2026 ASEE ANNUAL CONFERENCE June 21–24, 2026 | Charlotte Convention Center, NC
Host Sponsor UNC Charlotte
Paper ID #51915

Artifacts of Learning – The Polytechnic Experience

Dr. Nathan D Spike, University of Wisconsin - Stout

Author Biographies:

Nathan Spike, Ph.D. Assistant Professor at UW-Stout – spiken@uwstout.edu

Nathan Spike is an Assistant Professor at UW-Stout teaching courses in welding processes, thermodynamics, heat transfer, robotics, and manufacturing and mechanical engineering capstone.

Kevin Dietsche, Ed.D. Assistant Professor at UW-Stout – dietschek@uwstout.edu

Kevin Dietsche is an Assistant Professor at UW-Stout teaching courses in product development, design for industry, and mechatronics.

Gregory Slupe, Ph.D. Associate Professor at UW-Stout – slupeg@uwstout.edu

Gregory Slupe is an Associate Professor at UW-Stout teaching courses in casting processes and computer aided manufacturing.

Kevin B Dietsche, University of Wisconsin - Stout
Prof. Greg Slupe, University of Wisconsin - Stout

Artifacts of Learning – The Polytechnic Experience

Abstract

Recently revised curriculum to a welding course for engineers and purchase of a welding-capable six-axis industrial robot, provided the authors with an opportunity to measure to what extent, if any, student artifact creation has on the development of career interest in fields related to industrial robotics. A mixed methods approach involving phenomenological descriptive research was conducted in addition to quasi-experimental research. Course development took place over a three-semester sequence, with the authors measuring student general, academic, and career interest towards industrial robotics within the course. Initially (first iteration), content was delivered in a lecture-only format. As the course module was developed (second iteration), live robotic welding demonstrations were implemented, and finally (third iteration), an assignment was integrated using the industrial robot and resulted in an educational artifact – an object(s) which students keep. Likert style questions were asked of students at the conclusion of each semester as the curriculum changed, comparing results against courses which already utilize educational artifacts in their instruction. As part of the mixed methods approach, three university instructors were asked what type of hands-on projects they have incorporated into their respective courses, if the projects were taken home, and perceived impact on student interest in the course subject. Thematic analysis and discussion based on the lived experience of these instructors is offered. The educational methodology utilized in this study ties to Seymor Pappert's foundational theories relative to constructivism, and its known advantages of having students develop project-based work. Connections are also made to project-based learning and its ability to influence engagement, motivation, and information retention.

Introduction

From an educators' macroscopic view, three basic questions have been dealt with regarding the development of education. Who gets it, what happens to them (the student) during it, and where do they (the student) go after it [1]? John Dewey stated this another way, educator's ought to "Give the pupils something to do, not something to learn; the doing is of such a nature as to demand thinking; learning naturally results [2]." The resulting research was conducted to better understand the impact of the authors' instructional methods and student outcomes at a polytechnic designated institution; towards hands-on/applied experiences of engineering and technology students.

Educational research established multiple methods proven useful in delivering content. Methods of imparting knowledge fall into three general categories of active, passive, and interactive [3]. In traditional education, lecture is a means of passively imparting knowledge, with little interaction between the teacher and the student…this form of education can be considered "boring" but does have its positive attributes [3].

In the Handbook of College Teaching: Theory and Application it is noted that lecture can provide advantages such as

1) teaching a large group of learners

2) provide a lower cost to students and

3) cover larger amounts of material [4].

Alternatively, modern methods of education include both active and interactive means. In looking at the differences between passive learning and active/interactive learning, the latter typically involves students to be "active" and engaged with each other as well as their peers during the learning process [5].

One such form of active learning revolves around artifacts of learning. Artifacts derived within an educational setting have strong ties to experiential learning. Dewey [6] and Vygotsky [7] encouraged and defined experiential learning which provides theoretical foundations for project-based learning (PBL). Project-based learning is a well-researched method in which the transfer of learning from the teacher to the pupil is known to be effective given certain key elements [8]. It is well known that within the project-based learning structure, effective learning environments exist [9].

