

**Integrating Coding in Utah FFA Agriculture Technology and Mechanical Systems Career Development Event**

Bradley D. Borges  
Applied Sciences, Technology & Education  
Utah State University  
2800 Old Main Hill  
Logan, UT 84322  
435-797-1802  
[brad.borges@usu.edu](mailto:brad.borges@usu.edu)

Laura Rice  
Agricultural Economics, Sociology, and Education  
Penn State University  
386 Shortlidge Road  
215 Ferguson Building  
University Park, PA 16802  
814-865-5461  
[lrs203@psu.edu](mailto:lrs203@psu.edu)

Michael L. Pate  
Applied Sciences, Technology & Education  
Utah State University  
2800 Old Main Hill  
Logan, UT 84322  
435-797-0989  
[michael.pate@usu.edu](mailto:michael.pate@usu.edu)

Joseph S. Furse  
Applied Sciences, Technology & Education  
Utah State University  
2800 Old Main Hill  
Logan, UT 84322  
435-797-1802  
[joseph.furse@usu.edu](mailto:joseph.furse@usu.edu)

Donald M. Johnson  
Agricultural Education, Communications & Technology  
University of Arkansas  
1120 West Maple  
Fayetteville, Arkansas 72701  
479-575-2039  
[dmjohnso@uark.edu](mailto:dmjohnso@uark.edu)

## **Integrating Coding in Utah FFA Agriculture Technology and Mechanical Systems Career Development Event**

### **Introduction and Framework**

Programming and microcontrollers are being implemented in several areas of agriculture such as irrigation, animal production, and precision agriculture applications (Darr et al., 2007; Kurkute et al., 2018; Liu, 2022). SBAE students want to engage in learning new technologies relevant to current industry experiences (McBride & Talbert, 2022) and teachers require specific professional development or training to incorporate new technologies (Morey et al., 2023). By adding these new technologies, new learning opportunities are created for both the student and teacher (Rambe & Khaola, 2023). For ease of implementation of microcontrollers into SBAE curriculum, Arduino is a suitable option. This is an open-source microcontroller that has a large community backing for all levels of education and novice to advanced users. (Arduino, CITE) Arduino's integrated development environment (IDE) uses a variation of the C++ programming language (Schaffer, 2022).

One avenue to introduce these technologies to both students and teachers is through FFA Career Development Events (CDE). As teachers train students to compete, new technologies emerging from the agricultural industry can spark student interest. In this context, the adoption of Arduino represents an Authority Innovation-Decision within Rogers' (2003) Diffusion of Innovation framework. Unlike optional or collective decisions, an authority-based decision occurs when an influential body mandates the use of a specific innovation. In this study, a team activity for the 2024 Utah Agriculture Technology and Mechanical Systems (ATMS) CDE was implemented by the contest superintendent. Because the contest guidelines dictated the use of Arduino, teachers saw a relative advantage to adopt the technology to ensure their teams remain competitive. Alternatively, due to the authority-based decision of including a new technology into the CDE, students that perform well in traditional contest areas may struggle to adopt the new technology due to an adoption lag for Arduino.

This study investigated the relationship between how students performed on the various contest areas with the implementation of a new technology in the team activity. This study aligns to the AAAE research value "*Increasing Prosperity Through Innovation in AFNR Systems*" (AAAE, 2023, pg. 14) by introducing SBAE students to new technologies that are being utilized in the agricultural industry through a career development event competition. The research objective for this study was to identify the relationship between performance on the Arduino programming team activity and student performance on the written exam, critical thinking tasks, and tool and parts identification and technical questions team activity.

### **Methods**

This study employed a non-experimental correlational design. Data were collected from 44 teams that competed at the 2024 Utah ATMS CDE. Teams, with a maximum of four members, participated in four activities: a written exam, knowledge/critical thinking activities, tool and parts identification and team activity (280 points possible). The team activity was split evenly between two parts, a traditional set of technical questions and a new Arduino troubleshooting and coding activity. The scoring for the first four activities was based on points for correct answers, while the Arduino activity was scored using a condensed nine-item rubric adapted from

previous research (Johnson et. al., 2023). Data analysis involved using descriptive statistics to summarize team performance. Correlations were run between the Arduino activity and the other contest areas. The effect size for each correlation was determined by squaring the rho value. Spearman's Rank correlation was run because the Arduino team activity variable was not normally distributed ( $p > 0.05$ ). Data analysis will be performed using R (R Core Team, 2020).

