Digital Media Academy

Digital Media Academy

Tech Camps for Ages 12-17

2019 Evaluation Report

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Prepared by EPIC STEM Evaluation Services
at The University of Texas at Austin
Texas Advanced Computing Center

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Introduction

Project Overview

Digital Media Academy (DMA), originally known as the Academy for New Media, was founded through the Academic Technology Department at Stanford University in 1999. In 2002, DMA became a private institution that aims to be the "Best Tech Camps Ever," providing enriching, technology-focused summer camps at universities and other sites across the United States and Canada. DMA offers academies and courses in over 25 programs for kids and teens aged 9 through 18 across the following 6 pathways:

- 3D Modeling and Design
- Coding and Artificial Intelligence
- Film and Photography
- Game Design
- Music Production
- Robotics and Engineering

DMA Tech Camps courses are developed and taught by technology instructors and professionals from the tech industry. The courses are project-based and utilize software and hardware currently being used in industry. Courses are aimed at developing students' skills in a wide variety of areas, such as C++, Java, Raspberry Pi, LEGO robotics, and Ableton. Ultimately, DMA Tech Camps are meant to provide students experiences that will inspire and enable them to pursue careers in science, technology, engineering and/or mathematics (STEM) fields.

Evaluation Overview

DMA contracted with the Expanding Pathways in Computing (EPIC) STEM Evaluation Services at The University of Texas at Austin (UT) Texas Advanced Computing Center (TACC) to improve its data collection measures and conduct an external pilot evaluation of its Tech Camps courses for students aged 12-17, which includes 10 courses across its six pathways in Summer 2019. The objectives of the external evaluation were to:

- Provide consultation on strengthening established Tech Camps satisfaction surveys for DMA students in all age groups and ensure greater consistency in evaluative data collection measures;
- Develop a Student Post-Survey customized to assess the effectiveness and outcomes of 10 Tech Camps teen courses on student learning, attitudes and efficacy in STEM, and future intent and needs to continue STEM involvement;
- Collect qualitative data on student perceptions of the program and its impact;
- Conduct statistical and content analysis on all survey, focus group, and student data; and
- Report evaluative findings and recommend strategies for strengthening the program and evaluation moving forward.

To these ends, the EPIC evaluators collaborated with DMA to obtain access to previously administered surveys and online instructional materials and course content. The evaluators used this information to create research-based surveys for DMA's future use with all students. The evaluators designed a **Student Post-Survey** to be administered through DMA's data collection software at the end of the Tech Camps from June through August 2019 for students of all ages.

The Student Post-Survey also included quantitative and qualitative items customized to assess the effectiveness and outcomes of the following 10 Tech Camps teen courses that were assessed in the pilot evaluation:

- T05 Intro to Filmmaking
- T71 AI and Machine Learning
- T60 Electronic Music Production with Ableton
- T72 2D Animation and Digital Illustration
- T57 Game Design with Unity
- T29 Intro to Java Programming
- T35 Graphic Design
- T59 Python and Electrical Engineering with Take-Home Laptop
- T34 Digital Photography and Photoshop
- T42 Autonomous Arduino with Take-Home Robot

To enable evaluators to more fully assess the impact of Tech Camps on students, the evaluators conducted one mid-camp **Student Focus Group** at a Tech Camps site in Austin, Texas in July 2019. The Student Focus Group Protocol was developed by the evaluators to obtain DMA students' perceptions, experiences, outcomes, recommendations, and future needs.

DMA supplied the evaluators with student demographic data and the data gathered from the Student Post-Survey for the 10 courses in the pilot evaluation. The evaluators conducted statistical and content analysis on the Student Post-Survey, Student Focus Group, and student data to assess the Tech Camps course outcomes, share findings, and provide recommendations to strengthen the program and evaluation moving forward. This evaluation report shares these findings and recommendations.

Survey Findings

Participant Profile

A total of 874 students in the 10 Tech Camps courses responded to the Student Post-Survey for the pilot evaluation in Summer 2019. Since 35 students took the survey for two courses, the total number of survey responses was 909. Of the 874 unique respondents, about one-third (35%) were female, 13% had previously enrolled in a Tech Camp course, and 4% were scholarship recipients (see **Table 1**).

Table 1. Number and Percent of Tech Camps Survey Respondent Demographics (N=874)

	N	%
Gender		
Male	567	65%
Female	307	35%
Scholarship Status		
Did Not Receive Scholarship	840	96%
Received Scholarship	34	4%
Prior Enrollment		
No	758	87%
Yes	116	13%

As shown in **Table 2**, about one-fifth (18%) of the respondents attended Tech Camps in Toronto, 16% at New York University (NYU), and 10% at Harvard. Students from University of California, San Diego (UCSD), Seattle, and Chicago made up about one-fifth (21%) of respondents. One-third (34%) of the respondents participated in camps at the remaining locations: University of British Columbia (UBC) (6%), Duke (5%), Houston (5%), University of California, Los Angeles (UCLA) (4%), George Washington University (GWU) (4%), Irvine (4%), Austin (4%), McGill (1%), Pennsylvania (1%), and Stanford (<1%).

Table 2. Number and Percent of Tech Camps Survey Respondents by Location (N=874)

	N	%
Toronto	159	18%
New York University (NYU)	144	16%
Harvard	91	10%
University of California San Diego (UCSD)	65	7%
Seattle	62	7%
Chicago	57	7%
University of British Columbia (UBC)	49	6%
Duke	46	5%
Houston	42	5%
University of California Los Angeles (UCLA)	37	4%
George Washington University (GWU)	35	4%
Irvine	33	4%
Austin	31	4%
McGill	13	1%
Pennsylvania	7	1%
Stanford	3	<1%

Nearly an equal proportion (15-16%) of respondents were enrolled in Intro to Filmmaking (16%), AI and Machine Learning (16%), Electronic Music Production (16%), and 2D Animation and Digital Illustration (15%) (See **Table 3**). One-tenth were enrolled in Game Design, 9% in Intro to Java Programming, 7% in Graphic Design, 4% in Python and Electrical Engineering (EE), 4% in Digital Photography, and 3% in Autonomous Arduino.

Table 3. Number and Percent of Tech Camps Survey Respondents by Course (N=874)

	N	%
T05 Intro to Filmmaking	142	16%
T71 AI and Machine Learning	138	16%
T60 Electronic Music Production with Ableton	136	16%
T72 2D Animation and Digital Illustration	128	15%
T57 Game Design with Unity	91	10%
T29 Intro to Java Programming	75	9%
T35 Graphic Design	63	7%
T59 Python and Electrical Engineering with Take-Home Laptop	39	4%
T34 Digital Photography and Photoshop	36	4%
T42 Autonomous Arduino with Take-Home Robot	26	3%

Tech Camps Satisfaction and Preferences

Most (89%-96%) respondents agreed or strongly agreed with all statements assessing their satisfaction with the Tech Camps. As **Figure 1** shows, 95-96% of respondents were satisfied with their DMA Tech Camps experience overall as well as with the course content and activities, course instructor, and facilities and campus experience. The vast majority (83-92%) of respondents were satisfied with the breaktime and lunch activities, would recommend DMA to others, and were interested in taking more DMA courses in the future. Slightly more than half (52%) would not prefer to use their own laptop/device in DMA courses.

Figure 1. Percent of Tech Camps Participant Responses on Satisfaction Statements

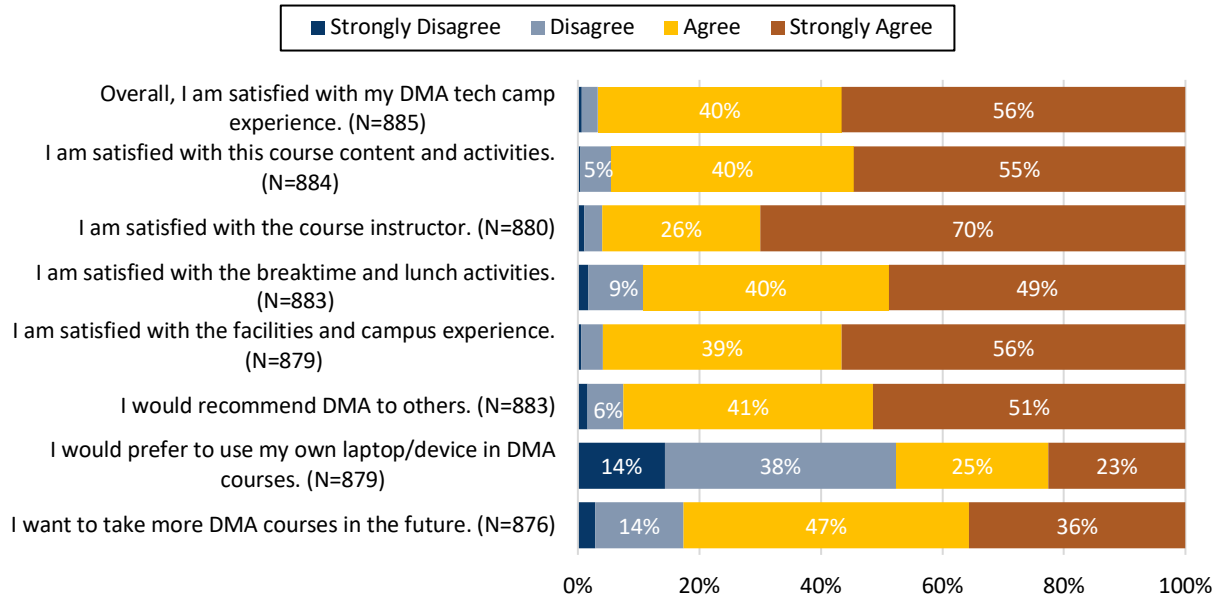


Table 4 shows respondents' agreement with satisfaction statements by course. Of the 93% of students who reported they would recommend DMA to others, there was a slightly lower proportion of agreement among students in Python and EE (83%) and AI and Machine Learning (86%). Over half of the students in Intro to Java (55%), Autonomous Arduino (53%), Game Design (55%), Python and EE (61%), and Electronic Music Production (56%) would prefer to use their own device.

Table 4. Percent of Tech Camps Participant Responses That Agreed or Strongly Agreed with Satisfaction Statements by Course and Overall (N=876-885)

	Intro to Filmmaking		Intro to Java		Digital Photography		Graphic Design		Autonomous Arduino		Game Design		Python and EE		Electronic Music Production		AI and Machine Learning		2D Animation		Overall
	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Overall, I am satisfied with my DMA Tech Camps experience.	**96%**	140	**96%**	82	**100%**	36	**98%**	61	**98%**	40	**98%**	87	**91%**	54	**98%**	134	**96%**	134	**98%**	117	**96%**
I am satisfied with this course content and activities.	**95%**	140	**96%**	82	**100%**	36	**98%**	61	**98%**	40	**94%**	87	**91%**	54	**96%**	134	**87%**	133	**97%**	117	**95%**
I am satisfied with the course instructor.	**94%**	140	**98%**	80	**100%**	36	**100%**	61	**95%**	40	**99%**	87	**98%**	53	**96%**	134	**90%**	132	**98%**	117	**96%**
I am satisfied with the breaktime and lunch activities.	**88%**	138	**91%**	82	**75%**	36	**93%**	61	**90%**	40	**85%**	87	**91%**	54	**90%**	134	**87%**	134	**91%**	117	**89%**
I am satisfied with the facilities and campus experience.	**95%**	138	**95%**	82	**94%**	36	**98%**	61	**95%**	39	**92%**	86	**94%**	54	**97%**	133	**97%**	133	**98%**	117	**95%**
I would recommend DMA to others.	**96%**	139	**94%**	82	**94%**	36	**97%**	61	**95%**	40	**94%**	87	**83%**	53	**93%**	134	**86%**	134	**94%**	117	**92%**
I would prefer to use my own laptop/device in DMA courses.	43%	137	**55%**	82	36%	36	37%	60	**53%**	40	**55%**	87	**61%**	54	**56%**	134	48%	134	34%	115	48%
I want to take more DMA courses in the future.	**87%**	139	**83%**	81	**75%**	36	**90%**	60	**87%**	39	**80%**	84	**83%**	54	**84%**	133	**75%**	134	**83%**	116	**83%**

Note: The number of responses (N=876-885) is greater than the unique number of students (N=874) who responded to the survey because 35 students responded to surveys for two courses.
Note: Instances where more than 50% of responses agreed or strongly agreed with the statements are displayed in bold font.

Ordered logit models were estimated to investigate whether students' gender, prior enrollment status, and course predicted their satisfaction. The following satisfaction items were used in the analyses: 1) overall DMA Tech Camps experience, 2) course content and activities, and 3) course instructor. Students' responses to satisfaction statements were coded as: 1 = "Strongly Disagree," 2 = "Disagree," 3 = "Agree," and 4 = "Strongly Agree." Only groups that were found to have significant differences are shown in the figures. The large differences in the subgroup sample sizes may have skewed results, making it difficult to detect significant differences that may have been detected were more students included in the analyses.

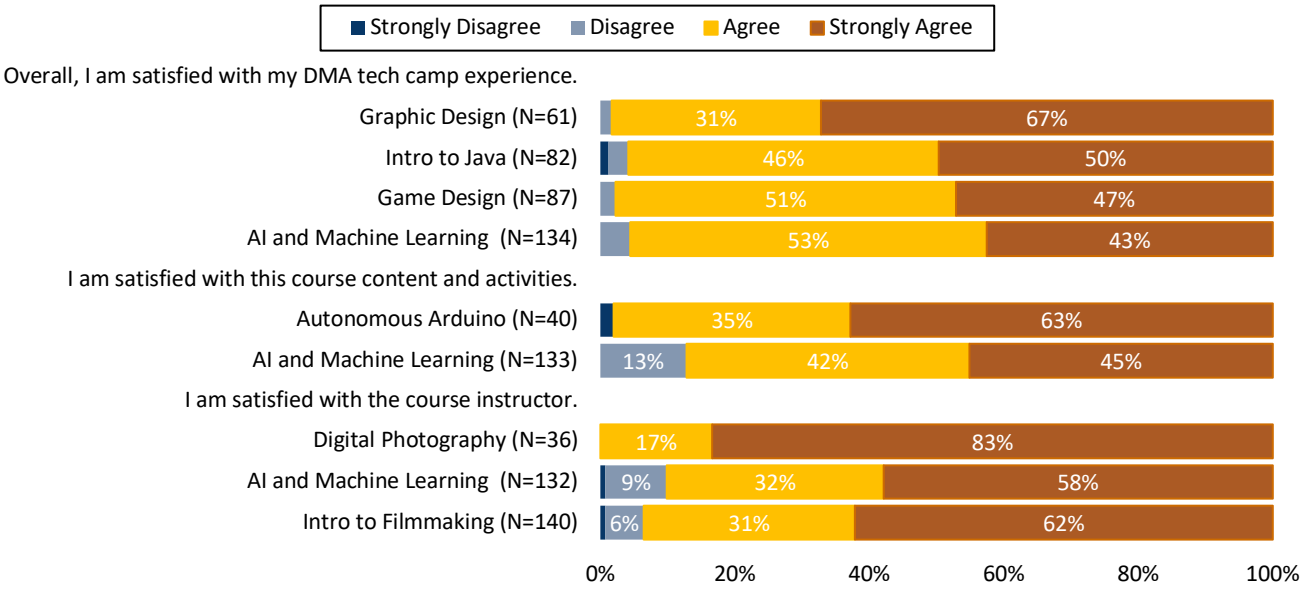
Differences in Satisfaction by Course

For some courses in the pilot evaluation, the course significantly predicted students' satisfaction with their overall Tech Camps experience. Students in Intro to Java (*M*=3.45, *SD*=0.61), Game Design (*M*=3.45, *SD*=0.54), and AI and Machine Learning (*M*=3.38, *SD*=0.57) reported statistically significantly lower levels of satisfaction with their overall experience than Graphic Design students. Graphic Design was used as the reference group for the analyses of satisfaction with overall camp experience because students in this course reported proportionally the highest level of satisfaction on this item (*M*=3.66, *SD*=0.51). See **Figure 2** and **Table A1** in the Appendix for more information on the courses with significant differences.

Also, compared to students enrolled in Autonomous Arduino (*M*=3.58, *SD*=0.64), students in AI and Machine Learning (*M*=3.32, *SD*=0.69) reported statistically significantly lower levels of satisfaction with course content and activities (see **Figure 2** and **Table A2** in the Appendix). Here, Autonomous Arduino was used as the reference group for the ordered logistic regression analyses because students in this course reported the highest proportional level of satisfaction with course content and activities.