The University of Wisconsin-Stout prides itself on the ability to deliver instruction based on three polytechnic tenets: applied learning and research, business and industry collaboration, and career-focused experiences [10]. Manufacturing process courses offered within the Engineering and Technology Department connect to these tenets, and have students produce educational artifacts (artifacts of learning)-items that can be taken with them at the conclusion of a given semester. Support for utilizing educational artifacts, also named as souvenirs, can be found in literature [11,12]. In previous work, the authors have hypothesized the "use of demonstrations of equipment and the inclusion of educational artifacts will (in addition to reenforcing technical course content) increase student interest in pursuing careers related to equipment used in the class [13]."

Joining and Casting Processes (ETECH 253) is a course where students spend half of their time in the Foundry Lab with learning objectives related to "industry practice to produce cast metal parts covering casting/tooling design and development, production requirements and field application [14]." The other half of the course is spent in the Weld Lab with learning objectives related to "industry practice towards the joining of metals, covering machine set up and operation, defect analysis, weldment design, and automation [14]." A revision to this course completed in Fall of 2022 introduced automation topics into the welding unit supported by the purchase of the Yaskawa welding robot pictured in Fig. 1. As content for the revised course was developed – specifically in the lab demonstration – an opportunity was recognized to measure the impact of educational artifacts on student interest in each subject. Furthermore, the authors could measure student interest under three different conditions: before a demonstration was implemented, after an intermediate demonstration with no artifact generated, and following a final demonstration that resulted in an artifact students can take home.

The authors submitted preliminary findings to the Fall 2023 ASEE North Midwest Section Annual Conference from the first semester of the 3-semester course development sequence [13]. This work presents the full three semester sequence while including qualitative data collected as a means of measuring change, if any, of student interest given a manufacturing process when subjected to various levels of engagement within the process.

Fig. 1. Robot cell picture.

Methods – Instruction

This study employed a mixed-methods approach, integrating both quasi-experimental and phenomenological methodologies as detailed by Gall, Gall and Borg [20]. The quasi-experimental approach examined the development of artifacts in relation to student general, academic, and career interest. The phenomenological methodology investigated instructors' lived experiences with regards to student artifact creation within their applied, hands-on laboratory courses. The quasi-experimental component allows for the comparison of outcomes between groups, while the phenomenological approach provides deeper insight into how university instructors perceive and interpret the effect student artifact creation may have, or not have, on the development of career interest.

There are two course objectives in ETECH 253 associated with automated welding processes: *describe the benefits and drawbacks of automated welding systems* and *perform cost analysis of manual vs automated welding processes*. Lecture material, equipment demonstration, and the generation of an artifact have been developed to satisfy the former objective. The development of the course content associated with this learning objective took place over a three-semester sequence as outlined in Fig. 2.

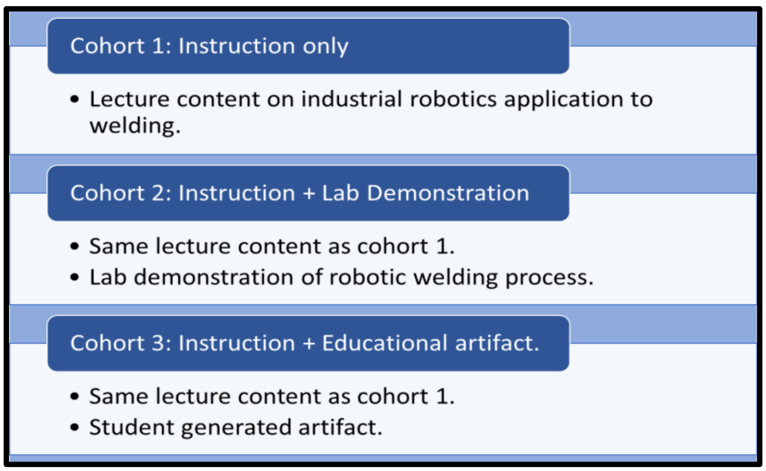

Fig. 2. Course development sequence.

