Standardized Work Lesson

Objective

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1) To learn concepts pertaining to standardized work.
2) To learn how using standard operating procedures in a process can benefit the system.
3) To learn how cycle time, takt time and WIP inventory are used to identify labor imbalances, improvements from push to pull manufacturing, and help locate waste.

Skill Level: Middle School Student Level	**Prep time:** 5 Minutes **Class time:** 50 Minutes

Materials

(4) Lego Kit #6912

(8) Plastic bins for placing 'raw materials', and the work-in-progress.

(4) Set of Instructions (refer to documents included):
Instruction set #1 (Bad work instructions with bad sequencing for Lego plane)
Instruction set #2 (Bad work instructions with good sequencing for Lego plane)
Instruction set #3 (Good work instructions with bad sequencing for Lego plane)
Instruction set #4 (Good work instructions with good sequencing for Lego plane)

(1 per group) Activity Worksheet

(1) Projected Stop-Watch (entire class can see it)
(1 per student) Writing utensil for worksheet

Standards

Disciplinary Core Idea / Performance Expectations	
Disciplinary Core Idea: ETS1C: Optimizing the Design Solution **Performance Expectations:** MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.	
Practices ☒Asking questions / defining problems ☐Developing / using models ☐Planning / carrying out investigations ☒Analyzing / interpreting data ☒Math / computational thinking ☐Constructing explanations / design solutions ☐Engaging in argument from evidence ☒Obtaining / evaluate / communicate	**Crosscutting Concepts** ☐Patterns ☒Cause and effect: Mechanism / explanation ☐Scale, proportion, and quantity ☐Systems and system models ☐Energy / matter: Flows, cycles, conservation ☐Structure and function ☐Stability and change

Background Information

Introduction:

Imagine a world in which customers are unable to tell how reliable a product is; it would be very dangerous and chaotic. Today we live in a global marketplace where common standards are becoming increasingly vital, and standardization is important in creating and sustaining quality.

In a manufacturing environment, employees are encouraged to think in terms of final consumers and place them at the heart of the production process, which makes quality management an emphasis. This is achieved by creating, maintaining and continuously improving efficient processes in the organization. The implementation of a well-planned work standardization project can result in lower product variability, decrease the amount of defects, and ultimately, higher standards of quality in the products.

The process of creating 'standard practices' is an ongoing process. Standard and best practices are relative and not set in stone, and standard operations should not be thought of as rigid and unchangeable. A process that may be the 'standard and best practice' now can get outdated quickly. It is up to the organization to continuously improve on it by:

- Identifying current and future customer needs and meeting them
- Continuous improvement: measuring, monitoring, analyzing and improving

In conclusion, creating standards establishes order in an increasingly complex world. They meet the changing market needs and are customer driven. Customers benefit because their safety and satisfaction are both greatly enhanced. It helps ensure the timely delivery of high quality products to consumers, while maintaining and improving the high standards of quality in the products.

Background Information

-What exactly is standard work?

As defined by the dictionary from isixsigma.com, standard work is a detailed definition of the most efficient method to produce a product (or perform a service) at a balanced flow to achieve a desired output rate. It breaks down the work into elements, which are sequenced, organized and repeatedly followed.

Each step in the process should be defined and must be performed repeatedly in the same manner. Any variations in the process will most likely increase cycle time and cause quality issues. It typically describes how a process should consistently be executed and documents current 'best practices.' It provides a baseline from which a better approach can be developed, allowing continuous improvement methods to leverage learning. Three necessary components in standard work are (1) takt time, (2) cycle time and (3) SWIP (Standard Work-in-Progress). These terms will be covered in other lessons, so the students' knowledge of these will be reinforced from doing multiple lessons.