Finally, students in Intro to Filmmaking (*M*=3.55, *SD*=0.64) and AI and Machine Learning (*M*=3.47, *SD*=0.69) reported statistically significantly lower levels of satisfaction with their course instructor compared to students who participated in course Digital Photography (*M*=3.83, *SD*=0.38; see **Figure 2** and **Table A3** in the Appendix). Digital Photography was used as the reference group for these analyses because these students reported the highest proportional level of satisfaction with their course instructor.

Figure 2. Percent of Tech Camps Participant Responses on Satisfaction Statements by Course



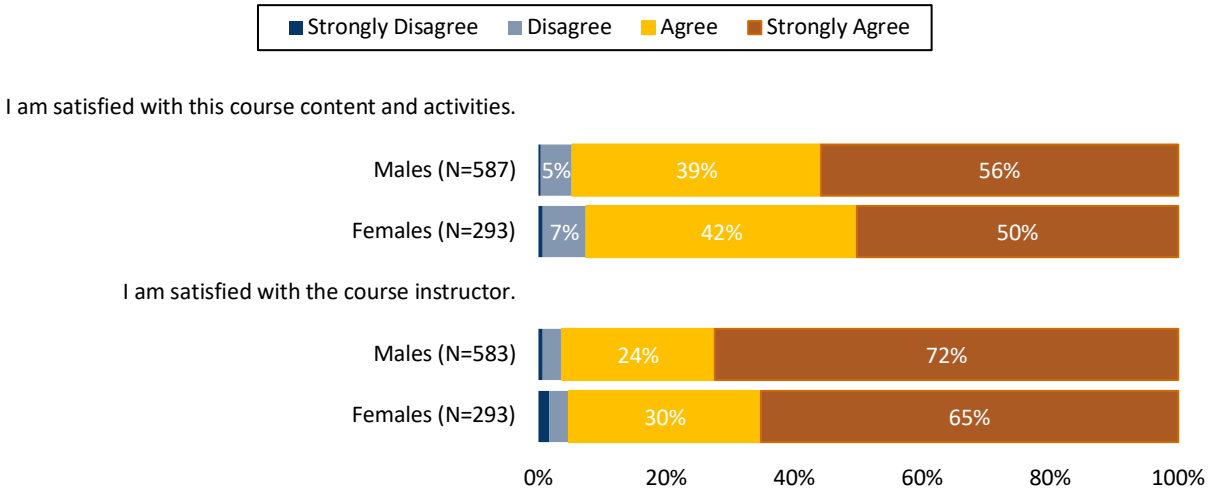
Note: Only courses that are statistically significantly different from the reference course are shown in the figure.

Differences in Satisfaction by Gender and Previous Enrollment

Students' gender and prior enrollment status were not statistically significantly predictors of their satisfaction with their overall Tech Camps experience. However, students' gender was a statistically significant predictor of students' satisfaction with course content and activities (p=.02; See **Figure 3**). Specifically, compared with female students, the odds of male students having a higher level of satisfaction was 1.42 times greater, holding all other variables (i.e., prior enrollment status and course) in the model constant. Students' prior enrollment status was not found to be a significant predictor.

Gender was also a significant predictor of students' satisfaction with their course instructor. Specifically, compared with female students, the odds of male students having a higher level of satisfaction was 1.43 times greater, holding constant prior enrollment status and course. Students' prior enrollment status was not found to be a significant predictor.

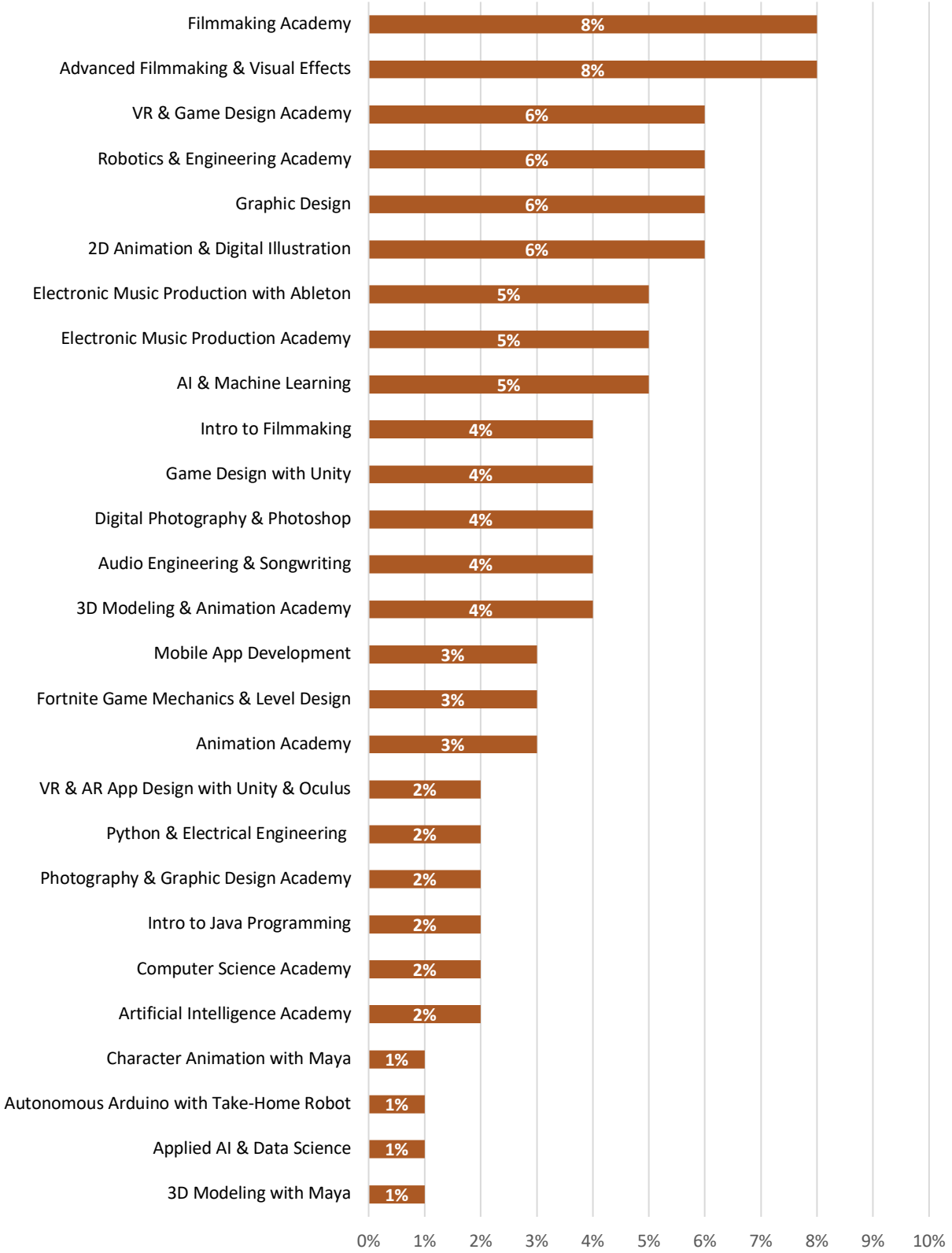
Figure 2. Percent of Tech Camps Participant Responses on Satisfaction Statements by Gender



Course Interest

Students who agreed or strongly agreed that they wanted to take additional DMA courses were provided a list of course offerings and asked to select those they were interested in taking. As **Figure 4** shows, Filmmaking Academy, Advanced Filmmaking and Visual Effects, Virtual Reality (VR) and Game Design Academy, Robotics and Engineering Academy, Graphic Design, and 2D Animation and Digital Illustration and Digital Illustration were courses that interested students the most. Further analysis by gender showed that Filmmaking Academy and Advanced Filmmaking and Visual Effects were the two most interesting courses to male students, while 2D Animation and Digital Illustration and Graphic Design were the two most interesting courses to female students.

Figure 3. Percent of Tech Camps Participants Interested in Specific DMA Courses (N=672)



Suggested Courses

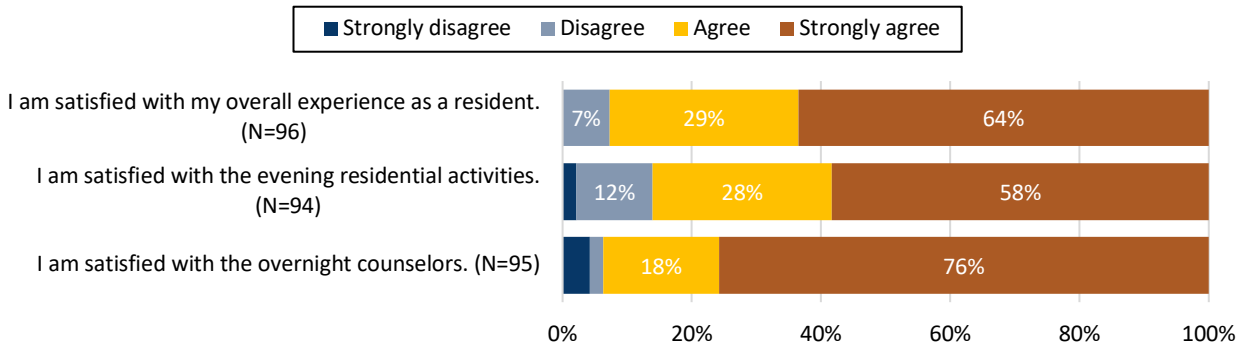
When students were asked what other courses they would like DMA to offer, multiple course themes emerged in their responses (N=375):

- **Game Design:** "Learning how to make games," "I would stay in game design because it is very fun and interesting," and "Making large games."
- **Other Coding Languages:** "Probably more coding languages (not including Scratch or Python; maybe JavaScript)," "Intro to C++ or C#," and "I would like to do more coding camps that teach different coding languages."
- **Music Production:** "Intro to music making," "Any other music production classes," and "Electronic Music Production with FL Studio."
- **Minecraft:** "Minecraft for teens" and "Minecraft Learning."
- **Fortnite:** "Fortnite coaching" and "Fortnite skin design."
- **(Advanced) Graphic Design:** "More graphic design stuff" and "Maybe a course that's like a more in-depth graphic design class that you can take after taking the first one."
- **Art/Drawing:** "Painting or traditional art," "Pencil Sketching class," and "A physical art class such as painting or drawing."
- **Creative/Screen/Fictional/Film Writing:** "I would like DMA to offer a creative writing class," "Help with Screenwriting/Storytelling," and "Screenwriting class."
- **Robotics/Robots:** "Remote controlled robot," "Robot building/programming," and "Lots of animation and robotics courses."
- **Other:** songwriting, character design, YouTube videomaking, 3D printing, advanced 2D animation, advanced filmmaking, web design/development, advanced coding classes, virtual reality, stop-motion animation, advanced artificial intelligence and machine learning, etc.

Satisfaction with Overnight Program

Of the 874 survey respondents, 100 participated in the overnight program. As **Figure 5** shows, almost all overnight participant respondents agreed (indicating Strongly Agree or Agree) that they were satisfied with their overall experience as a resident (93%) and with their overnight counselors (94%). Most respondents (86%) agreed that they were satisfied with the evening residential activities.

Figure 4. Percent of Overnight Participant Responses on Satisfaction Statements



STEM Outcomes

As shown in **Figure 6**, most (77-96%) of the survey respondents agreed or strongly agreed that their learning and attitudes toward STEM improved as a result of participating in the Tech Camps. Nearly all (96%) of the respondents said they now know more about the course topic and are able to do things they were not able to do before the course. Most students said they are more likely to keep trying and not give up when working on a difficult problem (88%) and that they are more confident they can learn STEM topics as a result of the course they took (85%). Over three-fourths of respondents indicated that they increased their interest in STEM (80%) and their interest in pursuing a career in STEM fields (77%) as a result of their participation.

Figure 5. Percent of Tech Camps Participant Responses on Outcome Statements

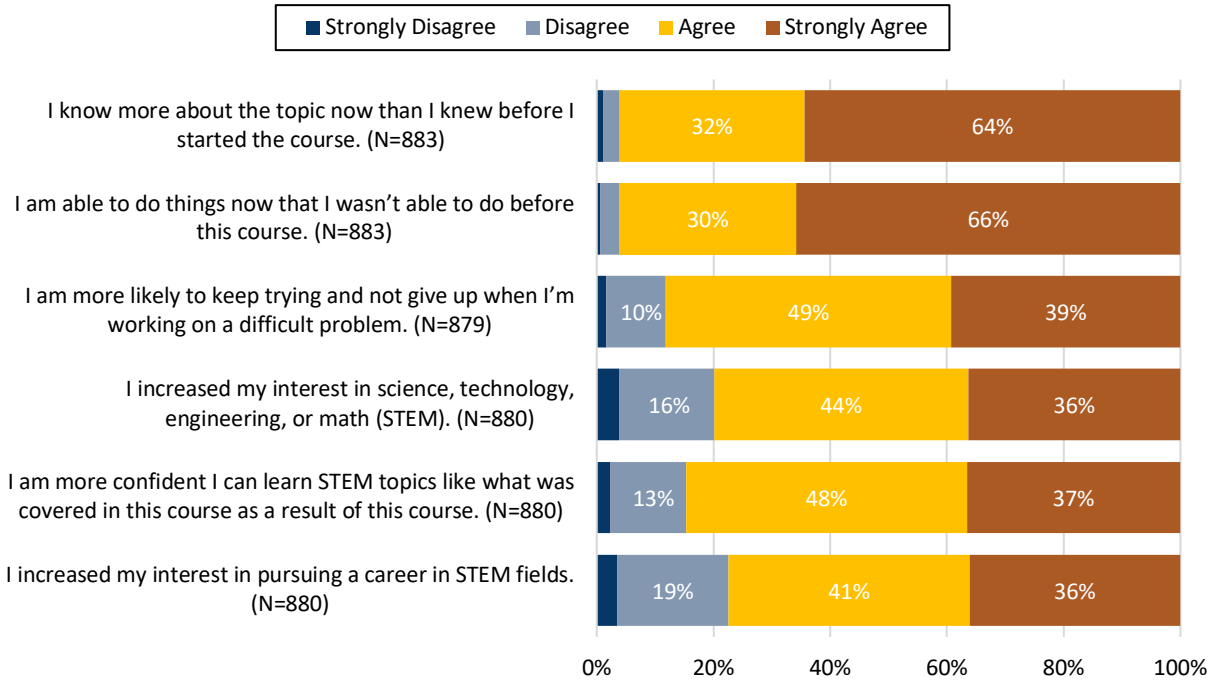


Table 5 shows respondents' agreement with outcome statements by course. Of the 80% of respondents who agreed they increased their interest in STEM, the two courses with the highest percentage of agreement among students were Autonomous Arduino (98%) and AI and Machine Learning (90%). Also, of the 77% of respondents who agreed that they increased their interest in pursuing a career in STEM fields, the highest proportion of agreement was found among students in Autonomous Arduino (93%) and Python and EE (87%).