During the first semester (Spring 2023), a single lecture was delivered. Students are not expected to have prior knowledge of industrial robotics at the beginning of ETECH 253. The lecture material developed covers orders of automation as described in DeGarmo's Materials and Processes in Manufacturing [15], a general history of the development of industrial robotics, classification of robot types, features of manipulator robots, implementation and safety considerations – all in the context of use for automated welding processes. Student work associated with this content involves a quiz and project which involves cost analysis of manual and robotically completed weldments.

The second semester (Fall 2023), lecture material was supplemented with a live demonstration of the Yaskawa welding robot. The welding demonstration was conducted on T-Joint fillet weld in the horizontal position as shown in Fig. 3. and covered basic set up, teach pendant functions, and parameters (wire feed speed, gas flow, arc length, travel speed, work/travel angle). At this point in the class, students are well versed in parameter selection as it relates to the manual process and their effect on weld quality, critical to both manual and automated processes.

Fig. 3. The T-Joint weldment used in the semester 2 demonstration (right) and the fixture used to tack the members together (left) [13].

The third and final semester (Spring 2024) of course module development implemented a two-weldment project completed by students. Students prepared two weldments – one to be completed manually using the Gas Metal Arc Welding (GMAW) process, and one to be completed by the robot. The artifacts generated were a pair of steel pencil holders [Fig. 4.]. The students could take these home. The pencil holders were comprised of 0.3125 inch flat plate (2.5 inches x 4 inches) and two 2.5 inch lengths of steel tubing; one 1.25 inch square tube and one 1.75 inch round tube, each with a 0.125 inch wall thickness. These geometries were selected to create a weldment more difficult to weld manually, highlighting the robot's ability to perform repetitive tasks with precision and consistency.

Fig. 4. Pencil holder weldment completed by the Yaskawa welding robot (left) and completed manually by a student (right)

Methods – Survey (Quantitative)

A three-question survey for administration at the end of a course was developed to measure student interest in each manufacturing process. Students responded anonymously via a Canvas survey using a Likert scale [16,17]. The following choices were offered: Strongly Agree, Agree, Neither Agree nor Disagree, Disagree, and Strongly Disagree. The questions measured a student's general interest in a subject, their interest in taking further courses involving a subject, and their interest in pursuing a job or career related to a subject. Results of the survey were to be evaluated under the following:

Null Hypothesis: The mean student interest level does not differ between courses using artifact-based instruction and those using traditional instructional methods.

The survey was administered during each semester. Welding automation content was developed simultaneously. As a baseline, the survey instrument was also delivered within two other automated manufacturing process courses. These two courses did not have any change in instructional methods or course content. Research and Development (COURSE B) covers content related to "research and development procedures applied to specific industrial material and processing problems" and makes use of a CNC Router to generate artifacts in the form of carved wooden panels as shown in Fig. 5.

Fig. 5. CNC Router used in ET 422 and produced educational artifacts [13].

Computer Aided Manufacturing (ETECH 303) covers content related to "Justification for and application of computer assistance in manufacturing process; machine process control, inventory and materials handling, robotics and automated assembly, product design and part grouping in relation to total manufacturing operation." ENGR 325 Computer Aided Manufacturing for Manufacturing Engineers convers content related to the "effects of product mix and demand patterns on manufacturing system design and selection of process control methods. Introduction to quick changeover strategies and reprogrammable automation including numerically controlled machine tools, robotics, group technology, CAD/CAM, automated inspection and other computerized processing techniques." Both of these courses involve the use of CNC Mills which generate artifacts such as small game pieces, business card holders, and plastic injection molds as shown in Fig. 6.

Fig. 6. CNC Mill used in ETECH 303 and ENGR 325 along with associated educational artifacts [13].

The three-question survey was as follows:

1) To what extent do you agree with the following statement? I am personally interested in "*process*".

2) To what extent do you agree with the following statement? I am interested in taking additional courses involving "*process*".

3) To what extent do you agree with the following statement? I would be more likely to apply for a job involving "*process*".

