares and costs \$22 (quote from Home Depot, 6.26.22)
  - Labor to install a roof is approximately \$2.25 per square foot (research 6.26.22)
- Installers must be harnessed to a line anchored to the ridge of the roof
- Union Apprenticeship Training: <https://unionroofers.com/where-we-are/#/?filter=State-%3AIL>
- **Problems:**
  - a. Identify the type of roof (gable vs hip), take measures, determine the area to be roofed with felt & shingles, and calculate the cost for materials and installation using the given blueprints.
  - b. Find the slope of a roof using an image in Desmos & write a corresponding equation of the rafter, <https://www.desmos.com/calculator/pt4im8eyrt>

### H. Glazing Contractor

- Determine energy efficiency
  - Note: “The amount of glass on the exterior walls of a (building) affects its energy efficiency. Windows are a major source of heat loss in the winter and a large source of heat gain in the summer. A rule of thumb is that the area of the windows should be approximately 10% of the area of the (building) to provide a balance between natural lighting and excessive energy consumption” (Fulton & Lombard, 1997, p.40, retrieved from <https://archive.org/details/blueprintforgeom0000fult>)
  - **Problem:** Find the total area of the windows and divide by the square footage of house to determine the % of glass for energy efficiency.

### I. HVAC Technician or Mechanical Engineer

- **Problem:** Determine the cubic ft of space within the classroom to be heated & cooled
- **Activity:** Determine the HVAC load and the size of the HVAC unit for a house using given blueprints.

(Surface in square feet) x (height of the ceiling)

+ (# of occupants) x 100 BTU + (# of exterior doors) x 1,000 BTU + (# of windows) x 1,000 BTU

= Total HVAC Size in BTU's

- Formula Resource: <https://indeedhi.re/3mp1Kn6> (What does BTU stand for?)
- Example of HVAC Curriculum - <https://www.swic.edu/academics/career-degrees/hvacr/curriculum/>
- Community College Resource: SWIC – Keith Otten, HVAC Coordinator - [keith.otten@swic.edu](mailto:keith.otten@swic.edu)

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### J. Electrician or Electrical Engineer

- Union Resource: <https://www.ibew309.com/>
- **Activity** - Read Blueprints to Determine # of Lights/Switches/Outlets Needed in Building a House
- **Problem**: Calculate Area & Determine Lumens Needed for a Room
  - Reference: <https://www.alconlighting.com/blog/residential-led-lighting/how-do-i-determine-how-many-led-lumens-i-need-for-a-space/>
- **Activity**: Use a multimeter to collect & graph data - [https://digitalcommons.imsa.edu/pfs\\_tr/5/](https://digitalcommons.imsa.edu/pfs_tr/5/)
- **Problem**: Determine how many sq feet of south facing roof top space is available for solar panels
  - Note: Solar panels can reduce electricity usage and positively impact the environment. Most solar panels in the United States face south since maximum sunlight comes from the South all year long. Solar panels can be placed on tops powering homes & buildings.
- **Problem**: Determine the maximum # of panels that could be installed on a south facing rooftop. Then, use <https://sunroof.withgoogle.com/> to determine solar savings and/or the potential of the community.
  - Note: Residential solar panels are about 5.4 feet by 3.25 feet.
- **Activity**: Build a circuit (Reference: [https://youtu.be/KgnX-CZE\\_44](https://youtu.be/KgnX-CZE_44))
- **Activity**: Create a circuit to light up a light (create a front porch light for a house model).
- Solve equations involving Ohms Law - [https://www.electronics-tutorials.ws/dccircuits/dcp\\_2.html](https://www.electronics-tutorials.ws/dccircuits/dcp_2.html)
- Work on cell towers, light posts, in addition to wiring homes, etc.
- Measure and Bend Conduit
  - <https://www.mathscinotes.com/2018/01/electrical-conduit-math/>, <https://bit.ly/3szoR0e> , <https://www.kleintools.com/sites/kleintools/files/instructions/Conduit%20Bender%20Guide.pdf>
  - 5 Part Video: <https://youtu.be/G2uEOMwDEJ0>

### K. Flooring Contractor

- **Problem**: Determine flooring type and area to be covered within a new house. Then, determine the cost without installation. (Note: 6% must be added on for waste.)
- **Activity**: Put materials within a 3D house model to represent your flooring choices.

### L. Cement Mason

- Cement is an ingredient of Concrete
- Concrete is used to create curbs, sidewalks, patios, foundations, footings for decks, light posts, etc.
- Union Resource: <https://www.opcmia.org/us-locals/>
- Concrete can be made in bulk using ratios involving sand, aggregate, & cement <https://www.youtube.com/watch?v=sbPHsdLxkM>
- **Problem**: For large concrete projects, it recommended that professional cement masons be utilized. However, for a small project as a patio, sidewalk, or driveway, a DIY project is possible.
  - a. Determine the size of a back patio & calculate how many cubic feet of concrete would be needed to add a back patio to a new house in the Lansdowne Up development.
    - Note: A patio, driveway or sidewalk is usually 4 inches thick.
  - b. Determine how many bags of Quikrete Concrete mix will need to be purchased for the project.
  - c. Estimate the cost (without tax) to purchase the bags of concrete mix.
    - A 50-pound bag of Quikrete costs \$5.78 (Quoted from Lowes on 7.1.22) & will yield 0.375 cubic feet of concrete (<https://content.syndigo.com/asset/8a370d9a-ca8c-4c35-8fa4-be972ce72d41/original.pdf>)