Table 5. Percent of Tech Camps Participant Responses That Agreed or Strongly Agreed with Outcome Statements by Course and Overall (N=879-883)

	Intro to Filmmaking		Intro to Java		Digital Photography		Graphic Design		Autonomous Arduino		Game Design		Python and EE		Electronic Music Production		AI and Machine Learning		2D Animation		Overall
	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
I know more about the topic now than I knew before I started the course.	**93%**	139	**99%**	81	**100%**	36	**97%**	61	**98%**	40	**97%**	87	**96%**	54	**98%**	134	**97%**	134	**93%**	117	**96%**
I am able to do things now that I wasn't able to do before this course.	**90%**	139	**100%**	81	**94%**	36	**100%**	61	**100%**	40	**95%**	87	**98%**	54	**99%**	134	**96%**	134	**94%**	117	**96%**
I am more likely to keep trying and not give up when I'm working on a difficult problem.	**88%**	138	**86%**	80	**86%**	36	**92%**	60	**95%**	40	**86%**	87	**85%**	54	**93%**	133	**83%**	134	**89%**	117	**88%**
I increased my interest in science, technology, engineering, or math (STEM).	**71%**	138	**85%**	81	**69%**	36	**77%**	60	**98%**	40	**89%**	87	**87%**	54	**80%**	133	**90%**	134	**63%**	117	**80%**
I am more confident I can learn STEM topics like what was covered in this course as a result of this course.	**78%**	139	**89%**	81	**81%**	36	**85%**	60	**100%**	40	**90%**	87	**85%**	54	**84%**	134	**94%**	134	**71%**	115	**85%**
I increased my interest in pursuing a career in STEM fields.	**70%**	137	**80%**	81	**56%**	36	**73%**	60	**93%**	40	**80%**	87	**87%**	54	**83%**	134	**85%**	134	**66%**	117	**77%**

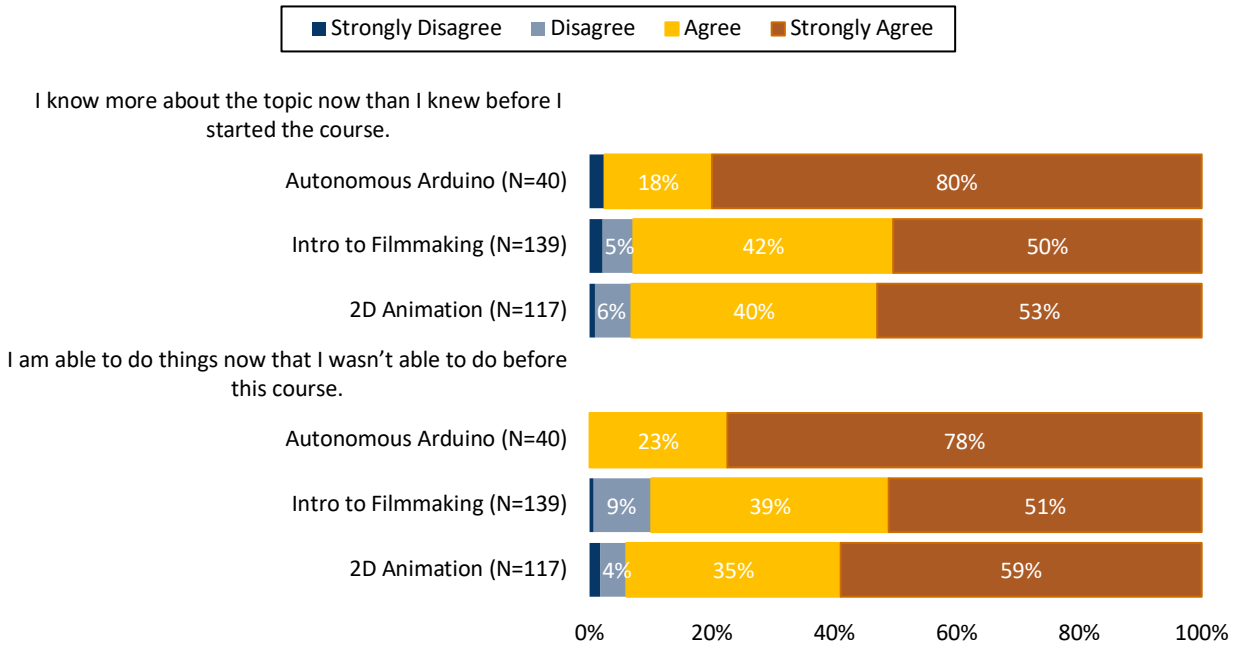
Note: The number of responses (N=879-883) is greater than the unique number of students (N=874) who responded to the survey because 35 students responded to surveys for two courses.
Note: Instances where more than 50% of responses agreed or strongly agreed with the statements are displayed in bold font.

Ordered logit models were used to investigate whether students' gender, prior enrollment status, and course predicted their agreement with the six outcome statements above. Outcome variables were coded as: 1 = "Strongly Disagree," 2 = "Disagree," 3 = "Agree," and 4 = "Strongly Agree." Again, note that only groups with significant differences are shown in the figures, and that variation in subgroup sample sizes were quite large and may have contributed to results of statistical analyses.

Differences in Outcome Statements by Course

Students in Autonomous Arduino reported the highest proportional level of agreement with all six statements (M=3.65, SD=0.37) compared to the other courses. As a result, this course was used as the reference category to which all other nine courses were compared in the ordered logit models. Logistic regression analyses revealed that for the first two statements measuring students' beliefs in overall learning and skills, students in Intro to Filmmaking and 2D Animation and Digital Illustration tended to report significantly lower levels of agreement than Autonomous Arduino students (See **Figure 7** and **Tables B1-B2** in the Appendix).

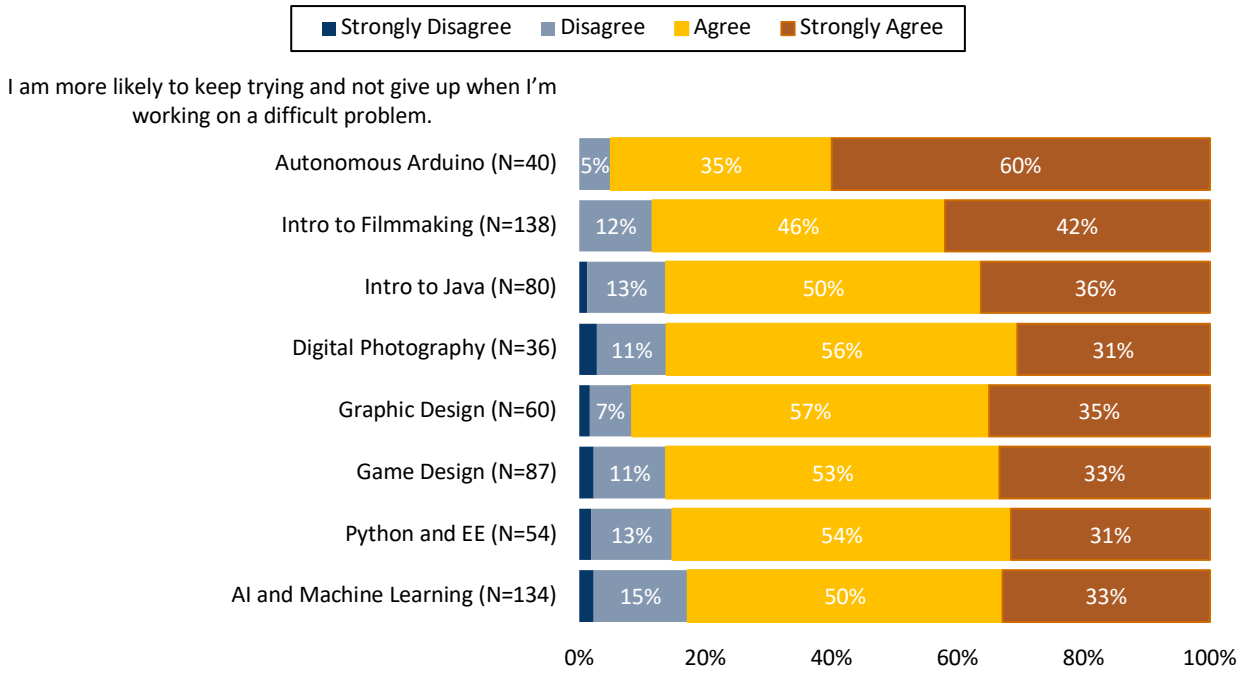
Figure 6. Percent of Tech Camps Participant Responses on Learning and Skill Statements by Course



Note: Only courses that are statistically significantly different from the reference course are shown in the figure.

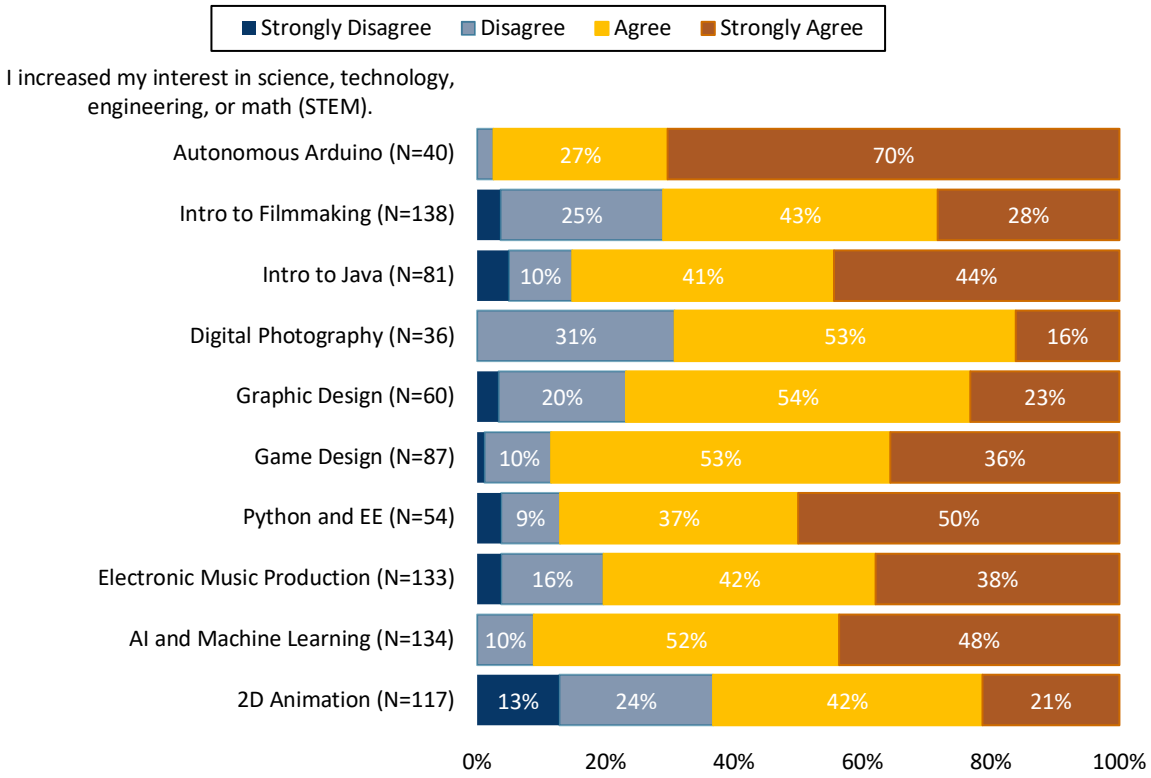
For the statement used to measure students' persistence, Autonomous Arduino students indicated significantly higher levels of agreement than students from the majority of other courses. The courses statistically significantly different from the reference course are shown in **Figure 8** and in **Table B3** in the Appendix. For each of the two statements used to measure students' interest and confidence in learning STEM topics, students in Autonomous Arduino indicated significantly higher levels of agreement than students from all of the other courses (see **Figures 9** and **10** and **Tables B4-B5** in the Appendix).

Figure 7. Percent of Tech Camps Participant Responses on Persistence Statement by Course



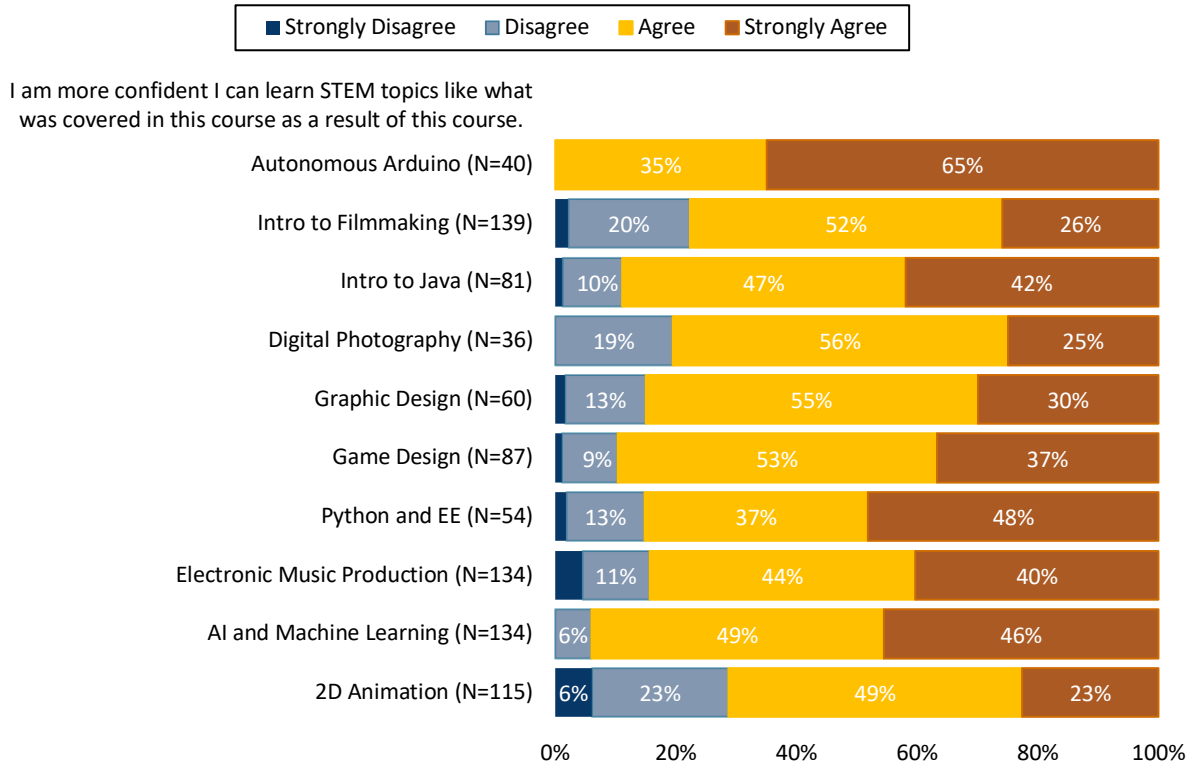
Note: Only courses that are statistically significantly different from the reference course are shown in the figure.

Figure 8. Percent of Tech Camps Participant Responses on STEM Interest Statement by Course



Note: Only courses that are statistically significantly different from the reference course are shown in the figure.

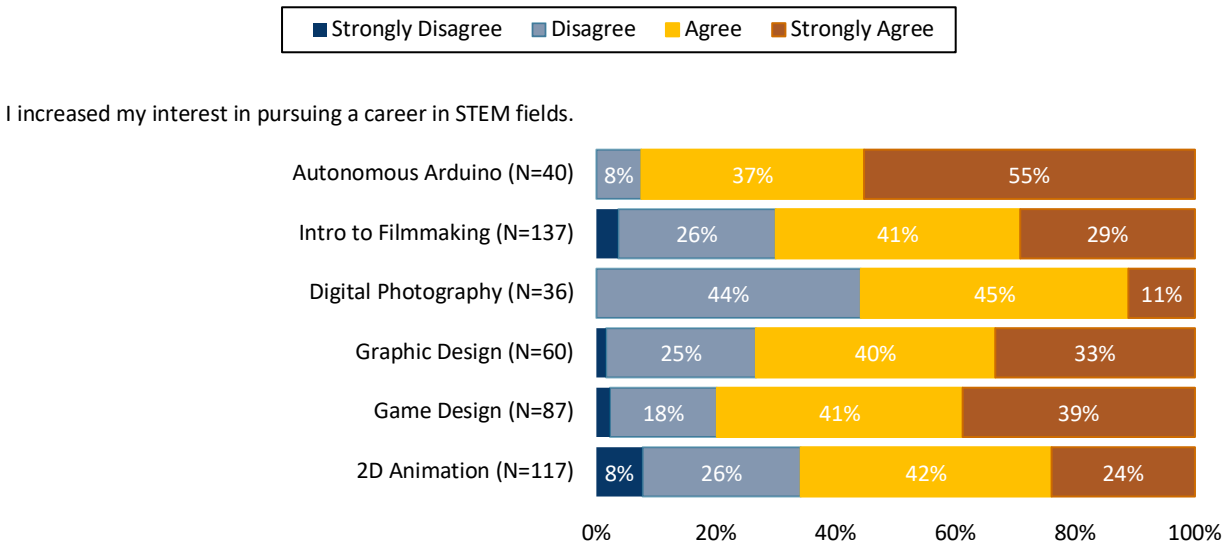
Figure 9. Percent of Tech Camps Participant Responses on STEM Confidence Statement by Course



Note: Courses statistically significantly different from the reference course are shown in the figure.

Autonomous Arduino students also reported statistically higher levels of agreement with the statement about STEM career aspirations than students in Digital Photography, 2D Animation and Digital Illustration, Intro to Filmmaking, Graphic Design, and Game Design (See **Figure 11** and **Table B6** in the Appendix).

Figure 10. Percent of Tech Camps Participant Responses on STEM Career Interest Statement by Course



Note: Courses statistically significantly different from the reference course are shown in the figure.

