

# LET'S GET PRINTING!

## THE "E-NABLING THE FUTURE" PROJECT

TRENT MCLEES - CEDAR BLUFF MIDDLE

### PROJECT SUMMARY

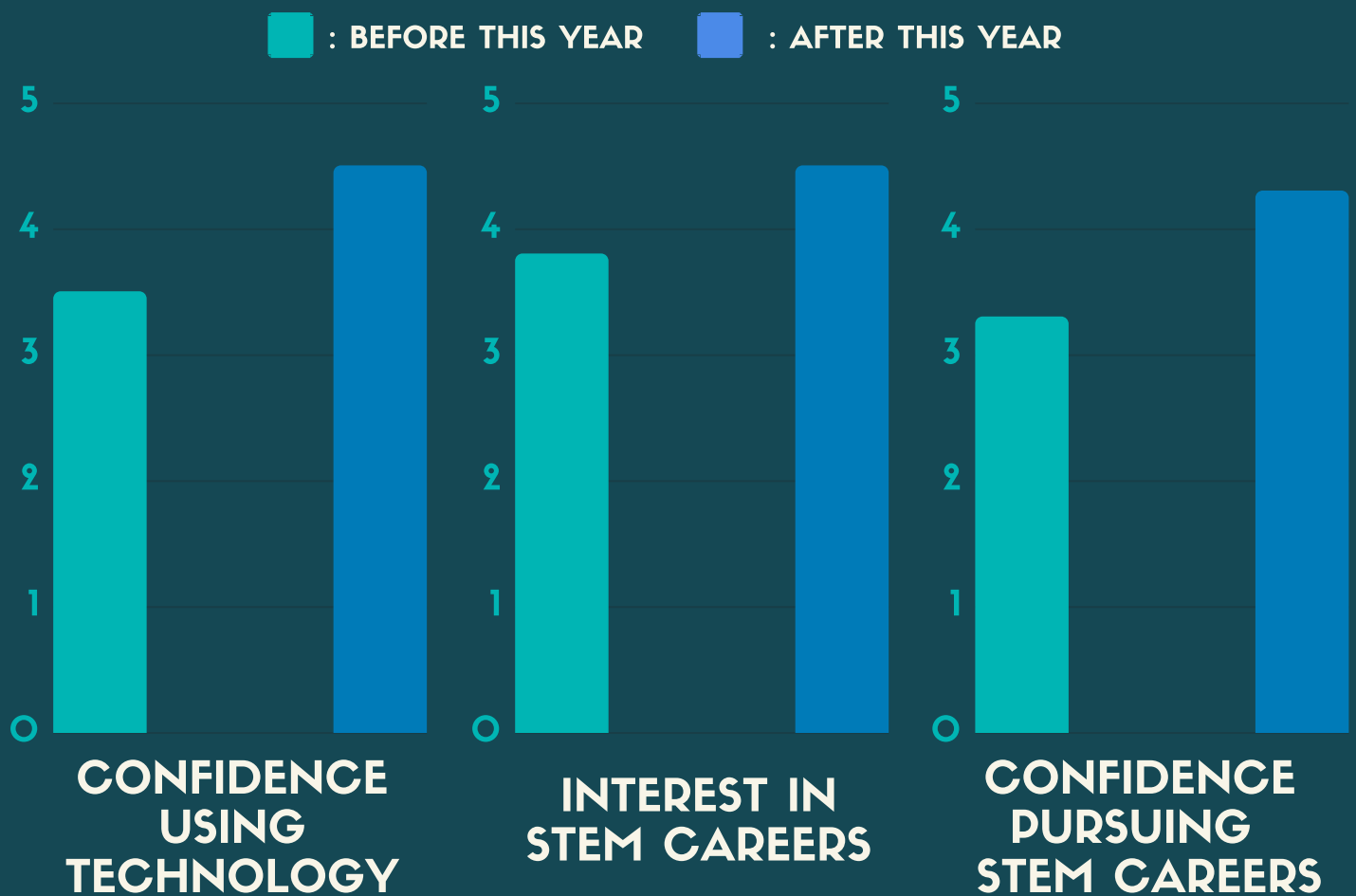
THROUGH OUR 3D PRINTING CLUB AND CURRICULAR COLLABORATION WITH SCIENCE AND ELA TEACHERS, WE HAVE BEEN ABLE TO PUT OUR 3D PRINTER TO MEANINGFUL USE FOR CEDAR BLUFF MIDDLE SCHOOL STUDENTS, IN ORDER TO DEVELOP THEIR ARTISTIC EYE, THEIR SELF-CONFIDENCE, THEIR CREATIVITY, AND THEIR TECHNOLOGICAL LITERACY. WITH THE ADDITION OF NEW PRINTERS, FILAMENTS, AND EXTRUDERS, WE SPENT THIS YEAR TRYING TO BUILD ON OUR PRE-EXISTING PROGRAM AND START OUR STUDENTS ON THE PATH TO A REAL WORLD APPLICATION OF 3D PRINTING TECHNOLOGY: THE PRODUCTION OF LOW-COST PROSTHETICS FOR A NON-PROFIT CALLED THE E-NABLE PROJECT.