For each class administered the survey "*process*" is replaced, with "industrial robots" for ETECH 253, ET 422 replaces "*process*" with "Computer Numerical Control (CNC) routers". ETECH 303 and ENGR 325 replace "*process*" with "Computer Numerically Controlled (CNC) equipment. Student responses to these questions using the Likert scale ratings can be related to numerical values for analysis.

Methods – Survey (Qualitative)

Phenomenological descriptive research was conducted in addition to quantitative research efforts. Three university instructors were asked the following questions:

1) What type of hands-on projects they have incorporated into their respective courses

2) If the projects were taken home

3) Perceived impact on student interest in the course subject

The research method employed, and data analysis followed procedures by Dahlberg, Drew and Nyström [18]. Interview audio transcripts and research notes were initially reviewed to gain an overall understanding of how respondents attended to the questions. Upon replaying and reviewing the interviews several times each for all three university instructors, the research methodology developed thematic clusters based on what was said, and how it was said, to bring into focus the meaning of each response (content). Lastly, the clustered meaning groups were examined collectively to better understand the phenomenon of teaching courses involving student produced, take-home artifacts relative to career implications.

It was determined that more depth was needed to better understand the research question upon completion of the first interview set. Interviews were completed with the same instructors and in the same manner as the first set of interview questions. The following questions were asked:

1) Can you think of a time when your artifacts(s) affected student career interest?
2) Can you come up with a student who produced an artifact(s) which affected their career interest?
3) Why did that/those artifacts(s) affect their career interest?
4) What do you believe happened?
5) How did that occur?

Results – Survey (Quantitative)

The survey instrument delivered to the ETECH 303 and ENGR 325 courses measuring interest in CNC Milling operations had 41 respondents in Spring 2023, 23 respondents in Fall 2023, and 22 respondents in Spring 2024. The survey instrument delivered to the ET 422 course measuring interest in CNC Routing operations had 16 respondents in Spring 2023, 21 respondents in Fall 2023, and 7 respondents in Spring 2024. The survey instrument delivered to the ETECH 253 course measuring interest in Industrial Robotic operations had 28 respondents in Spring 2023, 35 respondents in Fall 2023, and 62 respondents in Spring 2024. All survey responses are recorded in Table 1.

TABLE I
All Survey Responses

	ETECH 253														
	Question 1					Question 2					Question 3				
	5	**4**	**3**	**2**	**1**	**5**	**4**	**3**	**2**	**1**	**5**	**4**	**3**	**2**	**1**
Spring 2023	3	18	7	0	0	5	18	3	2	0	1	8	13	6	0
Fall 2023	9	22	3	1	0	6	20	8	1	0	6	12	11	6	0
Spring 2024	15	34	10	2	1	14	32	13	2	1	6	20	31	4	1
	ETECH 303 & ENGR 325														
Spring 2023	23	18	0	0	0	15	25	1	0	0	11	20	9	1	0
Fall 2023	9	13	1	0	0	7	14	0	2	0	6	6	9	2	0
Spring 2024	10	11	1	0	0	6	14	2	0	0	7	11	4	0	0
	ET 422														
Spring 2023	4	11	1	0	0	3	10	1	2	0	4	5	6	1	0
Fall 2023	6	15	0	0	0	4	11	6	0	0	5	12	3	0	1
Spring 2024	5	2	0	0	0	5	0	1	1	0	2	4	0	1	0

To account for variation in the number of responses from each class, data has been normalized to show the ratio of responses to each question. Fig. 7. through Fig. 9. show the normalized results from each manufacturing process.