Differences in Outcomes Statements by Gender and Previous Enrollment

As shown **Tables B1-B6** in the Appendix, students' gender and prior enrollment status were not found to be significant predictors of their agreement with outcome statements across all six ordered logistic models. In other words, male and female students indicated comparable levels of agreement with these statements, and their learning and attitudes did not differ significantly based of their prior enrollment in DMA Tech Camps.

Course-Specific Learning Outcomes

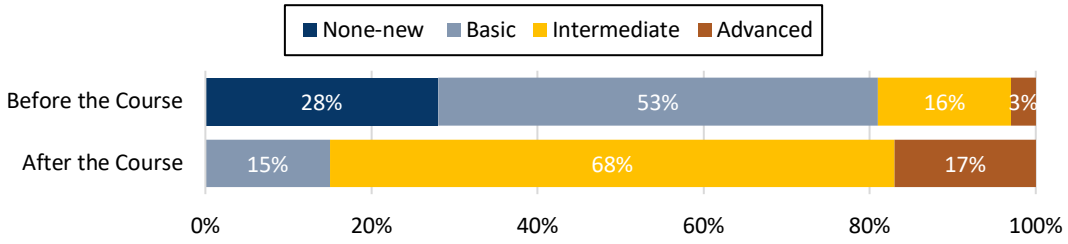
Students in each course were presented with items customized to the course(s) in which they had enrolled. They were first asked to retrospectively rate their level of expertise before taking their course and then asked to rate their expertise after taking their course. For example, students in Digital Photography and Photoshop were asked to rank their "expertise in digital photography and Photoshop before this course" on a 4-point scale, ranging from "none" to "advanced," and then asked to respond to the same item "after this course."

Students were also asked to assess changes in their understanding or abilities related to the course learning objectives as a result of participating in the DMA course(s). For example, Digital Photography students were asked to rate how much their understanding or abilities changed with respect to "photo manipulation techniques" on a 4-point scale from "did not change" to "improved a great extent." The findings from the customized survey items are presented for each course below.

2D Animation and Digital Illustration

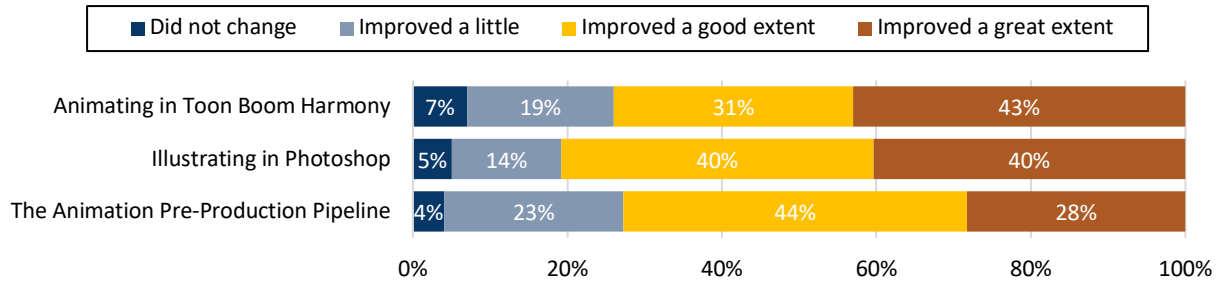
About 85% of survey respondents who took 2D Animation and Digital Illustration reported having intermediate to advanced expertise in this course area after taking the course. This was up from 19% who indicated having this level of expertise before taking the course (see **Figure 12**). A dependent t-test shows that the self-reported difference in expertise before and after taking the course is significant ($t(112)=16.49$, $p<0.001$; see **Table 6**).

Figure 11. Expertise in 2D Animation and Digital Illustration Before and After Course (N=113)



On average, more than 70% of survey respondents who took 2D Animation and Digital Illustration reported that their understanding/abilities related to the course learning objectives improved a good or great extent (see **Figure 13**). An independent t-test did not show a significant difference between male and female students in change in understanding/abilities ($t(115)=1.73$, $p>0.05$).

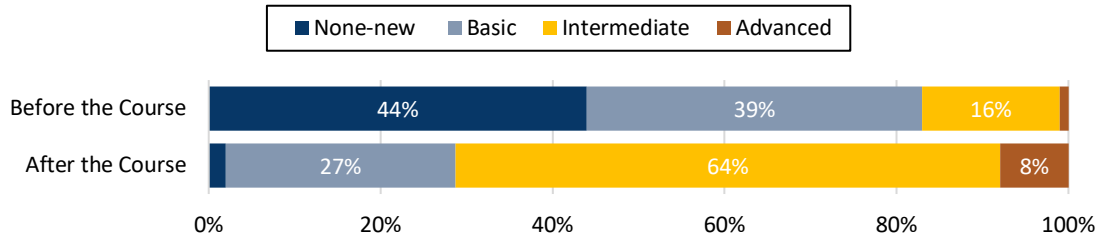
Figure 12. Change in Understanding/Ability in 2D Animation and Digital Illustration (N=117)



Artificial Intelligence and Machine Learning

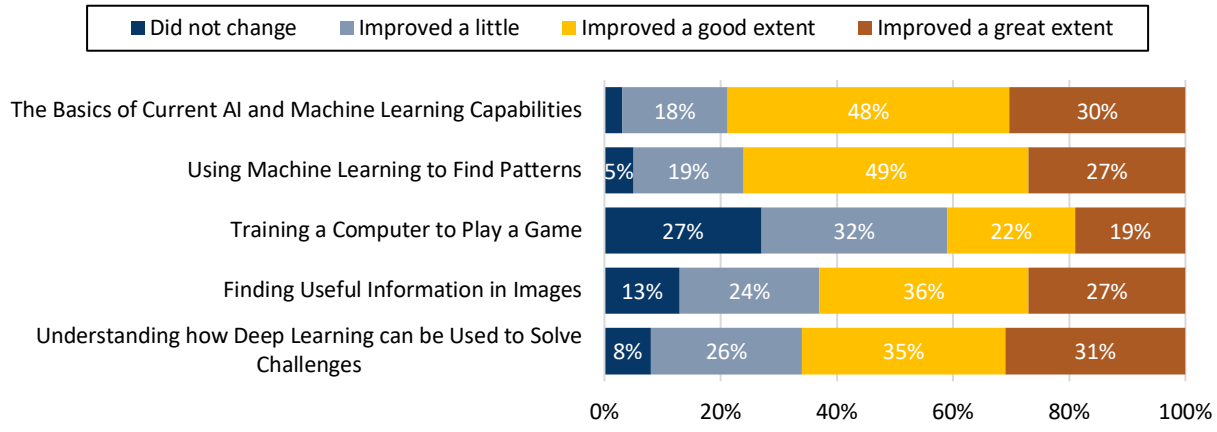
About 72% of survey respondents who took Artificial Intelligence (AI) and Machine Learning reported having intermediate to advanced expertise in this course area after taking the course (see **Figure 14**). This is compared to 17% who indicated having this level of expertise before they took the course. A dependent t-test shows that the self-reported difference in expertise before and after taking the course is significant ($t(132)=17.96$, $p<0.001$; see **Table 6**).

Figure 13. Expertise in AI and Machine Learning Before and After Course (N=133)



On average, more than 60% of survey respondents who took Artificial Intelligence and Machine Learning reported that their understanding/abilities related to the course learning objectives improved a good or great extent (see **Figure 15**). An independent t-test did not reveal a significantly different change in understanding/abilities between male and female students ($t(131)=0.70$, $p>0.05$).

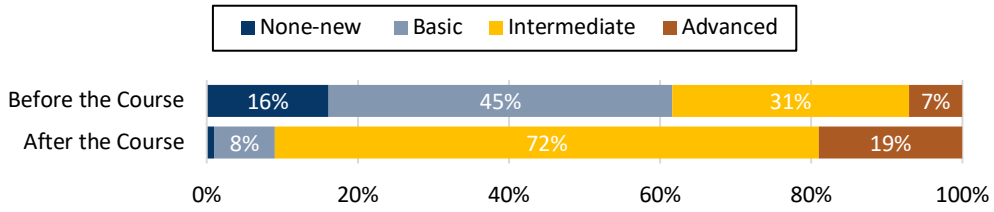
Figure 14. Change in Understanding/Ability in AI and Machine Learning (N=133)



Intro to Filmmaking

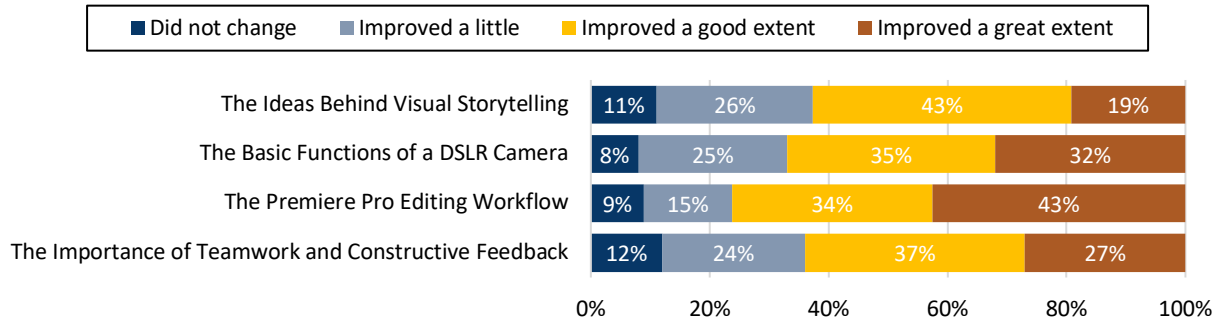
About 91% of survey respondents who took Intro to Filmmaking reported having intermediate to advanced expertise in this course area after taking the course, compared to 38% of respondents who indicated having this expertise level before taking the course (see **Figure 16**). A dependent t-test shows that the self-reported difference in expertise before and after taking the course is significant ($t(134)=13.14$, $p<0.001$; see **Table 6**).

Figure 15. Expertise in Filmmaking Before and After Course (N=135)



On average, more than 60% of survey respondents who took Intro to Filmmaking reported that their understanding/abilities related to the course learning objectives improved a good or great extent (see **Figure 17**). An independent t-test did not show a significant difference in change in understanding/abilities between male and female students ($t(137)=0.17$, $p>0.05$).

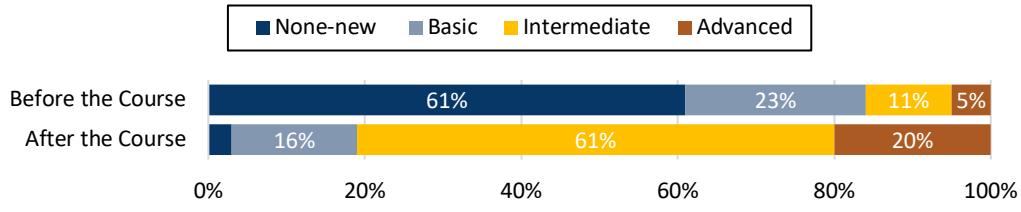
Figure 16. Change in Understanding/Ability in Filmmaking (N=139)



Graphic Design

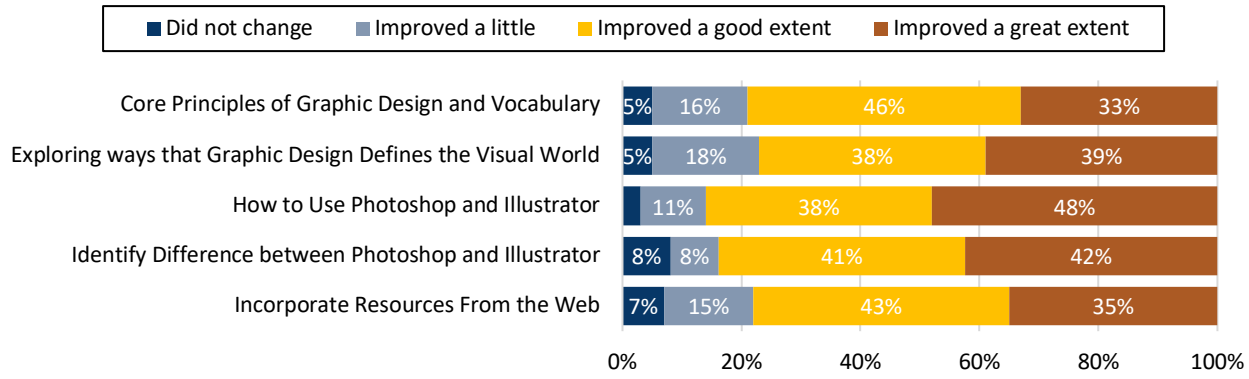
About 81% of survey respondents who took Graphic Design reported having intermediate to advanced expertise in this course area after taking the course, up from 16% who indicated this level of expertise before taking the course (see **Figure 18**). A dependent t-test shows that the self-reported difference in expertise before and after taking the course is significant ($t(60)=10.99$, $p<0.001$; see **Table 6**).

Figure 17. Expertise in Graphic Design Before and After Course (N=61)



On average, more than 80% of survey respondents who took Graphic Design reported that their understanding/abilities related to the course learning objectives improved a good or great extent (see **Figure 19**). An independent t-test did not show a significantly different change in understanding/abilities between male and female students ($t(58)=1.33$, $p>0.05$).

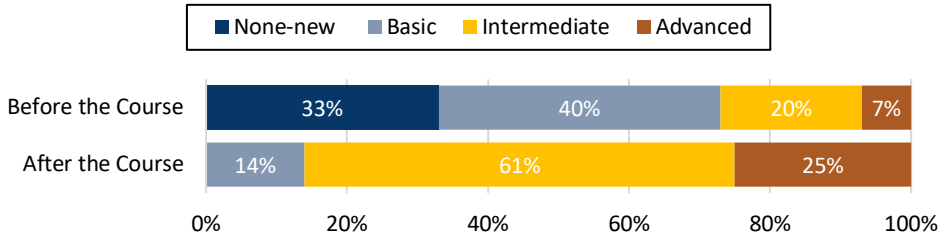
Figure 18. Change in Understanding/Ability in Graphic Design (N=60)



Electronic Music Production with Ableton

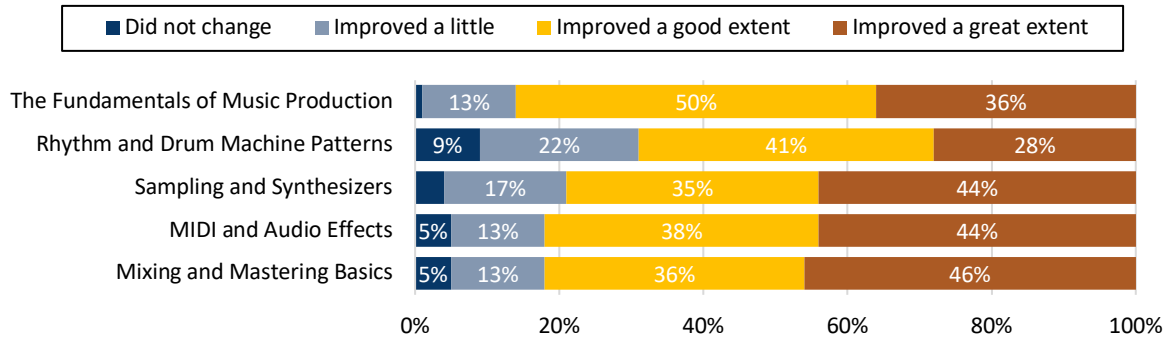
About 86% of survey respondents who took Electronic Music Production reported having intermediate to advanced expertise in this course area after taking the course (see **Figure 20**). This is compared to 27% who indicated having intermediate or advanced expertise before taking the course. A dependent t-test shows that the self-reported difference in expertise before and after taking the course is significant ($t(133)=17.05$, $p<0.001$; see **Table 6**).

Figure 19. Expertise in Electronic Music Production with Ableton Before and After Course (N=134)



On average, more than 70% of survey respondents who took Electronic Music Production reported that their understanding/abilities related to the course learning objectives improved a good or great extent (see **Figure 21**). An independent t-test did not reveal a significant difference in change in understanding/abilities between male and female students ($t(131)=0.10$, $p>0.05$).