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### M. Painter, Homeowner, or Business Owner

- Depending on the project, people may purchase paint and attempt a painting project themselves or hire a professional painter - Union Info: <https://www.dc58iupat.net/index.html>
- Technology has been developed by Sherwin Williams to match paint to precise digital images
  - Color Snap Visualizer App for an I-Phone or Android provides RGB color values for paint
  - Digitally represents the color as a combination of Red, Green, & Blue
    - Each of the three colors has a minimum value of 0 and a maximum value of 255.
      - **Problem:** Given that there are three different colors to start from and each has 256 possible values, how many different colors can be produced?
      - **Activity:** What color is created with the given RGB color values?
        - [https://www.w3schools.com/colors/colors\\_rgb.asp](https://www.w3schools.com/colors/colors_rgb.asp)
        - (0,0,0)
        - (255,255,255)
        - (0,0,255)
        - (255,140,0)
        - (100,149,237)
        - [https://images.sherwin-williams.com/content\\_images/sw-pdf-sherwin-williams-color.pdf](https://images.sherwin-williams.com/content_images/sw-pdf-sherwin-williams-color.pdf)
- Types of Paints
  - Latex vs oil based
    - Recycling latex paint vs disposing of oil-based paint at a Hazardous Collection Event such as: [www.co.madison.il.us/departments/planning\\_and\\_development/recycle\\_events.php](http://www.co.madison.il.us/departments/planning_and_development/recycle_events.php)
  - VOC paint, Low VOC, & Zero VOC paint
    - VOC, or “Volatile organic compounds” are chemicals found in paint that can be detrimental to the environment & human health
    - Reference: <https://www.buildwithrise.com/stories/low-and-zero-voc-paint-guide>
- Satin vs Flat paint
  - Satin good for high moisture or high traffic areas- <https://painttopics.com/satin-vs-flat-paint/>
- **Problem:** One quart of interior paint, certified as Greenguard Gold containing low VOC, covers 100 square feet & costs \$21. One gallon of the same paint covers 400 square feet & costs \$44. If two coats are recommended, determine what should be bought and how much it will cost to paint all of the interior walls of the soon to be built house in the Lansdowne Development.
  - Quotes from Home Depot on 6.26.22 (<https://www.homedepot.com/p/BEHR-ULTRA-1-qt-M520-2-After-Rain-Extra-Durable-Satin-Enamel-Interior-Paint-Primer-775004/311001442>)

### N. Landscape Contractor

- Deal with hardscapes (patios, sidewalks, fencing, decks, etc.) & softscapes (grass, trees, plants, etc.)
- **Activity:** Make a concrete light post model (using a toilet paper roll) and determine how many cubic inches of concrete are needed to make the model using the concept of volume of a cylinder. (Inspiration - <http://diyfunideas.com/diy-concrete-tea-light-candle-sticks/>)
- **Activity:** Create a site plan and calculate cost of sod as well as fencing (installation not included.)
  - A pallet of sod costs \$584 and covers 500 sq feet. (Quote from Home Depot 4.2.22)
  - Fencing costs, on average, \$25 per linear foot w/out installation <https://www.lawnstarter.com/blog/cost/fence-price/>
    - NOTE: Some cities may have cities ordinances on what is allowed.  
EX - [https://www.ofallon.org/sites/g/files/vyhlif1031/f/file/file/fence\\_final\\_is2\\_2.pdf](https://www.ofallon.org/sites/g/files/vyhlif1031/f/file/file/fence_final_is2_2.pdf)

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2. Partner with an organization and/or utilize community connections/resources
  - a. Habitat for Humanity - <https://lchabitat.org/>
  - a. Boy/Girl Scouts (Eagle Scout or Gold Award Project) Ex - <https://bit.ly/3OfQGoF>
  - b. R3 Development - <https://www.r3dev.org/>
  - c. Jackie Joyner Kersee Foundation - <https://jjkfoundation.org/>
  - d. Lansdowne UP - <https://www.lansdowneup.org/>
  - e. Ideas for Community Connections/Resources
    - i. Your own school (Ex. O’Fallon High School vocation class is building a tiny house this school year.)
    - ii. Park Director (New picnic structures for the park?)
    - iii. City Planner, developer, architect, etc. (Other ideas?)
  
3. Determine needs, what we know, and what need to know.
  - a. Painting Over Graffiti (Lansdowne Up & Nelson Mandela School)
  - b. New Dog Pens (Boy Scouts & Granite City APA)
  - e. Dog houses (R3 Development & the Gateway Pet Guardians)
  - d. Eco-friendly & energy-efficient design plans (Habitat for Humanity)
    - o Remijan, K. W. (2017). Project-Based Learning and Design-Focused Projects to Motivate Secondary Mathematics Students. *Interdisciplinary Journal of Problem-Based Learning*, 11(1). Available at: <https://doi.org/10.7771/1541-5015.1520>
  - e. Inform students of what is happening in the community
    - o New Dog Park, New Fire Station, New Subdivision, Potential New Library, etc.
  - f. Talk to people in the community and/or ask students to make observations/share what is needed or what is happening in the community
    - i. New Development in East St. Louis (Lansdowne Up)
    - ii. Container Homes Community in East St. Louis (Lansdowne Up)
    - iii. Raised bed gardens (Lansdowne Up, JJK Foundation, & the JJK FAN Center)
    - ii. Picnic tables (Lansdowne Up, JJK Foundation, & the JJK FAN Center)
  
4. Promote ways students can help meet the needs of the community or organizations through fundraising or volunteer service.