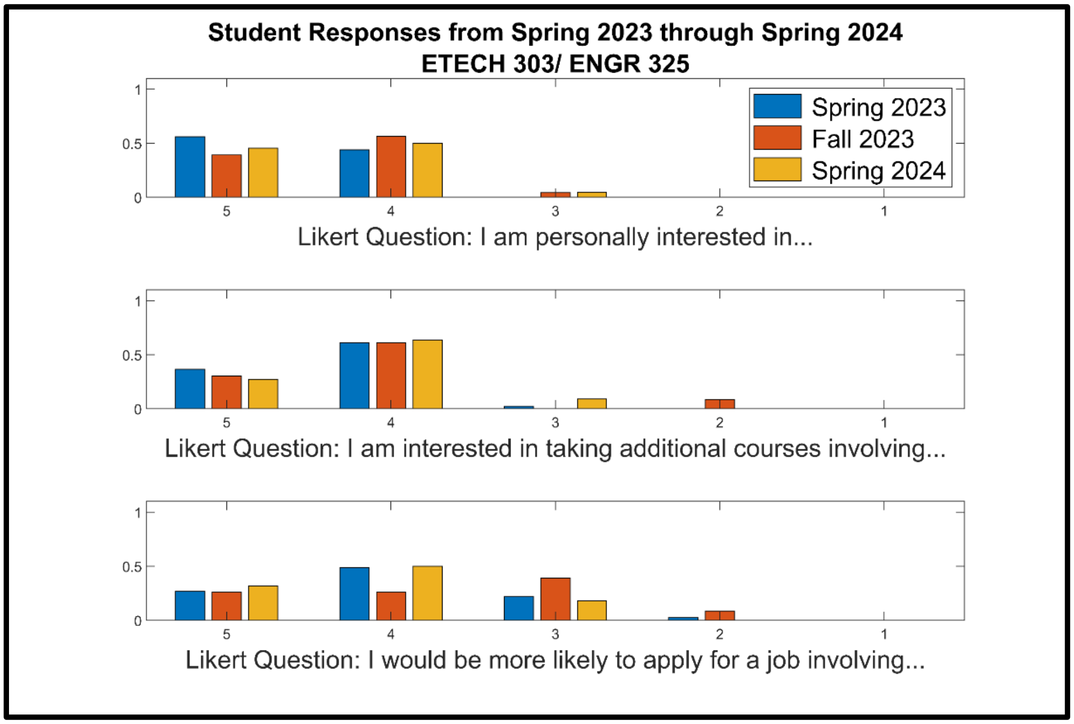

Fig. 7. Normalized results from all three semesters of ETECH 303 & ENGR 325.