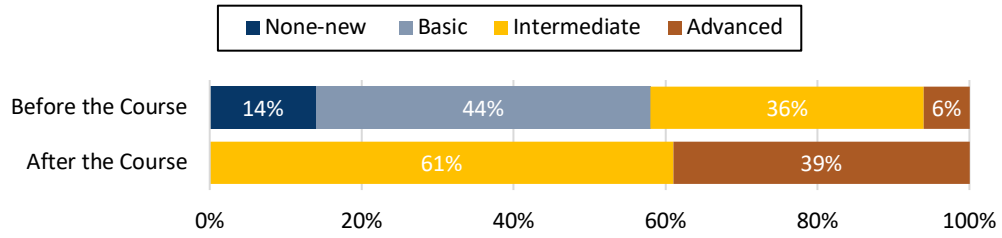
Figure 20. Change in Understanding/Ability in Electronic Music Production with Ableton (N=133)



Digital Photography and Photoshop

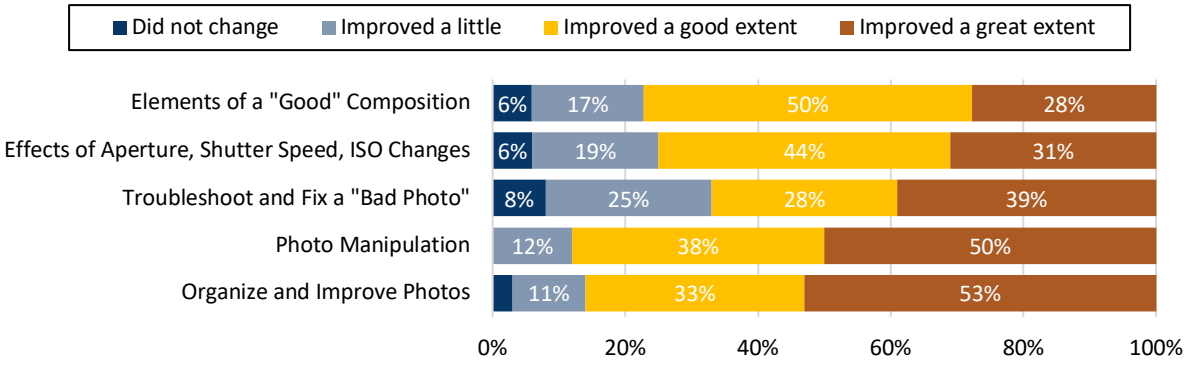
All (100%) survey respondents who took Digital Photography reported having intermediate to advanced expertise in this course area after taking the course (see **Figure 22**). This is an increase from the 42% of respondents who indicated having this level of expertise before they took the course. A dependent t-test shows that the self-reported difference in expertise before and after taking the course is significant ($t(35)=10.05$, $p<0.001$; see **Table 6**).

Figure 21. Expertise in Digital Photography and Photoshop Before and After Course (N=36)



On average, more than 70% of survey respondents who took Digital Photography reported that their understanding/abilities related to the course learning objectives improved a good or great extent (see **Figure 23**). An independent t-test did not show a significantly different change in understanding/abilities between male and female students ($t(34)=0.34$, $p>0.05$).

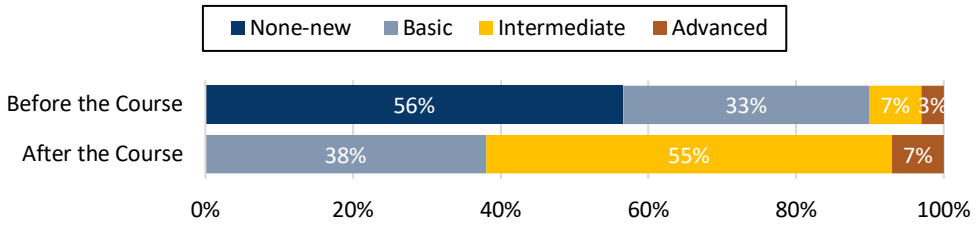
Figure 22. Change in Understanding/Ability in Digital Photography and Photoshop (N=36)



Game Design with Unity

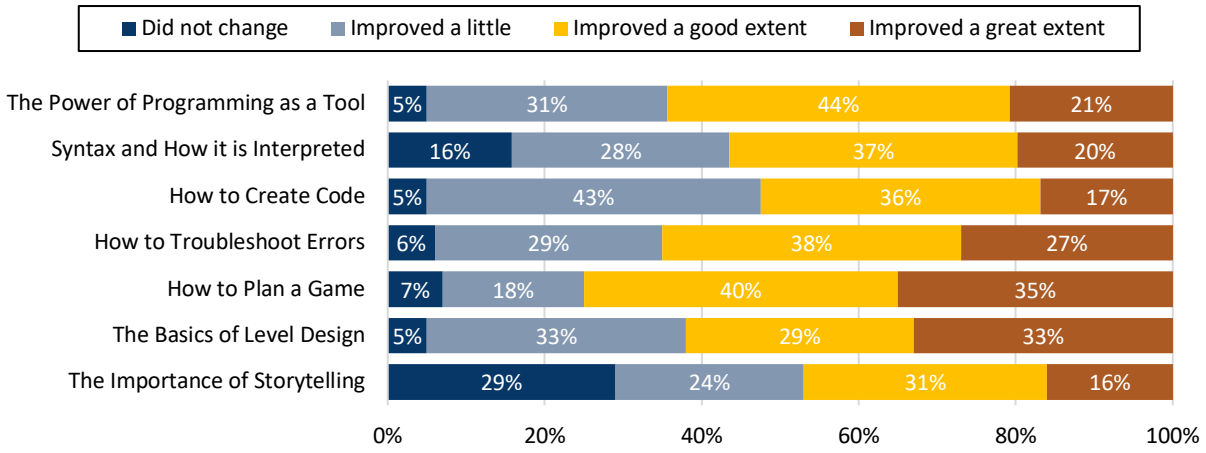
About 62% of survey respondents who took Game Design reported having intermediate to advanced expertise in this course area after taking the course, up from 10% who indicated this level of expertise before they took the course (see **Figure 24**). A dependent t-test showed that the self-reported difference in expertise before and after taking the course is significant ($t(86)=16.83$, $p<0.001$; see **Table 6**).

Figure 23. Expertise in Game Design with Unity Before and After Course (N=87)



On average, more than 50% of survey respondents who took Game Design reported that their understanding/abilities related to the course learning objectives improved a good or great extent (see **Figure 25**). An independent t-test did not show a significant difference in change in understanding/abilities between male and female students ($t(83)=0.28$, $p>0.05$).

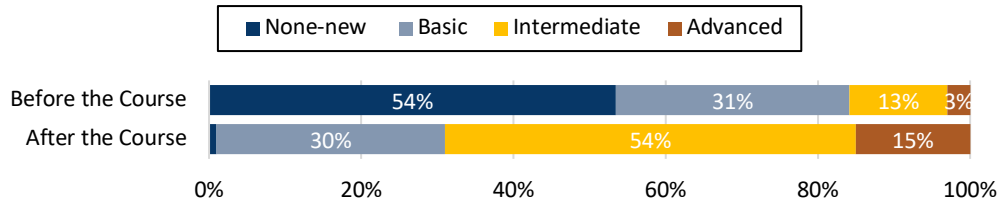
Figure 24. Change in Understanding/Ability in Game Design with Unity (N=85)



Intro to Java Programming

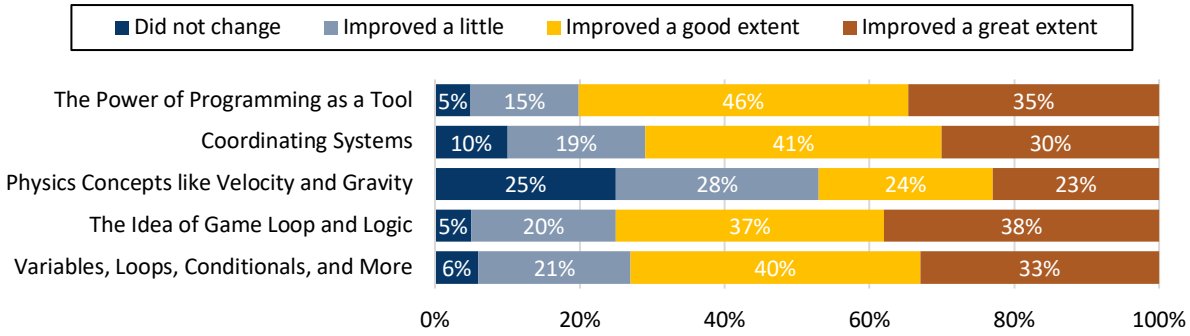
About 69% of respondents who took Intro to Java reported having intermediate to advanced expertise in this course area after taking the course, compared to 16% who indicated having this level of expertise before taking the course (see **Figure 26**). A dependent t-test shows that the self-reported difference in expertise before and after taking the course is significant ($t(79)=14.53$, $p<0.001$; see **Table 6**).

Figure 25. Expertise in Java Before and After Course (N=80)



On average, more than 50% of survey respondents who took Intro to Java reported that their understanding/abilities related to the course learning objectives improved a good or great extent (see **Figure 27**). An independent t-test did not reveal a significant difference in change in understanding/abilities between male and female students ($t(78)=0.53$, $p>0.05$).

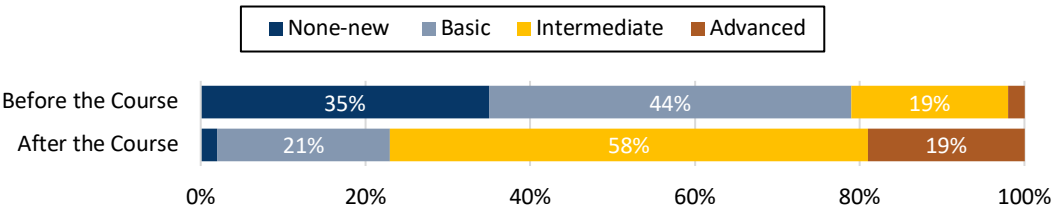
Figure 26. Change in Understanding/Ability in Java (N=80)



Python and Electrical Engineering with Take-Home Laptop

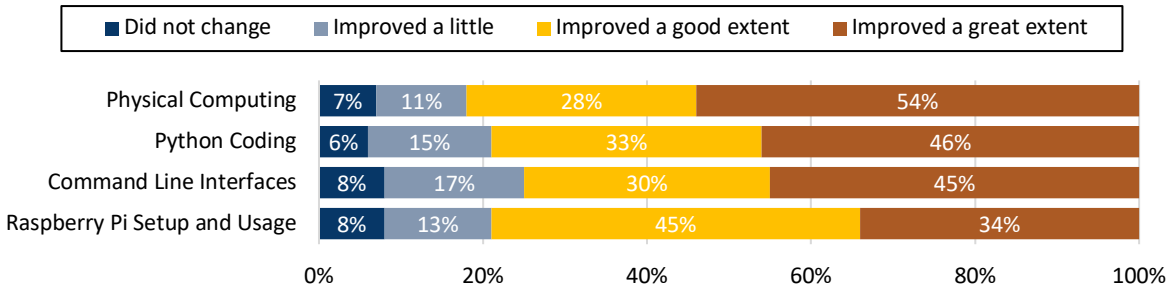
About 77% of respondents who took Python and EE reported having intermediate to advanced expertise in this course area after taking the course, compared with 21% who reported having this level of expertise prior to taking the course (see **Figure 28**). A dependent t-test shows that the self-reported difference in expertise before and after taking the course is significant ($t(51)=12.50$, $p<0.001$; see **Table 6**).

Figure 27. Expertise in Python and EE Before and After Course (N=52)



On average, more than 75% of survey respondents who took Python and EE reported that their understanding/abilities related to the course learning objectives improved a good or great extent (see **Figure 29**). An independent t-test did not reveal a significantly different change in understanding/abilities between male and female students ($t(52)=0.17$, $p>0.05$).

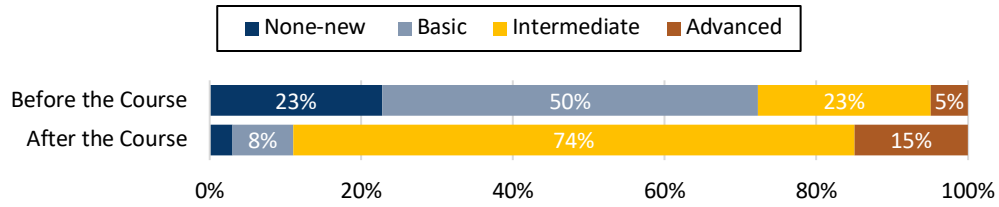
Figure 28. Change in Understanding/Ability in Python and EE (N=54)



Autonomous Arduino with Take-Home Robot

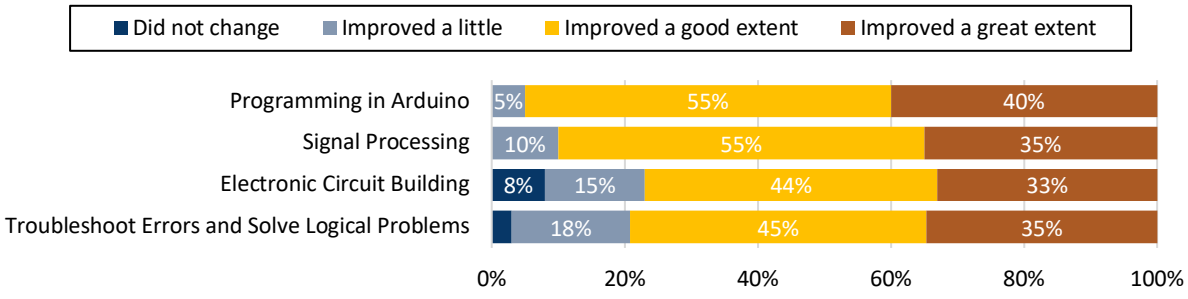
About 90% of survey respondents who took Autonomous Arduino reported having intermediate to advanced expertise in this course area after taking the course (see **Figure 30**). This is up from 28% of respondents who indicated having this level of expertise before taking the course. A dependent t-test shows that the self-reported difference in expertise before and after taking the course is significant ($t(38)=8.18$, $p<0.001$; see **Table 6**).

Figure 29. Expertise in Autonomous Arduino Before and After Course (N=39)



On average, more than 75% of survey respondents who took Autonomous Arduino reported that their understanding/abilities related to the course learning objectives improved a good or great extent (see **Figure 31**). An independent t-test did not reveal a significant difference in change in understanding/abilities between male and female students ($t(38)=0.62$, $p>0.05$).

Figure 30. Change in Understanding/Ability in Autonomous Arduino (N=40)



Learning Across Courses

As reported above, there was a significant difference in students' self-reported levels of expertise prior to and after taking the course for all 10 courses in the pilot evaluation. **Table 6** summarizes all dependent t-test findings regarding students' self-reported levels of expertise before and after DMA course(s).

Table 6. Self-Reported Expertise Before and After Taking DMA Course

Course Name	Mean (Before)	Mean (After)	Difference (After-Before)	N	t
2D Animation and Digital Illustration	1.94	3.01	1.08*	113	16.49
AI and Machine Learning	1.75	2.77	1.02*	133	17.96
Intro to Filmmaking	2.29	3.07	0.78*	135	13.14
Graphic Design	1.61	2.97	1.36*	61	10.99
Electronic Music Production with Ableton	2.01	3.10	1.10*	134	17.05
Digital Photography and Photoshop	2.33	3.39	1.06*	36	10.05
Game Design with Unity	1.57	2.69	1.11*	87	16.82
Intro to Java Programming	1.64	2.83	1.19*	80	14.53
Python and Electrical Engineering	1.87	2.94	1.07*	52	12.00
Autonomous Arduino	2.08	3.03	0.95*	39	8.18
Total	1.91	2.96	1.05*	870	43.08

Note: The expertise scale was coded as: 1 = "None", 2 = "Basic", 3 = "Intermediate", 4 = "Advanced"
* denotes that the difference is statistically significant at $p < .001$

Course Impact, Reactions, and Recommendations

Students were also asked to share additional information about their DMA Tech Camps experience on five open-ended questions. Examples of students' themed responses to each question are provided below.

What is the biggest impact this course had on you? (N=778)

Students were overwhelmingly positive in their responses to this question, and the majority were most impacted by their improved abilities in course-specific content areas. For example, students in AI and Machine Learning and Intro to Java primarily talked about developing programming skills, while students in Graphic Design and Digital Photography focused more on the equipment and software they are now able to use. Some talked about both, and several also discussed learning impacts more generally.