### GOALS

1. STUDENTS IN THE PROJECT E-NABLE GROUP WILL DEMONSTRATE A STATISTICALLY SIGNIFICANT INCREASE IN SELF-CONFIDENCE MEASURES INDICATING THAT THEY ARE CONFIDENT IN THEIR ABILITY TO PURSUE STEM CAREERS AND MAKE AN IMPACT ON THEIR COMMUNITY.
2. BY MAY 15TH, 2018, THE PROJECT E-NABLE GROUP WILL HAVE PRODUCED AND ASSEMBLED AT LEAST 4 PROSTHETIC HANDS, AND HAVE PLACED AT LEAST ONE HAND WITH AN INDIVIDUAL IN NEED.
3. AT LEAST 50% OF PROJECT E-NABLE STUDENTS WILL HAVE DEMONSTRATED A GROWTH IN THEIR FACILITY USING THE TINKERCAD DESIGN TOOL, BASED ON SAMPLE WORKS.

### RESULTS: GOAL #1

#### STUDENT SELF-CONFIDENCE SURVEYS



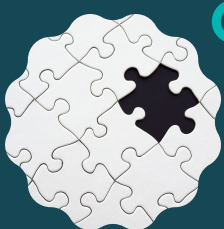
### RESULTS: GOAL #2

OUR SECOND GOAL WAS **PARTIALLY** MET. THE STUDENTS SUCCESSFULLY PRINTED AND ASSEMBLED TWO HANDS, WHICH WAS FIFTY PERCENT OF OUR PRODUCTION GOAL. HOWEVER, WE WERE UNABLE TO COMPLETE THESE IN TIME TO GET CERTIFIED BY THE E-NABLE ORGANIZATION, AND THEREFORE COULD NOT PLACE ANY PROSTHETICS WITH INDIVIDUALS IN NEED. WE PLAN TO PICK UP WHERE WE LEFT OFF THIS YEAR NEXT YEAR, AND ONCE THE APPROVAL PROCESS IS COMPLETE PRODUCE MORE HANDS, AND PLACE THEM WITH LOCAL AND NETWORKED RECIPIENTS. THE HANDS THE STUDENTS ASSEMBLED WERE SLIGHTLY MODIFIED VERSIONS OF THE PHOENIX HAND MODEL, RECOMMENDED BY THE E-NABLE PROJECT (PICTURED).



### CHALLENGE CORNER!

THIS GOAL WAS IMPACTED BY SEVERAL UNEXPECTED CHALLENGES. THE PRINTER SOFTWARE WAS IMPOSSIBLE TO INSTALL WITHOUT DISTRICT I.T. CLEARANCE, AND RAN SLOWER THAN ANTICIPATED. THE PRINTERS THEMSELVES NEEDED PRECISE CALIBRATION ADJUSTMENTS, AND THE DESIGNS HAD TO BE REPRINTED AND ITERATED TO MAKE ASSEMBLY POSSIBLE. WE ALL LEARNED THAT KEY TO SUCCESSFUL TO 3D PRINTING PROJECTS IS **PATIENCE!** THERE WILL BE LOTS OF ROADBLOCKS, SOME IMPOSSIBLE TO ANTICIPATE. **THE LEARNING HAPPENS WHILE YOU ITERATE** TO GET THE COMPLEX MACHINES TO BEHAVE THE WAY YOU WANT!

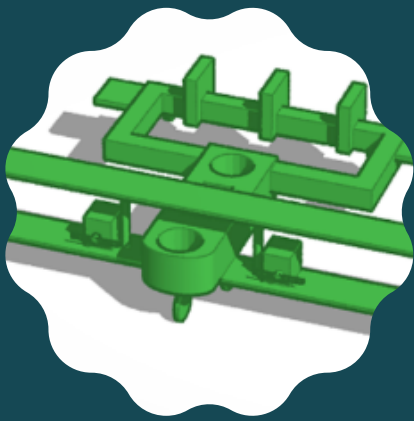


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## RESULTS: GOAL #3

STUDENT GROWTH IN TERMS OF THEIR OWN FACULTY WITH 3D DESIGN AND TINKERCAD WAS INCREDIBLE! STUDENTS WENT FROM DESIGNING SIMPLE OBJECTS LIKE HEARTS WITH TEXT IN THEM OR CUPS AND MUGS TO DESIGNING COMPLEX FIGURINES, CHARACTERS, AND MODELS! SOME EXAMPLES OF THEIR WORK ARE SHOWN BELOW!