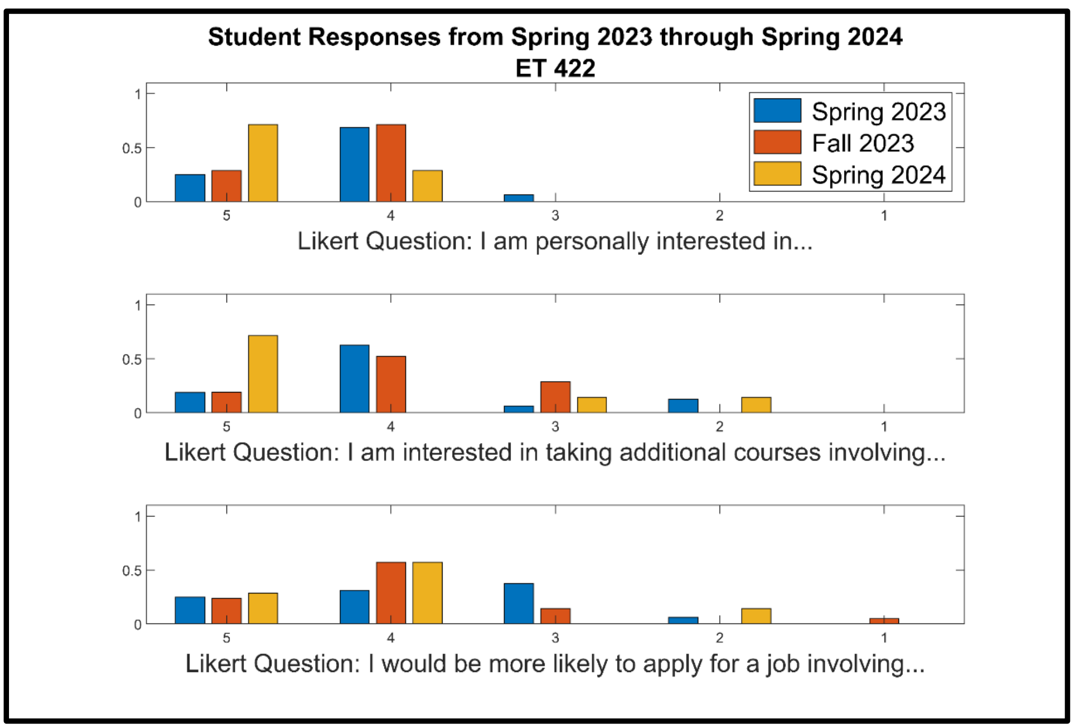

Fig. 8. Normalized results from all three semesters of ET 422.

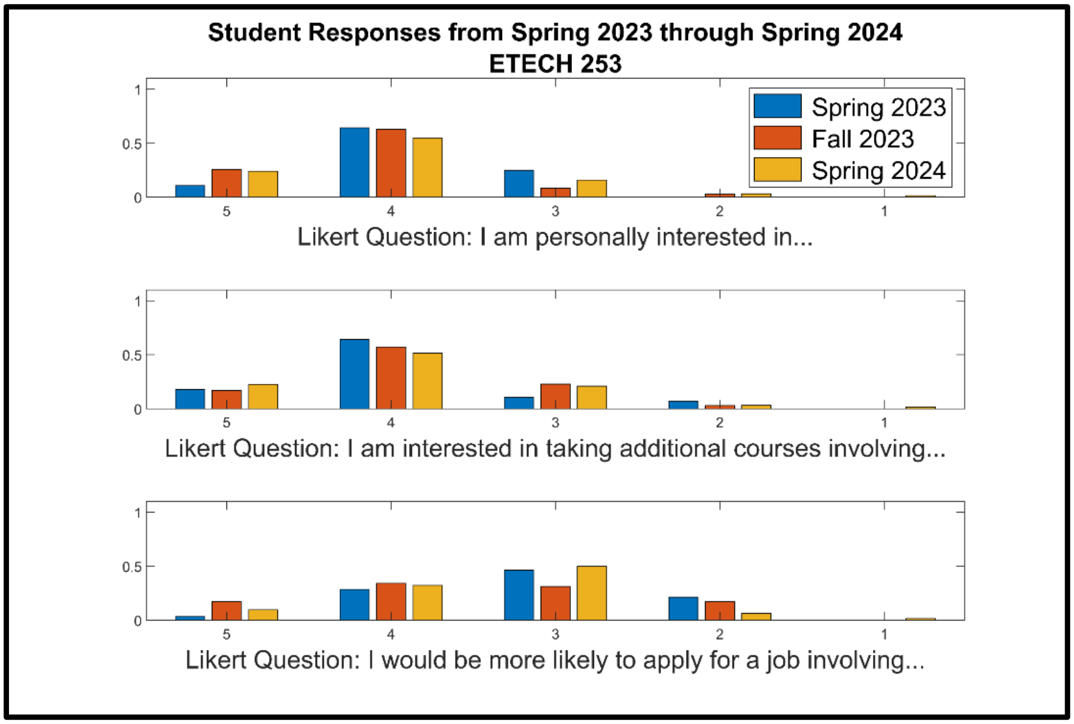

Fig. 9. Normalized results from all three semesters of ETECH 253.

Representations of data relevant to discussion of these results includes the statistical significance between groups of Likert responses and the response rate for each class. In order to objectively test the statistical significance of the variation in responses, the Kruskal-Wallis test [19] was used to evaluate the statistical significance of changes in Likert-scale responses between semesters, with the null hypothesis being there is no difference between semesters. This non-parametric test determined whether differences in student perceptions or outcomes were significant across the evaluated time periods. Table 2 shows the P-values for each question across semesters for each class the survey was administered to. Table 3 shows the response rate for each class on a semester-by-semester basis.