Real World Example

In the electronics manufacturing industry making good, clear, and detailed instructions with proper sequencing is extremely important to create circuit boards with high quality. To create a high quality product, manufacturing engineers analyze the many elements that go into making circuit boards such as: solder type, soldering process, masking requirements, flux type, wash cycle type, bake temperature, bake time, corrosion resistive coating thickness, what testing is needed, and other customer specifications. With all of these different variables and processes, finding the correct and fastest possible sequence without sacrificing quality becomes difficult. This also applies to instructions, many times customers/companies will require circuit boards for industrial or government type usages. These boards will generally have very specific component positioning and dimensioning needs, which means fixtures may need to be designed for the components along with instruction, for the workers, on how to use the fixture. The boards can also have different technology types on the circuit board, such as surface mount technology (SMT) and through-hole technology, which requires correct process sequencing and instructions that will not destroy the other technology type during the build process. So manufacturing engineers creating good standardized work on an electronics product will set a baseline for all workers to create a quality product. Then with the help of industrial engineers those processes can be further improved and fine-tuned.

Key Terms

Takt time (aka required cycle time): "Takt" is the German word for the baton that an orchestra conductor uses to regulate the speed, beat or timing at which musicians play. Takt Time is the rate that a completed product needs to be finished in order to meet customer demand. E.g. If you have a Takt Time of two minutes that means every two minutes a complete product, assembly or machine is produced off the line.

- Takt time = Daily time available/Required daily quantity (customer demand)
- Cycle Time: The average time between completed units.
- Work In Progress (WIP): The amount of work (parts, sub-assemblies, etc) that has entered the process but has not been completed.

Developing Standard Work can be a difficult task; however, if efficiently developed, it should allow virtually anyone to perform the work without any variance in the desired output.

To summarize, well-prepared standard work instructions, in general, will:

- Reduce variations in the final product
- Reduce cycle time of the process to meet or fall under the takt time
- Reduce defects/increase quality of the product
- Documentation of current 'best practices' provides a baseline for improvement
- Easier training of new operators
- Reduce potential injuries

Engage

The students will be drawn into the activity by:

- seeing how they can achieve faster cycle times in order to meet takt times,

- observing an increase in the quality of their Lego products.

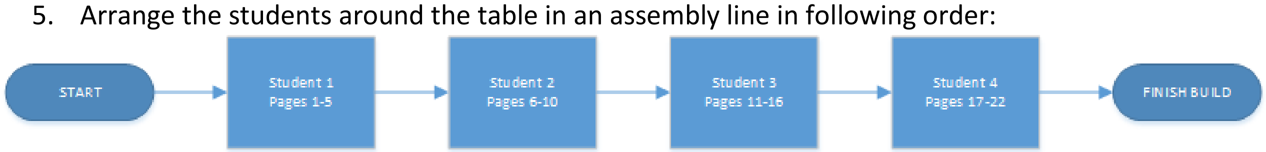
This is done through brainstorming for ideas to construct instructions/sequencing that are easier to use and comprehend, as well as performing the Lego activity itself.

Explore

<u>Experiment Questions</u>:
Do better instructions improve cycle times?
Does the sequencing affect cycle times?
Is product quality affected by differing instructions (Why)?
Is product throughput affected by differing instructions (Why)?
Would it be better for workers to have the same instructions?
Why and what constitutes the best instructions?
Would it help if each worker received the full set instructions and not just their own part?

<u>Procedure:</u>

1. Set up four tables. Provide each table with one Lego kit, one set of instructions, one worksheet, and two plastic bins: one labelled raw materials and the other WIP or work in progress.
2. Place all of the Legos in the raw materials bin.
3. Divide students into four equal groups and assign each group to a table.
4. Split up the instructions evenly amongst the students in the group. i.e. If 4 students per group then student 1 does steps 1-5, student 2 steps 6-10, student 3 steps 11-16, student 4 steps 17-22. They should also receive a worksheet to record the cycle time, but *<u>not</u>* the final page(s) with the plane diagram. The diagram is merely a reference for after the second run to show a better view.
5. Arrange the students around the table in an assembly line in following order:



6. Each student is responsible for their section of the instructions; every workstation (student) focuses on their own job and is not allowed to receive help from other members of the group. Workstations who are waiting to receive work may not show their instructions to the others or the one currently working, however they can look over their own. Those who are finished their part are free to show their instructions, face-up on the workspace.