- **Coding/Programming:** "[AI and Machine Learning] taught me how to code in Python and debug the code if it doesn't work," "[Game Design] taught me how to use C#, Unity, and coding in general," and "I learned how to code with Java language [in Intro to Java]. I want to dig more into this area."
- **Equipment/Software:** "[After Intro to Filmmaking], I am no longer afraid to use Premiere Pro; I am now very confident in what I can do," "The biggest impact [Digital Photography] had on me was that it taught me how to use a camera, how to photograph good photos, and how to edit and enhance my photos," and "[After Electronic Music Production], I am now able to use Ableton and … turn my musical ideas into a reality."
- **General Learning:** "[Electronic Music Production] gave me knowledge that I can apply in any field," "[Graphic Design] allowed me to do something that I really enjoyed and always wanted to do but didn't have the knowledge and resources to do," and "[In Animation and Digital Production], I learned things about my interests that I didn't previously know."

> "I really got into the learning experience with using different Adobe programs to create a product that I'm proud about."
> - Graphic Design student

Students also talked a great deal about the noncognitive impacts of the courses and how the courses enhanced their desire to pursue STEM fields.

- **Confidence:** "I was able to explore my abilities … and become more confident in being able to produce art I am proud of," "I'm now more confident in my knowledge of JavaScript and am able to find errors quickly and solve problems," and "It helped improve the skills that I didn't believe that I had."
- **Perspective/Interest:** "It opened my eyes to all the awesome things you can do using Photoshop and Adobe Illustrator," "I think this course changed the way I think of filmmaking and I improved my skills in editing and acting," and "Not only do I have an increased understanding of machine learning, but my interest in the topic has increased dramatically as well."
- **Career/Persistence:** "This course has solidified my decision to go into electronic music production in college," "It made me realize that I could potentially be a graphic designer because it was something I considered when I was younger and something that I am considering now," "This course has helped me to not give up as easily, especially if something doesn't work. It has helped me think about what exact field under STEM I'd like to pursue," and "This course's biggest impact was that you just [have] to keep trying."
- **Relationships:** "I had a great, supportive community that I really enjoyed and I was glad to know the people here," "The biggest impact that this program has had on me is that I was shy when I came here, and this course has helped me come out of my bubble and talk to people," and "[I] made friends and shared wonderful memories/moments."

> "It impacted my life path, and made me explore a career option I wasn't confident about before."
> - 2D Animation and Digital Illustration student

A smaller number of students commented on how courses made them more creative and the positive impact of the instructors. A few were unsure of what impacted them most, a couple said their course did not have an impact, and a couple were displeased with their experiences. One displeased student said they would determine the instructor in advance so as not to be "frustrated by misleading information." The other dissatisfied student said they did not feel as though they received the help they needed from the instructor because the "competent" and artistically "talented" instructor "was not good at teaching" and provided more encouragement to students "who were making [electronic dance music] type sounds."

What did you enjoy making or learning about the most? (N=789)

The majority of students who made something as part of their DMA course enjoyed the products they created and/or the process they had to go through in order to create or test those products. For example, over one-third of the filmmaking students said they enjoyed the editing process.

- **Creating Games:** "I really enjoyed making flappy bird because I found the coding very interesting and logical," "I loved making my special Pong game with artificial intelligence," and "[I liked] the process of solving a problem. In my case, it is to eliminate all the mistakes and bugs and make the game successfully run."
- **Creating Films:** "I enjoyed editing the most because I like using the effects and seeing how all the clips come together to create a final product" and "I enjoyed screenwriting and filmmaking (pretty much the whole course)."
- **Creating Animations:** "I enjoyed making the full animation and turnaround the most," "I enjoyed creating our characters for my animation," and "[I] enjoyed every part

> "I enjoyed the filming process, but I also enjoyed the editing process as well—even though in the past I didn't really like editing. Premiere was a lot more fun to work with."
> - Intro to Filmmaking student

of the process, but storyboarding and animating was my favorite part. (The character reference sheets were also really enjoyable)."

- **Creating Music:** "I definitely enjoyed finishing my song. Even though it definitely was not the best thing I had ever created, it was still cool that I was able to create something that I originally had no idea how to do in just a week" and "[I enjoyed] making synths and … making beats with other people."
- **Creating Robots:** "I enjoyed doing hardware stuff and building my robot," "[I] enjoyed making the car which senses objects and moves away," and "I enjoyed testing our robots in the final tournament."
- **Creating Graphic Designs:** Students enjoyed creating a wide variety of products, including "word art," "pop art," "simple characters," "low poly art," "drawings in artificial intelligence," and "logos."
- **Creating Technology:** Students liked building technologies that "have real life implications," such as "a Simon game," "a password generator," "a chat bot," their "weather program," and "a computer."

Learning specific content was noted as most enjoyable to a large number of students, especially in Digital Photography and courses focused on developing students' coding skills and/or understanding of artificial intelligence. Several students again discussed their learning in terms of the equipment and software used in their courses.

> "I enjoyed learning about all the different kinds of artificial intelligence, how they are used, how they can be applied, and what are their limitations."
> - AI and Machine Learning student

- **Learning Content/Skills:** "I loved coding and understanding the different Python commands and packages," "I enjoyed learning about the math behind everything," "I enjoyed learning about how to make a great photo, which includes composition, lighting, and editing," and "I enjoyed learning about color theory and shape psychology."
- **Learning Software:** "I enjoyed learning how to use Premiere and to edit my footage with it the most," "I enjoyed learning how to edit in Adobe Premiere and writing the script," "[I appreciated learning] how to use Adobe and Toon Boom," and "I enjoyed learning about all the different tools we had to improve our tracks, songs, remixes, etc."

Students in all 10 courses also discussed how they enjoyed creating their final project, and several remarked on how it afforded them autonomy and the opportunity to apply knowledge they had gained during their respective DMA courses.

- **Creating Final Project:** "I enjoyed the final project the most because it allowed for independence in deciding what I wanted to do," "Designing a final project based on the knowledge you had gained within the course was the most enjoyable aspect," and "I loved working on our final projects and playing around with tools to make awesome animations. I found that everyone here, regardless of artistic capability was able to use the technology fairly easily to their advantage and make relatively complex and/or detailed animations."

Students also talked a great deal about the noncognitive impacts of the courses. They made remarks indicative of improved content-specific self-efficacy and commented on positive social interactions.

- **Relationships:** "I enjoyed making friends," "I enjoyed making music and getting constructive feedback from my teachers and friends," and "I enjoyed making my own film and working with such cooperative people."
- **Confidence/Accomplishments:** "I enjoyed making our own projects and getting lots of help; so, in the future, I [will] know what to do without help," "I enjoyed watching my programs succeed," and "[I appreciated my] success after trying."

> "I really enjoyed when I finished working on my text feature, as it was really hard, but it was so satisfying to finish it."
>
> - Intro to Java student

What did you make or learn about that you liked the least? (N=733)

There were a wide variety of responses to this question because what was taught in the 10 classes varied to a great extent. However, there were some common themes that emerged. Just over 30 students said they were unsure about what they disliked (e.g., "I can't think of anything at this moment"). Approximately 25% said they liked something in particular, there was nothing they disliked, and/or they ultimately liked everything, even though they found some aspects difficult.

- **Liked:** "I pretty much enjoyed all the lessons handed to me, as they grew my capabilities even more," "I liked working with other people that have the same interests and passions as me," "I liked every part of what I was taught. I understood the reason for each topic and later applied them," and "There wasn't anything that I didn't like about the DMA. It was a really nice experience to have."
- **Liked/Challenging:** "I didn't have anything I liked the least, but I struggled sometimes on learning how to animate," "I loved the program, but it was hard to work for a straight few hours with no breaks. It just sometimes made it hard to focus," "I really liked everything, but I least liked the programming at the beginning because it was tedious and we didn't know shortcuts yet," and "The whole experience was amazing, but learning to work with others who have different views or opinions and not being able to agree sometimes was definitely something frustrating to learn."

> "[I disliked] nothing. Everything really expanded my knowledge of mathematics, computer science, artificial intelligence/machine learning, etc."
>
> - AI and Machine Learning student

The most common themes for what students liked least are provided below with some examples.

- **Introductory/Known Material:** "The course went over a lot of things I already know," "I least liked the intro piece to Python/the basics. Even though it did help me better understand the platform, it wasn't extremely fun" and "I felt that some of the photoshop tutorials were unnecessary."
- **Format/Curriculum/Instructor:** "The repetition helped me learn with a more concrete understanding, but it also seemed ineffective," "I didn't like that we weren't allowed to work during lunch/breaks," "I was not a fan of the rigidness of the curriculum," and "I did not like that we had so little guidance… The class size was so big that the teacher could not focus on the individual needs of the students."
- **Difficulties/Confusion:** "Some parts of coding were difficult to keep up with since we did the basic and advanced aspects back to back, making it difficult to grasp," "Making the robot was very hard," "I disliked how complicated the programs were at first."
- **Personal**: "I picked a boring dataset for the individual project," "[I dislike] the fact that my chords are slightly off and I can't fix it now," and "I did not like my character design (but that is my fault)."
- **Insufficient/Wasted Time:** "We spent too much time learning about random music stuff that didn't relate," "We go too fast," and "I did not like how little time we had to scout/shoot for the film."

- **Groupwork/Relationships:** "I disliked working with a few people" and "There wasn't really anything I disliked when I made/learned about something, but I didn't like how our filmmaking groups were chosen for us until the final project."
- **Technical Issues (in Python and Electrical Engineering and AI and Machine Learning):** "The usage of 'keras' provided a large number of problems for the entire class as well, as there were a number of problems with the installation of the plug-in," "[There was] not much [I disliked], except the pi-tops weren't fully functional," and "The Wi-Fi was terrible."
- **Course-Specific Activities and Topics: Table 7** lists some of the activities and topics students mentioned as least liked. Each listed activity or topic was mentioned no more than 15 times, and items listed less than 3 times were excluded from the table. Example responses are also provided below the table.

Table 7. Least Liked Activities and Topics by Course

Course Name	Project/Activity
2D Animation and Digital Illustration	• Animation, animatics, turnarounds, storyboarding • Final project, character sheet
AI and Machine Learning	• Coding/debugging, copying code, Boston Housing project • Regression, neural networks, machine learning, artificial intelligence
Intro to Filmmaking	• Scriptwriting, editing, camera/angles, silent movie, acting, storyboarding • Promo project, pre-production
Graphic Design	• Pen tool • Triangle activity
Electronic Music Production	• Mixing, mastering
Digital Photography	• Double exposure
Game Design	• Coding/debugging, Find the Object game, scriptwriting
Intro to Java	• Classes, shapes • Collisions, making games
Python and EE	• Coding
Autonomous Arduino	• Robot

Note. The more commonly mentioned items are presented first for each course. Items mentioned fewer times are in the second row for each course. Items mentioned by less than three students were excluded.

- *2D Animation and Digital Illustration:* "Animating is extremely frustrating," "I didn't like making the turnaround," and "Storyboarding was somewhat difficult, and the fact that we had to make two when we only had a few hours a day made it very difficult."
- *AI and Machine Learning: "*[I least like] being extremely specific which each line of code; however, I do realize that is what coding is," "I didn't like debugging the errors in my code," and "[I disliked] copying the instructor's code."
- *Intro to Filmmaking:* "[I dislike] the editing process at times," "I dislike writing the script," and "[I] don't like the acting."
- *Graphic Design:* "We learned how to vectorize images via the pen tool, but he later showed us that there is a button to do this. The pen part wasn't necessary" and "I disliked the triangle exercise."

> "I liked all of the material that we learned, but the project I had the least fun on was the silent movie since there was no sound."
>
> - Intro to Filmmaking

- *Electronic Music Production:* "Mixing and automation [are my least favorite]" and "[I least like] mastering because it is pretty complicated."
- *Digital Photography:* "[I least liked] the double exposure because it was harder, but [it was] still fun" and "[I least liked] taking photos of people."
- *Game Design:* "Most of what we had learned was very useful; however, parts of the object find game didn't seem useful for us to know," and "I didn't like debugging one small text feature for one and a half days."
- *Intro to Java:* "I don't like learning classes much; however, it seems like an important skill which will help a lot in different projects," "Building pictures and shapes was something I disliked," and "I liked learning the games least because it [was] complicated and [there were] so many codes."
- *Python and Electrical Engineering:* "[I least like] the coding" and "[I least like] the Buzzer program in the Raspberry Pi."
- *Autonomous Arduino:* "[I least liked] putting the parts of the robot together" and "The thing I liked the least about the course was building the frame because it was hard to place pieces together."

> "I didn't really like learning about programming, as it was very complex and all of it was just about memorizing the content."
> - Game Design student

About 6% of students listed software or noted what they disliked about software used in their courses. While most listed Toon Boom, Adobe products, and Photoshop, a few mentioned Ableton and Unity.

- **Toon Boom:** "Toon Boom is a clunky piece of software that is frustrating to work with. You can't color in a different layer or transform images easily without accidentally creating a keyframe. For something that is supposed to be industry standard, it is very laggy and inaccessible."
- **Adobe:** Illustrator, Dimension, InDesign, Premiere Pro
- **Photoshop:** "I disliked having to create everything for my game in Photoshop" and "[I dislike] certain picky, tricky aspects of Photoshop."
- **Ableton:** "Learning Ableton, although it was better in the long run. I didn't like it because I was more interested in techniques that could be applied across all DAWs instead of one DAW" and "[I dislike] Ableton's price."
- **Other:** Lightroom, Massive, Unity, Krunker

> "I have a love/hate relationship with Toon Boom."
> - 2D Animation and Digital Illustration student

A small proportion of students (approximately 5%) shared comments that did not fall into any of the above themes, but the sentiment of their statements was unclear.

- **Other comments:** "I wish we went deeper into editing," "I learned that making music takes time, and it's very hard to make things in short amounts of time," "I made skits/short films, and I loved editing the most," "I learned how hard it is to create an idea for a movie," "The way we learned about Ableton was kinda weird but still was effective," and "Everything is absolutely magical, except the code is so complex."

What could your instructor do differently to make future courses better? (N=720)
Again, students were mostly positive in their responses and many common themes emerged. Approximately 9% said they did not know or were unsure, and some of these students added comments such as, "He did super well; I loved the course." Over 35% said nothing needed to be changed, with a large proportion of those students sharing how much they appreciated the instructor and/or course.

- **Great Instructor:** "My instructor was completely amazing, and he did a great job following everybody's pace. He was always extremely willing to help out. No negative comments," "[The instructor] did a very good job; so, don't try to fix it if it ain't broken," and "My instructor was the best camp instructor I have ever had. He helped me and other classmates when we needed help. [My instructor] also knew the right time to make a joke, and it made us laugh. There was nothing he could have done more."
- **Great Course:** "I think my instructor doesn't have to change anything, because I think the course is perfect the way it is," I had a good time taking this course," and "Nothing really. It was a good course."

> "The instructors were both great and super helpful; I would not have wanted anyone else to be teaching me."
> - Game Design with Unity

A little over half of the responses included suggestions to make future courses better. Some suggestions were specific to instructor actions, while others focused more on the curriculum (e.g., "Make the course longer and/or more advanced") and camp structure (e.g., "Breaks should be optional") Only a couple of students were principally negative (e.g., "The instructor completely misled me"). With the exception of the "Other" category, each theme below represents comments made by at least 5% of students who offered suggestions. Approximately one-fourth of the students suggested instructors provide better, more detailed, or slower explanations. The second most common theme, "More Time," was suggested by approximately 10% of students. The remaining themes are listed in order of frequency.

- **Explanations:** "Maybe explain things more clearly to people who are new to code instead of just saying, 'plug this code in,'" "Explain the tools we need to use a little better," and "The one thing I would have liked for my instructor to do more often would be to walk us through it step by step. That's the only thing he could have done better. I really liked him and he taught very well!"
- **Increase Time:** "Give us more time, and maybe focus on one or two really good projects," "I wish the 2D course could be longer since we needed more time," and "Give a little more time to help students understand individual commands and their functions, so that they could easily create a more complicated project."
- **Attentiveness/Accessibility:** "[It would be better if the instructor was] asking [questions] and helping/checking in more on the individual level rather than asking for a raise of hands," "[I suggest the instructor] give extra help at lunch time or during break times, and "Make sure everybody is at the same level."
- **Course-Specific:** Responses varied greatly by course. Students' course-specific suggestions are provided in **Table 8**.