TABLE II
Mean Likert responses

P values for each question across three semesters for each class.			
ETECH 303 & ENGR 325			
	Q1	Q2	Q3
P	0.99	0.93	0.65
ET 422			
	Q1	Q2	Q3
P	0.83	0.60	0.43
ETECH 253			
	Q1	Q2	Q3
P	0.55	0.68	0.79

TABLE III
Survey response rates

Survey Response Rates					
ETECH 303 & ENGR 325		ET 422		ETECH 253	
SP23	85%	SP23	94%	SP23	35%
FA23	92%	FA23	95%	FA23	58%
SP24	96%	SP24	33%	SP24	78%

Results – Survey (Qualitative)

Question set one results:

Three instructors were interviewed that had students produce take home artifacts over the fourteen-week semester. The number of take-home artifacts ranged from six to ten depending on the course. Some projects were not taken home. In certain cases, they were unintentionally left at school upon completion of the semester, in others, the quality of the work did not meet course standards, and subsequently, the artifact was not allowed to be taken home. Moreover, projects of exceptional quality were used as demonstration pieces by one instructor. For a plastics engineering instructor, material from artifacts not taken home was recycled and repurposed. Another instructor commented “I think it's more fun to make something you’re going to keep rather than a widget, right? Nobody cares about it because it’s just something (without practical purpose). What are you going to do with it? But I've had a lot of people say they have the little box, and they put their change in it, or they throw their keys in it. The flower almost everybody gives to either their girlfriend or their mom or some other family member, grandma or whatever, for Christmas or for Mother's Day.”

Question set two results:

Technical difficulties with one of the interviews impeded evaluation. As such, the following are the results of two of the three interviews conducted.

Across both interviews, participants described student-created artifacts as catalytic experiences that connect learning to future vocational direction. Artifacts functioned first as entry points to anchor attention and situate content into a more tangible reality, and later as enduring evidence of competence—objects students can touch, revisit, and use to recall the learning process, including visible “mistakes” that become sites of reflection. In both accounts, career interest emerged less from the finished product than from the lived process of making: grappling with constraints, troubleshooting tools and materials, iterating designs, and ultimately overcoming apprehension to build confidence and agency. When projects carried authentic purpose (e.g., medical-device components, recycled-material products, heirloom-quality builds) and sometimes broader contribution (e.g., sustainability, community benefit), students experienced making as meaningful work, which supported identity shifts from “course-taker” to “designer/problem-solver”—a shift reinforced when alumni later referenced these artifact experiences as formative for subsequent employment or further study.

Discussion/Conclusions/Future Work

While there are variations in the distribution of responses to the Likert surveys, there are not obvious trends. Table one shows P-values across all questions and courses to be well above threshold for rejection of the null hypothesis. While this seems to indicate minimal impact of the use of demonstrations and educational artifacts on student interest, the interesting result comes from the response rate. The survey implemented was given with no incentives or requirements; it was entirely voluntary to the students enrolled in the courses. All but one survey administration to the ET 422, ETECH 303, and ENGR 325 courses had response rates at or above 85% with one outlying section having a very low response rate which may have been influenced by variations in the administration process.

In ETECH 253, the survey response rate increased every semester. It may be concluded that as hands on activities, demonstrations, and take-home artifacts are introduced, there is an accompanying increase of student engagement with the material, leading to more willingness to form and provide opinions on the process they are studying.

Perhaps the interviews reinforced what is already well known in career and technical education; the learning outcome or objective should dictate the artifact to be created and positively affect learners. Therefore, one can conclude the intention/objective of the artifact to be produced must be carefully considered by the instructor prior to its implementation into a course. Does the created artifact result in immediate use/application in and of itself, or perhaps the knowledge and skill developed as a result of creating the artifact? Does the created artifact result in an extension to career aspiration (the focal point of the present study) or application of knowledge and skill on the job. Does the artifact have a tertiary effect beyond immediate and/or future use for the learner?

While the application of a learner's knowledge or skill is not always/certainly/positively known as it relates to time, great care should be considered to how the production of an artifact will illuminate/facilitate/cultivate learning. In the interest of the present study, follow-up questions could continue to examine the extent to which graduated students reached back/reconnected with the three professors interviewed to gain a better understanding of the impact the creation of artifacts had on their careers. One of the interviewed instructors had a student come into his college class; the student had already completed all the same projects at his local high school. It had become apparent that all the artifacts created in the college course were adopted by the new technology education instructor.