## Results

All 44 teams participated in each of the four contest areas. Table 1 shows the average score for each contest area of the 2024 Utah State ATMS CDE competition.

**Table 1**

*Results of Contest Areas for 2024 Utah State ATMS CDE competition*

| Variable                           | <i>M (SD)</i>  | Points Possible |
|------------------------------------|----------------|-----------------|
| Individual Skills                  |                |                 |
| Written Exam*                      | 24.65 (5.61)   | 50 pts.         |
| Knowledge/Critical Thinking*       | 36.96 (5.52)   | 62 pts.         |
| Tool and Parts Identification*     | 24.35 (10.88)  | 62 pts.         |
| Team Activity                      |                |                 |
| Technical Questions Team Activity* | 62.52 (39.71)  | 140 pts.        |
| Arduino Team Activity              | 106.82 (44.15) | 140 pts.        |

*Note:* \* - identifies the traditional skills

Table 2 shows the correlation and effect size for each variable correlated back to the Arduino team activity scores. All contest areas scores showed a significant ( $p < 0.05$ ) positive correlation to the Arduino team activity scores demonstrating a medium effect size (Maher et al., 2013).

**Table 2**

*Correlation and Effect sizes between Arduino Team Activity and other Contest Areas*

| Variable                            | <i>r</i> | <i>P</i> | <i>r</i> <sup>2</sup> |
|-------------------------------------|----------|----------|-----------------------|
| Written Exam                        | 0.53     | < 0.001  | 0.279                 |
| Knowledge/Critical Thinking         | 0.57     | 0.003    | 0.325                 |
| Tool and Parts Identification       | 0.57     | < 0.001  | 0.325                 |
| Team Activity - Technical Questions | 0.65     | < 0.001  | 0.423                 |

## Conclusion, Discussion & Recommendations

The findings suggest a significant positive relationship between student performance on the new, technology-based Arduino activity and their performance in traditional CDE areas. This supports students who perform well in fundamental agricultural mechanics knowledge and skills also tend to perform well on the Arduino challenge. This is a promising finding, as it suggests that the integration of new technology does not need to be a completely separate skill set but can be built upon existing foundational knowledge. Additionally, we recommend including new technologies into CDE competitions to better prepare students for future careers. In conclusion, this study validates the potential for integrating new technologies, like microcontrollers, into established CDEs.

## References

- American Association for Agricultural Education (AAAE). (2023). *AAAE Research Values*. <https://aaaonline.org/National-Research-Values>.
- Arduino. (2025). Arduino UNO R3 user manual. <https://docs.arduino.cc/resources/datasheets/A000066-datasheet.pdf>
- Darr, M. J., Stombaugh, T. S., Shearer, S. A., & Gates, S. R. (2007). A new course to teach microcontrollers and embedded networking to biosystems and agricultural engineers. *International Journal of Engineering Education*, 23(4), 716–722.
- Johnson, D. M., Pate, M., Estep, C. M., & Wardlow, G. (2023). Using self-efficacy theory to design Arduino instruction for novices: A replication study. *Journal of Research in Technical Careers*, 7(1), 68–84. <https://doi.org/10.9741/2578-2118.1125>
- Kurkute, S. R., Deore, B. D., Kasar, P., Bhamare, M., & Sahane, M. (2018). Drones for smart agriculture: A technical report. International. *Journal for Research in Applied Science & Engineering Technology*, 6(4), 341–346. <https://doi.org/10.22214/ijraset.2018.4061>
- Liu, Y. (2022). Smart greenhouse monitoring and controlling based on NodeMCU. *International Journal of Advanced Computer Science and Applications*, 13(4), 597–600. <https://doi.org/10.14569/IJACSA.2022.0130970>
- Maher, J. M., Markey, J. C., & Ebert-May, D. (2013). The other half of the story: Effect size analysis in quantitative research. *CBE—Life Sciences Education* 12(3), 345–351. <https://doi.org/10.1187/cbe.13-04-0082>
- McBride, S. M., & Talbert, B. A. (2022). Openness and preparedness of senior FFA members toward technology in agriculture. *Journal of Agricultural Education*, 63(1), 98–114. <https://doi.org/10.5032/jae.2022.01098>
- Morey, T., Foster, D., & Ewing, J. (2023). Virtual mentoring in agricultural education: Describing digital literacy, technology self-efficacy, and attitudes toward technology of secondary agricultural educators. *Journal of Agricultural Education*, 64(1), 12–27. <https://doi.org/10.5032/jae.v64i1.27>
- R Core Team (2020). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. <https://www.R-project.org/>
- Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). Free Press.