> "My instructor did a great job at tailoring the class to help us pursue our individual interests. We had an ample amount time to work on individual projects. However, the trade-off was that lessons were sped through, and he covered a lot of material very quickly, not allowing much time to synthesize all the information."
> - Electronic Music Production with Ableton student

Table 8. Suggestions for Instructors by Course

Course Name	Suggestions
2D Animation and Digital Illustration	• "Make smaller animations," "Create gaming activities," "Maybe we can learn how to lip sync our animation and learn how to animate a walk cycle"
AI and Machine Learning	• "Make a syntax dictionary to define the stranger aspects of the code," "[Add more about] neural networks," "[Have] less focus on Python," and "[Include] more [about] creating artificial intelligence that learn to play a game."
Intro to Filmmaking	• "Teach us more about the different camera angles and shots," "We could have made smaller films that were from different genres," and "Do a big movie with everyone working together, or use different editing apps."
Graphic Design	• "Give more freedom and less activities like the triangle exercise," "Have a class for logo creating," and "Assign a fictional client to allow students to understand the process of working with an actual client."
Electronic Music Production	• "Make music with more samples," "Show us more of mixing," and "Offer some more help in working with melodies," and "Explain … problems you can encounter when making music and what you can do to stop such instances."
Digital Photography	• "[Choose] more varied places for photos," "[Include] some more editing," "Focus on the three main components when using different styles of photography (e.g. high shutter speed for stop action or low shutter speed for motion blur; hi-key and lo-key photography for products)."
Game Design	• "Teach about different methods in using certain code, such as the differences between transform.translate and transform.position," and "Just teach the basics of C#."
Intro to Java	• "I am [understand] what I am supposed to do in a program, but writing it in Java is confusing. They could help me write Java more" and "Syntax check."
Python and EE	• "Play more smash."
Autonomous Arduino	• "Have us spend time designing or thinking about the robot's final form."

- **Preparedness/Technology:** "Be able to solve complex problems," "Test the equipment for technical difficulties beforehand. It took up most of the first day, but the tech people on hand were very efficient," and "Give us more equipment."
- **Greater Depth/Advanced Topics:** "He was quite good, but he could have expanded upon topics more and covered a larger range of topics," "Maybe spend a little bit more time on advanced photoshop techniques," and "Dive deeper into sound design and synthesis."
- **Management/Rules/Schedule:** "Set boundaries in the learning aspect (i.e., when to speak and when not to speak)" and "She was a great instructor! If I had to say something, I would say she could just give us stricter timelines because graphic designers do have specific timelines to work under."
- **Other:** Autonomy ("Give us just a little more control"), Teacher-Student Ratio ("We need more instructors"), Reduce Direct Instruction/Copying ("Keep things more short and sweet for more [work] time"), Groupwork ("Let people work together if they want to"), Skill Level Accommodations ("Perhaps there can be a universal package for all instructors teaching this course so that experienced students aren't limited by new ones"), etc.

> "Give us a schedule so that we can have a basic idea of what we will learn in this week and what we will do specifically every day."
>
> - Intro to Java student

If you have any additional comments, please share them here. (N=310)
Almost 40% of students who responded to this question said they had no comments to share or did not know of any comments to make. Consistent with previous findings, students were largely positive, with another almost 40% of responses including either general friendly remarks (e.g., "Best of wishes to you all!") or expressing that they liked the camp, course, instructor, or overnight program.

- **Great Overall:** "I REALLY love this program. I would TOTALLY do it next year," "Thank you for this amazing opportunity here in this camp," and "I love you, DMA!"
- **Great Course:** "This camp helped me learn how music is made and how fun it is to actually make the music tracks themselves," "This course really helped me and I know so much more about photoshop and illustration" and "I loved 2D Animation so much. It is easy to learn and do and a great start to DMA for me. It helped that we had a professional and funny teacher and TA to help us along."
- **Great Instructor/Counselor:** "The TA and instructor were both very nice and created a safe and comfortable environment," and "[The instructor] taught the Linux commands very well, and helped with coding the project," and "[My instructor] deserves a pay raise; he is a very good teacher. Without him, my graphic design experience wouldn't have been as good."

> "I had no experience at all with film before this class, and I now feel very confident in my abilities. I would not have been able to do it without my instructor and instructor assistant."
> - Intro to Filmmaking student

Students' comments that did not fit into the aforementioned themes were quite varied; as such, they were not very representative of the students overall. However, several comments included suggestions that mirrored the described in the responses to the former questions.

- **Suggestions:** Add Instructors/TAs, add more advanced classes, make skill level more uniform in classes, make breaks optional, match course content to online descriptions, provide a summary handout for students' future use, improve lunch options, minimize "childish" activities for teens, make classes longer, address technology issues, supply Windows instead of Macs, provide autonomy.

A few students also made requests that their products not be shared (e.g., "Don't share my song or upload it to your website"), described a negative experience (e.g., "I felt like the camp wasn't focused on us having fun; it felt like they were trying to meet deadlines"), or shared a positive experience (e.g., "Everyone is fun and will actually engage and listen to you. I think I'll continue working on my project outside of DMA").

Focus Group Findings

EPIC STEM Evaluation Services developed the DMA Student Focus Group Protocol and conducted a focus group at the DMA Tech Camps in Austin, Texas on July 11, 2019 to collect in-depth information on student perceptions, experiences, outcomes, and recommendations related to the camp and its courses.

Participant Profile

A total of 13 Tech Camps students participated in the focus group. As shown in **Table 9**, two (15%) of the focus group participants were female. About one-third of participants were in 7th grade and one-third were in the 8th grade. Two respondents were in 10th grade and one participant each was in 6th, 9th, or 12th grade. Participants were divided almost equally across the three Tech Camps courses, with five enrolled in Electronic Music Production, four in the Content Creation course, and four in Virtual Reality (VR) and Augmented Reality (AR) App Design. Five students indicated that this (their current course) was the first course they had taken at Tech Camps, whereas three students said it was their second course, and two said it was their 3rd or 5th Tech Camps course. Approximately one-quarter of the students were participating in the overnight program.

Table 9. Focus Group Participant Demographics (N=13)

	N
Gender	
Male	11
Female	2
Grade Level	
6th	1
7th	4
8th	4
9th	1
10th	2
12th	1
Current Course	
Electronic Music Production	5
Content Creation and Streaming with YouTube and Twitch	4
Virtual Reality (VR) and Augmented Reality (AR) App Design with Unity and Oculus	4
Number of Tech Camps Courses Taken	
1 course	5
2 courses	3
3 courses	2
5 courses	2
8 courses	1
Overnight Program Participant	
No	10
Yes	3

Student Perceptions and Feedback

Focus group participant responses to questions regarding their satisfaction with the camp and their course(s), outcomes resulting from their courses, and recommendations they had for the camp, were themed and are presented below.

Camp/Course Satisfaction

All focus group participants said they were satisfied with the Tech Camps experience. When asked why they wanted to participate in their Tech Camps course, nearly all interviewees said they wanted to learn the content of the specific course or were drawn to the focus on technology. In describing what they liked best about the Tech Camps or their courses overall, participants said they liked when they were given the flexibility to work on their individual projects, being able to learn new software in a way that could be applied to their own interests and projects, and the helpfulness of certain instructors. Participants did not like activities/content that took them away from working on their projects or were not what they expected.

Flexibility to Work on Individual Projects

All focus group participants agreed that having the freedom and flexibility to work on their individual projects was one of the best aspects of the Tech Camps. One interviewee stated, "I like that [in Electronic Music Production] we all get to do our own thing. It is not really specific. We learn how to make music, but we each get to make our own set of music." Another student said, "I like that we do not have a specific project we have to do. We can just do our own thing. We do not have to follow any [specified] order."

> "I enjoy summer camps, with the typical archery and canoeing. But I have always been a lot more tech savvy. So, when I found out there was a camp that was entirely focused on tech, I signed up."
>
> -Focus group participant

Learning to Use Specific Software

Interviewees across all three courses also agreed that they liked learning to use their course's respective software in depth. Similar to the theme of work flexibility, the interviewees appreciated the generalizability of their software learning experiences because they facilitated application to the students' own projects of interest. For example, one student, who was taking his eighth Tech Camps course, said, "We are not being forced along a path to do a specific thing. Rather, we are learning how to use the software instead of learning how to make something while using the software."

Helpfulness of Instructor

Most interviewees also agreed that they appreciated the quality of their instructor, with one student saying, "[Our instructor] is nice, he is helpful, and he is really flexible. He asks, 'Is there anything y'all want to get done?' And he goes around and asks us what we want to do."

> "We had a really good instructor. I feel like I would not have learned as much if I did not have such a great instructor."
>
> -Focus group participant

Least Favorite Aspects of Camp/Course

When asked what they liked least about the camp or their courses, interviewees commented on things that took time away from working on their projects such as breaktimes or learning things that were not required for their projects. One student mentioned that breaks, when mandatory, could take away from their camp experience: "Breaks can be jarring at times because you want to work on your [project]…. Then there is also a lot of time spent trying to teach the [content], which is understandable because there are

people in here that probably have not taken this class or any class like it before…. But the breaks do not leave much time at all to actually work on anything." Another student explained, "[Class time] is always focusing on what you are going to do, but most of the time you do not even use [what you learn] in your final project, and you are probably not going to use it. So [the instructors are] just showing you stuff when you could be working on your project. That is my biggest issue."

Some participants in the Content Creation course indicated that the course content differed from what they expected. One student stated, "I came here for YouTube and Twitch, and I really wanted to work on that. For the first two days, we did…. We were learning how to use the software, Photoshop, to edit. We posted a video and everything. But then we started getting into making a movie in a group. I was not exactly pleased about that because I would rather be doing something on YouTube and Twitch." Other students in the Content Creation course echoed this sentiment. Another interviewee stated, "I have learned a lot from the class, but I would just rather work on the things I came here for than make a movie."

> "It is still a really fun class, but it is not what we were expecting."
> -Focus group participant (Content Creation Course)

Course Outcomes

Interviewees were asked a series of questions to assess the outcomes of the courses on their learning of course content, attitudes and beliefs about STEM, interest in taking STEM courses, and aspirations to pursue STEM careers. All interviewees readily agreed that they learned more about the topic of their course than they knew before taking the course. About half of the participants said that access to the equipment and software in their course was most useful to their learning, and several participants felt that their courses provided a better idea of the type of work expected in pursuing a degree in a STEM subject. Because many students were already interested in pursuing STEM majors in college, they indicated that their experience in the Tech Camps did not change their specific majors of interest. However, almost all participants agreed that the sense of accomplishment they derived from using technology in their courses encouraged them to pursue their prior technology-related interests.

Useful Aspects of the Course

When asked what aspects of the course were most useful to helping learn the topic, six students mentioned having the equipment that was provided in their courses, including the particular laptop keyboards and computer software (Ableton, Premier Pro, Photoshop). One student said that learning to use the software in a hands-on format was useful, stating, "The fact that you use all the apps [in learning] how to make different things work [was useful]." Another student said that the instructor was the most useful aspect of the course.

> "This was my third [camp of the summer], and I was probably most excited about this one out of all of them."
> -Focus group participant

When discussing the software used, two participants said that time spent dealing with various logistical and technical issues took away from the usefulness. One stated, "Setting up all the stuff [was not useful]. We had to create usernames and passwords and that would take a really ridiculous amount of time to do. Then there is this short amount of time that we have left. The next day, we move onto something else and we have to repeat the whole process again."

Attitudes and Beliefs about STEM

Interviewees were asked how, if at all, the course influenced their attitudes and beliefs about STEM. One student shared that the course helped changed their expectation of the work involved in the subject area, saying, "It made me see there is a lot more you actually have to do than I first expected in order to get the end product that you want." Although others agree, another student said that their attitudes did not change, explaining, "Not really. I already kind of knew what to expect."

Interest/Confidence in Taking Other STEM Courses and Ability to Learn STEM Topics

When asked if they were interested in taking more courses in STEM subjects now that they participated in the camp, nine participants said yes, two said maybe, and two said no. Interviewees who felt that the course did not increase their interest in taking other STEM courses felt that there was a difference between what was offered in the formal school learning environment and what was offered at Tech Camps. As one student put it, "At school, we are focusing on different things from what we do here at summer camp. This [camp] is more like hobbies [versus academic subjects]." Another student added, "School is different because you have an entire year to work on a bunch of [various] subjects you need to know. And at this [camp], we only have a week to learn a lot [tech-focused things]." A third student shared, "I do not see how it will equate to school. I know it does not and that this is the only way to learn [these tech-related skills]."

> "I would love to do this rather than do schoolwork. I could probably do this all year."
> -Focus group participant

Many students agreed when asked if they had more confidence in their ability to learn STEM topics after taking this course. They also agreed that they not only improved in their ability to learn various technologies, but were also more willing to learn different types of technology.

Influence on College Major

All students indicated that they had wanted to pursue STEM degrees in college before they started the camp. When asked if the camp influenced what they wanted to major in, four students said yes and eight said no. Those who said no but indicated that they still wanted to major in the STEM subjects said that they had a strong interest to do so prior to the Tech Camps. One student stated, "I have a really strong love for Astronomy. So, I already know what I want to major in… I do not think anything is really going to beat that. This is really fun – I like Ableton, and it is a really useful skill – but I like Astronomy."

> "I have always liked Computer Science, so I am going to [major in] Computer Science."
> -Focus group participant

Some of the respondents also discussed how what they learned in Tech Camps was more of a hobby, and that their college or career interests lay elsewhere. One of these students said, "I have always been set on Engineering, and I was just doing YouTube and Twitch as a fun thing off to the side. For myself, at least, I do not feel like I would be able to hold [YouTube and Twitch] as a steady job." A second student shared, "I have always loved animals. I do love Ableton, and that is why I came to this camp. But I am pretty much set on being a vet." Another student stated, "I have been more interested in building computers, how they work, and all the mechanics in them. I just came to the camp so I could make YouTube videos and learn how to do all that stuff."

One student who felt that their Tech Camps experience *did* change their ideas of what they wanted to major in shared that they derived a satisfaction from the technological accomplishment of completing their final project: "It was really satisfying because you are working really hard all week to try to complete this final project, and when you actually have it done, you can see it on your computer screen and you are just like, 'I made this.' After this student brought this up, all other participants also agreed that the camp gave them the same feeling of accomplishment. One participant felt that the camp helped to reinforce their prior professional interests, stating, "Doing Content Creation, the movie portion kind of influenced me. I already had my head set on going to film school, but [the class] is influencing me to go [further]."

> "Before the first time I took one of the Digital Media camps, I had really wanted to go into Sea Life and Biology. After that camp, I wanted to do more stuff with technology and computers. So, it really changed my mind."
>
> -Focus group participant

Recommendations and Future Needs

When asked what recommendations they had to improve the courses, focus group participants mentioned wanting to have greater input on how their time in class is spent, described certain changes for the Content Creation course, and made suggestions regarding the duration of breaks and the overall camp. Four students said they would prefer to use their own laptops or devices in their courses. In general, the students indicated that they enjoyed the camp, and nine participants said they would take more Tech Camps courses in the future. Of those who said they would not take more courses, a few explained that though they liked the courses, they do not enjoy summer camps in general. One student noted that they would be attending college the following year and would be unable to take more Tech Camps courses.

Greater Student Input on Course Activities (Content Creation and Streaming with YouTube and Twitch)

Focus group participants, particularly from the Content Creation course, mentioned wanting to have more input on how the time is spent in their course. For example, a student in Content Creation said, "People should be able to do more of what they want their YouTube channel to be based off of…. For example, you should be able to… choose to do something that will make your gaming videos more entertaining, instead of just making a movie." Another student stated, "We were almost made to do an intro [in the videos we made]. I did not exactly want to do that – I did not want to show my face [on video] – but we ended up doing that anyway. I mean, I was fine with that, but I would probably have preferred to do something else."

Additional Course Suggestions

Three students described changes they wanted to see to the existing Content Creation course. One student said, "Maybe just [how to use a] game, like how to [take] a game and then post it on YouTube, instead of doing more of a movie and blog." Another student suggested, "I think the YouTube Content Creation class [takes] more of an [approach to videos] where you show your face. I think it would be kind of cool if there was a similar class that was for anonymous channels where you do not show your face or anything like that." Another student suggested the camp offer more advanced coding classes: "I wish there was a more advanced AI and machine learning class. I am not sure if they had [one]. I took one last year."