7. Start the clock and each group begins building their plane as quickly as possible, without sacrificing quality (meaning color is correct, and correct pieces are in their correct locations).
8. They then place their completed parts in the work-in-progress bin and pass both bins to the next student for their turn.
9. Record the time that the group takes to completely assemble their plane onto the worksheet. (If groups take longer than 20 minutes (if time is a factor, this number can be adjusted accordingly) have them stop and record what step they got to instead).
10. The students compare their plane to the final picture in their instruction of what the plane should look like and answer the question on the worksheet under. After run one have the students disassemble the planes and place the pieces back in the materials bin, not for run 2.
11. Have a discussion about what went well and what didn't throughout the run. As well as what they think caused their results that they got. This can lead into the 'experiment questions'.
12. For the second run, the student groups exchange instruction set #1 with instruction set #4 and instruction set #2 with instruction set #3.
13. Repeat steps 7-10 for the second run, and afterwards give the plane
14. Groups share results with the class and discuss the differences between the two runs, this discussion should also include the 'experiment questions'.
15. After the discussion, students should finish filling out the worksheet and if time allows discuss the worksheet with entire class. At this time also tell the students which instruction had bad or good instructions and sequencing (they can write this on the worksheet, but is not required). (If time is a problem consider just asking the worksheet questions to the entire class or questions that will cover the main points of a good standardized process).

Explain

1. **What do you think are the reasons for the difference in the times to make the product?**

The difference in the manufacturing sequence and the quality of the instructions. Expect fastest times for the groups using the well written instructions with good sequencing, slowest for badly written instructions with bad sequencing, and somewhere in the middle for the other two. (These results can be skewed do to the students having different Lego experiences, as well as having done it once the second run for everyone could potentially go faster than the first. But the students should still feel the difference between the instructions).

2. **What do you think made a bigger difference in the times: the bad sequencing or bad instructions?**

For the most part, badly written and complicated instructions slow down the process significantly more than badly sequenced products. However for more complicated processes (not Legos) this might not be the case. There are processes or products where an incorrect sequence will result in a completely useless item, ergo the sequencing becomes more important than clear instructions.

3. **What do you think contributed to defects in the product?**

-Badly written instructions contribute to operator (student) errors and product defects.
a) Lack of a parts list
b) Black and white instructions means students aren't able to distinguish the right colors.
-Sub-par product sequencing
-Students' initial unfamiliarity of the procedures.

4. **How does improving the production using standardization affect the quality of a product?**

-Reduces variation in the products, ensuring higher quality products.
-New operators can come in and produce the exact product by following the standard procedures.

Elaborate

1. **Where are some other places that you could see better instructions improve the quality of a product or the time that it would take to make it?**

-Products that require you to put together yourself, e.g. IKEA furniture.
-Standard instructions have been implemented in organizations outside of the manufacturing industry, for example, health care. E.g. syringe disposal procedures.

2. **How could the instructions be further improved to make them easier to follow?**

Include more pictures/diagrams, clearly written and detailed steps (words), multiple views (top, bottom and side views).

3. **How does the difference in the operators' skill levels affect the production times?**

There exists a learning curve for the operators; the more familiar they are with the procedures, the faster and better they get. Also, some people are inherently faster and more skilled than others which contributes to quicker production. This attribute is considered while assigning employees their responsibilities. For example, the faster operators could be assigned to the more complex workstations.

4. **In what ways would using standardized work benefit a company?**

Answers are provided from the summary of the benefits of using standardized work provided in the "Background Information" section.

5. **Why should standard operations not be considered permanent?**

Standard and best practices are relative and not set in stone. They also change frequently and what may be the 'best practice' the previous year could now be outdated. The workers' current skill levels, available equipment, product demand, etc. have to be taken into consideration when deciding if those practices are still applicable in the current environment. They have to be frequently reviewed and updated to maintain their quality, so no standard operation should be considered rigid and unchangeable.

Resources

Additional Resources:
http://www.lean.org/workshops/WorkshopDescription.cfm?WorkshopId=20

Resources Used:
http://www.leansimulations.org/2010/05/standard-pig.html
http://www.isixsigma.com/dictionary/standard-work/
http://businesscasestudies.co.uk/bsi/standardization-and-quality-management/introduction.html#axzz2qcCcOXI6