The second set of interviews gives way to the idea that artifact-centered pedagogy functions not merely as an instructional strategy but as a mechanism for identity formation, linking student made artifacts to confidence, persistence, and vocational imagination. The conclusion might argue artifacts mediate critical transitions—from apprehension to agency and from coursework to career—by integrating process, purpose, and reflection into a single lived experience.

References

[1] Archer, Margaret. *Social origins of educational systems*. Routledge, 2013.

[2] Dewey, John. "An as experience." *Education* (1938).

[3] Wang, Yuemeng. "A comparative study on the effectiveness of traditional and modern teaching methods." *2022 5th International Conference on Humanities Education and Social Sciences (ICHESS 2022)*. Atlantis Press, 2022.

[4] Prichard, Keith W., and R. McLaran Sawyer. *Handbook of College Teaching. Theory and Applications. The Greenwood Educators' Reference Collection*. Greenwood Press, 88 Post Road West, Westport, CT 06881, 1994.

[5] Giorgdze, Madona, and Marine Dgebuadze. "Interactive teaching methods: challenges and perspectives." *International E-Journal of Advances in Education* 3.9 (2017): 544-548.

[6] Dewey, J. "Democracy and Education–Simon & Brown Edition." *Milton Keynes: Lightning Source UK Ltd* (2011).

[7] Vygotsky, Lev Semenovich. *The collected works of LS Vygotsky: The fundamentals of defectology*. Vol. 2. Springer Science & Business Media, 1987.

[8] Saye, John W., and Thomas Brush. "Comparing teachers' strategies for supporting student inquiry in a problem-based multimedia-enhanced history unit." *Theory & Research in Social Education* 34.2 (2006): 183-212.

[9] Resende, Adson Eduardo, and Flávio Henrique Vasconcelos. "Design of educational artifacts as support to learning process." *Work* 41.Supplement 1 (2012): 61-68.

[10] "Mission & Values." *UW-UNIVERSITY*, 26 Sept. 2024, www.uwUNIVERSITY.edu/about-us/mission-values.

[11] Nowak, James, et al. "Communicating Advanced Manufacturing Concepts to Middle-school Students Using Lego-Machines (Work in Progress)." *2015 ASEE Annual Conference & Exposition*. 2015.

[12] Wang, Yuemeng. "A comparative study on the effectiveness of traditional and modern teaching methods." *2022 5th International Conference on Humanities Education and Social Sciences (ICHESS 2022)*. Atlantis Press, 2022.

[13] Spike, N., K. Dietsche, and G. Slupe, "Artifacts of Learning – The Polytechnic Experience (Work in Progress)," in *Proc. ASEE North Midwest Section Annu. Conf.*, 2023. [Online]. Available: https://openprairie.sdstate.edu/asee_nmws_2023_pubs/9

[14] "University of Wisconsin-Stout Bulletin." *University of Wisconsin-Stout - Modern Campus Catalog TM*, bulletin.uwUNIVERSITY.edu/. Accessed 14 Jan. 2025.

[15] Black, J. Temple, and Ronald A. Kohser. *DeGarmo's materials and processes in manufacturing*. New York: John Wiley & Sons, 2020.

[16] Likert, Rensis. "A technique for the measurement of attitudes." *Archives of Psychology* (1932).

[17] Cohen, Louis, Lawrence Manion, and Keith Morrison. *Research methods in education*. Routledge, 2002.

[18] K. Dahlberg, N. Drew, and M. Nyström, *Reflective Lifeworld Research*. Lund, Sweden: Studentlitteratur, 2001.

[19] Kruskal, William H., and W. Allen Wallis. "Use of ranks in one-criterion variance analysis." *Journal of the American statistical Association* 47.260 (1952): 583-621.

[20] M. D. Gall, J. P. Gall, and W. R. Borg, *Educational Research: An Introduction*, 8th ed. Boston, MA, USA: Pearson/Allyn & Bacon, 2007.