Changes to Camp Duration and Breaks

When asked if there was anything else they would like DMA to know, participants followed up on earlier comments about the camps' breaks and discussed the duration of the camp. One student gave an example from another camp, stating, "I went to this two-week camp once…. we had the first week to learn about all this stuff, and then we had the next week to put all of what we learned into [practice]. So, if there was a two-week camp provided here, that would be really awesome. Then there would not be so much time eaten up by all the breaks and stuff…. You could take [the breaks] and still have more time." Another student echoed this, saying, "Then you would have one week to learn everything and another week to do everything. That would be really nice."

> "It seems like [the camp] expects us to not be as interested in what we are doing...With all the breaks, it seems like they are trying to [be] more along the lines of a traditional outdoor summer camp, even though that is not what we really wanted."
>
> -Focus group participant

Similarly, students returned to the matter of required breaks. One student stated, "I think all breaks should be optional. This might just only be [related to the Content Creation class], but I think with most technologies, if you are trying to import something, or it finally exported into your project manager, and then you have to go on a break, it is really annoying to have to get back into the mindset of trying to sort everything out." Another student stated, "During summer, if [a student is] on [their] electronics, [they] usually will not take a break either way."

Summary and Recommendations

The primary purpose of this pilot evaluation was to assess the effectiveness and outcomes of DMA's Summer 2019 Tech Camps for ages 12-17. To this end, the EPIC STEM Evaluation Services team designed two data collection instruments—a Student Post-Survey and a Student Focus Group Protocol—and analyzed data collected via these instruments along with student data provided by DMA. A summary of survey and focus group findings and program recommendations are provided below.

Survey Findings

The Student Post-Survey, which had customized items for each of the 10 Tech Camps courses in the pilot evaluation, was administered to students enrolled across 16 sites in the United States and Canada. A total of 874 students from the 10 courses responded to the survey, and the findings were largely positive.

Satisfaction

The vast majority of survey respondents indicated satisfaction with their DMA Tech Camps experience overall, the content and activities related to their particular course, and their course instructor. While there were no gender differences in satisfaction of the Tech Camps experience overall, analyses showed males were more likely to rate their satisfaction with their course or course instructor higher than females. Proportionally, students in Autonomous Arduino rated their course satisfaction statistically significantly higher than students in AI and Machine Learning, but this finding should be interpreted cautiously, as there were more than three times the number of respondents in AI and Machine Learning as there were in Autonomous Arduino. The large majority of the 100 respondents who participated in the overnight program were also satisfied with their resident experience and overnight counselors. Unsurprisingly, given the above results, students also primarily indicated that they would not only be interested in taking DMA courses in the future but that they would also recommend DMA to others.

STEM Outcomes

The majority of respondents agreed or strongly agreed that their STEM learning and attitudes were enhanced as a result of participating in the Tech Camps, with Autonomous Arduino students reporting the highest level of agreement, proportionally, with all learning and attitude outcomes statements. Male and female students did not differ statistically in their responses. Students' self-reported expertise in their course's specific content area changed statistically significantly from the beginning to the end of the course. In other words, students in all courses, on average, believed their level of content-specific expertise improved as a result of their participation. In all courses except Game Design and Intro to Java, more than 60% (and sometimes as high as 80%) reported that their understanding or abilities related to each course-specific learning objective improved a good or great extent. Approximately half of the students in Game Design and Intro to Java indicated the same.

Additional Student Feedback

When asked specifically what in their courses impacted them most, students primarily pointed to course-related knowledge or confidence gained (e.g., Python programming skills, confidence using particular software) and general learning. They also commented on improved confidence and interest in STEM topics and in pursuing STEM fields and appreciated the opportunity to interact with like-minded peers. For most students, learning was the main goal; so, when asked what they liked learning about the most and least, they shared activities and topics they believed aided in or detracted from their learning. Some students felt as though the materials were too advanced, while others thought there was not enough depth. Students also varied in their learning preferences, with some wanting more guidance and others preferring less direct instruction and videos so they could focus on their projects.

The majority of students were very happy with their instructors, providing positive feedback and mentioning instructors by name. However, some students said the courses would be better if there were more instructors or teaching assistants because they did not believe the instructors had adequate opportunity to reach all students with project-specific questions. They also recommended the instructors provide clearer, more detailed explanations of new topics. A theme that was common among students in all classes was the need for more time. Students suggested reworking the Tech Camps structure within the allotted time (e.g., decrease breaks), extending the Tech Camps to include more days, or reducing the number of projects.

Focus Group Findings

The Student Focus Group was conducted with 13 DMA Tech Camps students in Austin, Texas in July 2019. Focus group participants were each enrolled in one of the following courses: Electronic Music Production, Content Creation and Streaming with YouTube and Twitch, or Virtual Reality with Augmented Reality App Design with Unity and Oculus. All focus group participants were highly complementary of their DMA Tech Camps experiences.

Satisfaction

Participants chose to enroll in their Tech Camps courses either because they were interested in a particular topic or because they were interested in technology more broadly. In both cases, students were satisfied with their DMA experience. They were particularly appreciative of the fact that they were able to engage in individualized projects and directly apply their learning, as opposed to being forced to complete a specific project or learning a topic with no intended application (as they are accustomed to in a standard school setting). They also were impressed by their instructors. They commented on both the instructors' friendliness and helpfulness in advancing their work forward.

The most regularly cited aspect they disliked involved anything that detracted from their time to work on their projects. Mandatory breaks were mentioned as disruptive as was the fact that instruction sometimes took precedence over application. Some Content Creation students claimed the course description did not match what was being taught in the course as well as they would have liked, and they were more interested in YouTube and Twitch than making a movie.

STEM Outcomes

In line with what was found in responses to the Student Post-Survey, all focus group participants believed their content-specific expertise had increased as a result of their DMA course. Something not surfaced on the survey was the fact that access to particular equipment and software was especially helpful—they would not have gained this experience had it not been for their DMA Tech Camps participation. The majority of students said the courses did not change their likelihood of following a STEM path because they were already planning to pursue a STEM path. This finding may help explain why only 77% of students agreed or strongly agreed that their interest in pursuing a career in a STEM field was increased as a result of participating in the Tech Camps.

Participants also noted the difference between taking STEM courses at school and participating in the Tech Camps, with some explaining how they participated in the Tech Camps so they could learn things they would not be able to learn at school. They did, however, feel as though the experience provided insight into what various STEM careers entail and, for many, it increased their interest and/or confidence in learning STEM topics and other technologies. All participants agreed that their DMA Tech Camps course had afforded them a real sense of accomplishment.

Recommendations

As has been demonstrated in this report, the vast majority of DMA Tech Camps students in the 10 courses included in the pilot evaluation were very satisfied with their experiences and believed they made significant learning gains as a result of their participation. On surveys and in focus groups, students provided several recommendations to improve the quality of the DMA Tech Camps experience.

As is the case with any learning situation, some students felt the material was too advanced, and some felt it needed more depth. Further, some students were dissatisfied with the large range of skill levels in their courses and others noted a misalignment between course descriptions and student expectations. To address these issues, it is recommended that DMA include more detailed descriptions of the courses online that specify their depth, activities, and prerequisite knowledge. It is also recommended that DMA add supplementary materials for instructors to provide particularly advanced students who would like the option to progress beyond the set course level. Another way to address this issue is to explicitly break down current courses into more distinct skill levels.

Relatedly, it is recommended DMA provide brief guides or "short cut" reference sheets for each of the software programs, programming languages, and/or other relevant content for students to refer to during DMA Tech Camps courses and after the course is complete. This could help novice learners maintain better pace and prove useful for students who want to maintain or progress their skills after participating.

While students primarily spoke highly of their instructors, some believed the instructors needed more familiarity with the content and/or software to provide better explanations and help students troubleshoot technological difficulties. It is recommended instructors complete course activities prior to teaching each year to reacquaint themselves with the content and to discover technological issues (e.g., software updates) that may impede student progress.

Another theme that surfaced in survey and focus group data was the lack of time. In some classes, much time was spent installing software and attempting to solve equipment issues. Some of this may be avoided if the above recommendation is heeded. To further address this issue, it is recommended DMA personnel install software prior to the first day and make certain all equipment if functioning as intended. Many students, especially those who were older or more advanced, suggested making breaks shorter or optional and allowing students to work during lunch. If allowable, DMA may consider increasing flexibility in break times to reduce disruptions to students who are "in the zone" and want to continue working.

Lastly, students' responses to the Student Post-Survey items assessing STEM outcomes and course-specific learning outcomes demonstrated that the DMA Tech Camps had a positive impact on students' interest, confidence, and persistence in STEM topics and technologies, along with increasing their learning and levels of expertise. In addition to keeping these items on future surveys, it is recommenced that further survey items be added to delve deeper into why student outcomes improved or did not improve. For example, an open-ended item asking students to explain why their interest did or did not increase could reveal the increased interest was attributed to an instructor or specific activity, whereas interest that did not increase could be due to an already high level of interest prior to the course. This depth of information, which was captured in the student focus group, helps to interpret the evaluation findings more accurately and better inform program improvement. Accordingly, it is also recommended that future evaluations of the Tech Camps include qualitative data collection efforts such as student interviews and focus groups across a variety of DMA sites and courses to better understand which program components contribute to or detract from the intended outcomes. This rich qualitative data will further enable DMA to understand, build upon, and strengthen the Tech Camps' positive impact on students.

Appendix

Table A1. Predicting satisfaction with overall DMA camp experience: Results from ordered logistic regression (N=881, model Likelihood Ratio Chi-square=30.61, *p*<0.01, Pseudo R^2=0.02)

Significant Predictor	Odds Ratio	*SE*	*z*	*p*
Course				
Intro to Java (vs. Graphic Design)	0.46	0.16	-2.20	0.03
Game Design (vs. Graphic Design)	0.42	0.15	-2.46	0.01
AI and Machine Learning (vs. Graphic Design)	0.34	0.11	-3.34	0.00

Note: Only statistically significant predictors (p < 0.05) are shown in the table.

Table A2. Predicting satisfaction with course content and activities: Results from ordered logistic regression (N=880, model Likelihood Ratio Chi-square=18.10, *p*<0.1, Pseudo R^2=0.01)

Significant Predictor	Odds Ratio	*SE*	*z*	*p*
Gender				
Male (vs. Female) Students	1.42	0.22	2.29	0.02
Course				
AI and Machine Learning (vs. Autonomous Arduino)	0.46	0.17	-2.14	0.03

Note: Only statistically significant predictors (p < 0.05) are shown in the table.

Table A3. Predicting satisfaction with course instructor: Results from ordered logistic regression (N=876, model Likelihood Ratio Chi-square=35.96, *p*<0.001, Pseudo R^2=0.03)

Significant Predictor	Odds Ratio	*SE*	*z*	*p*
Gender				
Male (vs. Female) Students	1.43	0.24	2.14	0.03
Course				
Intro to Filmmaking (vs. Digital Photography)	0.29	0.14	-2.56	0.01
AI and Machine Learning (vs. Digital Photography)	0.22	0.11	-3.14	0.00

Note: Only statistically significant predictors (p < 0.05) are shown in the table.

Table B1. Predicting STEM attitudes and beliefs (about learning): Results from ordered logistic regression (N=879, model Likelihood Ratio Chi-square=35.35, *p*<0.001, Pseudo R^2=0.03)

Significant Predictor	Odds Ratio	*SE*	*z*	*p*
Course				
Intro to Filmmaking (vs. Autonomous Arduino)	0.26	0.11	-3.09	0.00
2D Animation and Digital Illustration (vs. Autonomous Arduino)	0.31	0.14	-2.67	0.00

Note: Only statistically significant predictors (p < 0.05) are shown in the table.

Table B2. Predicting STEM attitudes and beliefs (about skills): Results from ordered logistic regression (N=879, model Likelihood Ratio Chi-square=34.40, *p*<0.001, Pseudo R^2=0.03)

Significant Predictor	Odds Ratio	*SE*	*z*	*p*
Course				
Intro to Filmmaking (vs. Autonomous Arduino)	0.28	0.11	-3.11	0.00
2D Animation and Digital Illustration (vs. Autonomous Arduino)	0.40	0.17	-2.14	0.03

Note: Only statistically significant predictors (p < 0.05) are shown in the table.

Table B3. Predicting STEM attitudes and beliefs (about persistence): Results from ordered logistic regression (N=875, model Likelihood Ratio Chi-square=21.43, *p*<0.05, Pseudo R^2=0.01)

Significant Predictor	Odds Ratio	*SE*	*z*	*p*
Course				
Intro to Filmmaking (vs. Autonomous Arduino)	0.47	0.17	-2.07	0.04
Intro to Java Programming (vs. Autonomous Arduino)	0.38	0.14	-2.54	0.01
Digital Photography (vs. Autonomous Arduino)	0.31	0.14	-2.56	0.01
Graphic Design (vs. Autonomous Arduino)	0.41	0.17	-2.21	0.03
Game Design (vs. Autonomous Arduino)	0.33	0.12	-2.94	0.00
Python and EE (vs. Autonomous Arduino)	0.31	0.13	-2.85	0.00
AI and Machine Learning (vs. Autonomous Arduino)	0.31	0.11	-3.28	0.00

Note: Only statistically significant predictors (p < 0.05) are shown in the table.

Table B4. Predicting STEM attitudes and beliefs (about STEM interests): Results from ordered logistic regression (N=876, model Likelihood Ratio Chi-square=82.80, *p*<0.001, Pseudo R^2=0.04)

Significant Predictor	Odds Ratio	*SE*	*z*	*p*
Course				
Intro to Filmmaking (vs. Autonomous Arduino)	0.15	0.06	-4.97	0.00
Intro to Java (vs. Autonomous Arduino)	0.33	0.13	-2.78	0.01
Digital Photography (vs. Autonomous Arduino)	0.12	0.05	-4.67	0.00
Graphic Design (vs. Autonomous Arduino)	0.16	0.07	-4.42	0.00
Game Design (vs. Autonomous Arduino)	0.27	0.10	-3.35	0.00
Python and EE (vs. Autonomous Arduino)	0.40	0.17	-2.14	0.03
Electronic Music Production (vs. Autonomous Arduino)	0.23	0.09	-3.83	0.00
AI and Machine Learning (vs. Autonomous Arduino)	0.40	0.15	-2.40	0.02
2D Animation and Digital Illustration (vs. Autonomous Arduino)	0.10	0.04	-5.93	0.00

Note: Only statistically significant predictors (p < 0.05) are shown in the table.

Table B5. Predicting STEM attitudes and beliefs (about confidence): Results from ordered logistic regression (N=876, model Likelihood Ratio Chi-square=61.66, *p*<0.001, Pseudo R^2=0.03)

Significant Predictor	Odds Ratio	*SE*	*z*	*p*
Course				
Intro to Filmmaking (vs. Autonomous Arduino)	0.18	0.07	-4.66	0.00
Intro to Java (vs. Autonomous Arduino)	0.38	0.15	-2.49	0.01
Digital Photography (vs. Autonomous Arduino)	0.20	0.09	-3.53	0.00
Graphic Design (vs. Autonomous Arduino)	0.25	0.10	-3.34	0.00
Game Design (vs. Autonomous Arduino)	0.32	0.12	-2.98	0.00
Python and EE (vs. Autonomous Arduino)	0.42	0.18	-2.05	0.04
Electronic Music production (vs. Autonomous Arduino)	0.32	0.12	-3.13	0.00
AI and Machine Learning (vs. Autonomous Arduino)	0.47	0.17	-2.08	0.04
2D Animation and Digital Illustration (vs. Autonomous Arduino)	0.14	0.05	-5.15	0.00

Note: Only statistically significant predictors (p < 0.05) are shown in the table.

Table B6. Predicting STEM attitudes and beliefs (about career aspiration): Results from ordered logistic regression (N=876, model Likelihood Ratio Chi-square=52.54, *p*<0.001, Pseudo R^2=0.03)

Significant Predictor	Odds Ratio	*SE*	*z*	*p*
Course				
Intro to Filmmaking (vs. Autonomous Arduino)	0.31	0.11	-3.40	0.00
Digital Photography (vs. Autonomous Arduino)	0.16	0.07	-4.23	0.00
Graphic Design (vs. Autonomous Arduino)	0.39	0.15	-2.39	0.02
Game Design (vs. Autonomous Arduino)	0.46	0.17	-2.15	0.03
2D Animation and Digital Illustration (vs. Autonomous Arduino)	0.25	0.09	-3.89	0.00

Note: Only statistically significant predictors (p < 0.05) are shown in the table.