## CHALLENGE CORNER!

WHEN WORKING WITH 3D PRINTING PROJECTS, YOU SHOULD ALWAYS EXPECT THE FOLLOWING CHALLENGES:

- THE PRINTERS ARE HIGHLY LIKELY TO JAM OR OTHERWISE MALFUNCTION
- MODELS CAN TAKE ANYWHERE FROM 15 MINUTES TO 12 HOURS TO PRINT, DEPENDING ON THE SIZE
- A PRINT JOB CAN FAIL AT ANY POINT IN THAT PROCESS DUE TO LAYER SHIFTING, FILAMENT JAMMING, OUTSIDE INTERFERENCE, LACK OF MATERIAL, POWER OUTAGE, OR SOME OTHER VARIABLE.
- STUDENTS WILL NEED INSTRUCTION IN AND SKILL WITH SLICING SOFTWARE, DESIGN SOFTWARE, PRINTING HARDWARE, AND BASIC TOOLS IN ORDER TO FOLLOW A PRINT THROUGH FROM BEGINNING TO END INDEPENDENTLY.
- PRINTERS AND MATERIALS ARE EXPENSIVE, FRAGILE, AND CERTAIN COMPONENTS HEAT TO DANGEROUS TEMPERATURES.
- MODELS DO NOT PRINT THE EXACT SIZE THEY ARE DESIGNED AND SLICED AT, DEPENDING ON PRINTER SETTING AND FILAMENT EXPANSION.

WHAT DOES ALL THIS BOIL DOWN TO? SIMPLY PUT - TIME!!! NONE OF THESE CHALLENGES ARE INSURMOUNTABLE, AND THEY ALL PROVIDE A SPACE WITHIN WHICH STUDENTS CAN LEARN. FOR EXAMPLE, OUR STUDENTS WERE ABLE TO LEARN THE STEPS TO LOAD AND UNLOAD FILAMENT TO AVOID JAMS, THEY LEARNED HOW TO IDENTIFY A LAYER SHIFT AND CANCEL A PRINT BEFORE THINGS WENT TOO LONG AND MATERIAL WAS WASTED, AND THEY LEARNED HOW TO ADJUST SCALE IN A SLICING SOFTWARE TO ACCOUNT FOR MODEL SIZE SHIFTING. ALL THIS LEARNING TAKES TIME ON THE FRONT END, AND MAY MEAN THE ROAD TO A COMPLETED PROJECT IS LONGER AND HARDER THAN YOU OR YOUR STUDENTS ANTICIPATED. HOWEVER, IF YOU CAN SUPPORT STUDENTS AND IF THEY KEEP THEIR ENTHUSIASM AND ENGAGEMENT, THE FINAL PRODUCT WILL BE NOT JUST A 3D PRINTED TRINKET BUT ALSO A GREAT LEARNING EXPERIENCE, AND FUTURE PROJECTS WILL BENEFIT FROM LESSONS LEARNED.



## LESSONS LEARNED

WHAT IMPACT HAS THIS HAD ON MY PRACTICE? SIMPLY PUT, IT HAS HELPED ME REALIZE ONE KEY THING THAT IS INTEGRAL TO SUCCESSFUL STEAM LEARNING PROJECTS: THE STUDENTS ARE LEARNING THE TEMPERAMENTS AND MINDSETS NEEDED TO SUCCEED WITH TECHNOLOGY JUST AS MUCH, IF NOT MORE, THAN THEY ARE LEARNING THE SKILLS. STUDENTS NEED TO BE ENGAGED WITH MEANINGFUL PROJECTS AND TO BE ABLE TO SEE THE VALUE IN THE STEPS OF THOSE PROJECTS IN ORDER TO SUCCEED WITH TECHNOLOGY. SO MUCH OF SCIENCE AND TECHNOLOGY WORK - WHETHER IT BE C.A.D. OR PROGRAMMING OR ENGINEERING - IS THE ITERATIVE PROCESS OF TRYING AND FAILING. IF STUDENTS DON'T KNOW WHAT THEY ARE TRYING AND FAILING IN ORDER TO ACHIEVE, DON'T KNOW WHAT SUCCESS WILL LOOK LIKE WHEN THEY SEE IT, OR DON'T HAVE A PLAN WHERE THEY CAN LOOK BOTH FORWARD AND BACK AT THE JOURNEY THEY RE ON, IT BECOMES NEARLY IMPOSSIBLE TO KEEP THEM MOTIVATED WHEN THE ISSUES START TO SLOW THE PROCESS DOWN. THIS IS ESPECIALLY EVIDENT WITH 3D PRINTING. THE PROMISE IT MAKES TO THE IDEALISTIC EDUCATOR AND ENTHUSIASTIC STUDENT IS ENTICING: INSTANTLY CREATE A FASCINATING OBJECT FROM THIN AIR! HOWEVER, THE REALITY IS MUCH LESS STIMULATING: LABOR FOR HOURS IN A DESIGN SOFTWARE TO CREATE A MODEL THAT MAY STILL FAIL TO PRINT, THEN TRY IT TO IDENTIFY THE PROBLEMS, THEN REPEAT.

THE BIGGEST TIP I HAVE LEARNED FROM THIS PROCESS IS TO PLAN WITH THE STUDENTS, AND SET THIS EXPECTATION FROM DAY ONE:

WE LEARN BY FAILING, WE LEARN BY HAVING PATIENCE, AND WE CREATE THINGS TRULY WORTH MAKING BY REPEATED EFFORT AND CONTINUAL IMPROVEMENT.

IT MAY NOT BE AS EXCITING AS PRINTING OFF A FORTNITE DESIGN FROM THE INTERNET IN 3 HOURS, BUT IT IS INFINITELY MORE REWARDING.

