Evaluation Report for Q2Work Project

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Abstract:

QuanTime is an educational event that is designed to promote quantum awareness and engagement for middle and high school students and teachers nationwide. The high-level goals of the program are to (1) show teachers that they can integrate quantum activities without quantum knowledge, and (2) show students that quantum information science and engineering (QISE) is interesting to learn about and leads to rewarding, stable careers. In an effort to better inform future deliveries of QuanTime activities, a needs assessment survey was designed collaboration between Haynes Evaluation LLC, The Learning Partnership LLC, and the Q2Work Project leadership. The survey was administered to science teachers across the nation. The findings of the survey provided valuable insight into what teachers want and need so that they can integrate quantum into their classwork. The findings also informed detailed recommendations to improve future QuanTime activities with the goal of engaging more students in quantum activities.

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Introduction

The Project

QuanTime is an educational event that is designed to promote quantum awareness and engagement for middle and high school students and teachers nationwide. QuanTime requires no educator expertise in quantum science, similar to the "Hour of Code" Computer Science Education program held by Code.org. The high-level goals of the program are to (1) show teachers that they can integrate quantum activities without quantum knowledge, and (2) show students that quantum information science and engineering (QISE) is interesting to learn about and leads to rewarding, stable careers. QuanTime activities are educational in nature, but the event primarily serves as a public awareness and marketing campaign for the field of QISE.[1] In an effort to better inform future deliveries of QuanTime activities, a needs assessment survey was designed and administered.

This Evaluation

A survey to assess the needs and preferences (within the context of the QuanTime project) of science teachers across the nation was designed in collaboration between Haynes Evaluation LLC, The Learning Partnership LLC, and the Q2Work Project leadership. The survey was administered in January 2024 and received 190 responses. This evaluation is an analysis of those responses, including recommendations for future application of QuanTime activities.

[1] Taken from prior Evaluation report by The Learning Project

Survey Results

Demographics of Respondents

The survey was administered to lists of different types of secondary science teachers from K-12 schools all across the nation. The teachers that replied were mostly public high school teachers from suburban areas. The exact breakdown of the respondents is detailed in the graphs below which show the setting for the schools, the types of schools and the grade taught by the teachers that responded to the survey (Figure 1 - Figure 3).

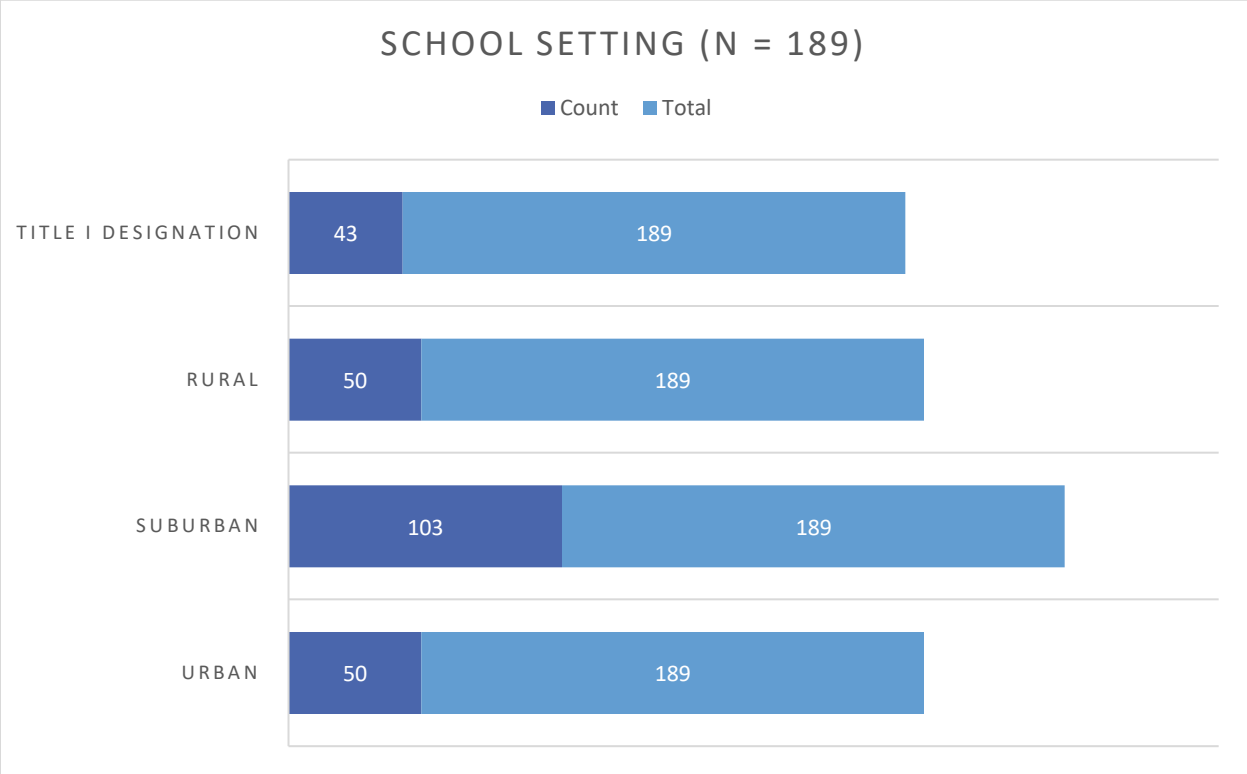


Figure 1 Respondent Breakdown by School Setting

Further exploration looked at the breakdown of respondents by state/territory. The results indicate that the teachers that answered the survey are well distributed across the US where 39 of 57 possible locations were represented as shown in the table below (Table 1) .

Table 1 Breakdown by State or Territory

Location	Count of Respondents	Percentage of Total
Alabama	0	0%
Alaska	0	0%
Arizona	8	4%
Arkansas	2	1%
California	21	11%
Colorado	4	2%

Location	Count of Respondents	Percentage of Total
Connecticut	4	2%
Delaware	1	1%
District of Columbia	0	0%
Florida	4	2%
Georgia	2	1%
Hawaii	0	0%
Idaho	1	1%
Illinois	6	3%
Indiana	3	2%
Iowa	1	1%
Kansas	3	2%
Kentucky	4	2%
Louisiana	3	2%
Maine	0	0%
Maryland	0	0%
Massachusetts	10	5%
Michigan	4	2%
Minnesota	2	1%
Mississippi	2	1%
Missouri	2	1%
Montana	0	0%
Nebraska	2	1%
Nevada	5	3%
New Hampshire	0	0%
New Jersey	9	5%
New Mexico	0	0%
New York	6	3%
North Carolina	3	2%
North Dakota	0	0%
Ohio	16	9%
Oklahoma	2	1%
Oregon	0	0%
Pennsylvania	10	5%
Rhode Island	2	1%
South Carolina	2	1%
South Dakota	2	1%
Tennessee	2	1%
Texas	20	11%
Utah	2	1%
Vermont	1	1%
Virginia	9	5%
Washington	1	1%
West Virginia	1	1%
Wisconsin	7	4%
Wyoming	0	0%
American Samoa	0	0%
Guam	0	0%
Northern Mariana Islands	0	0%
Puerto Rico	0	0%
U.S. Minor Outlying Islands	0	0%
U.S. Virgin Islands	0	0%

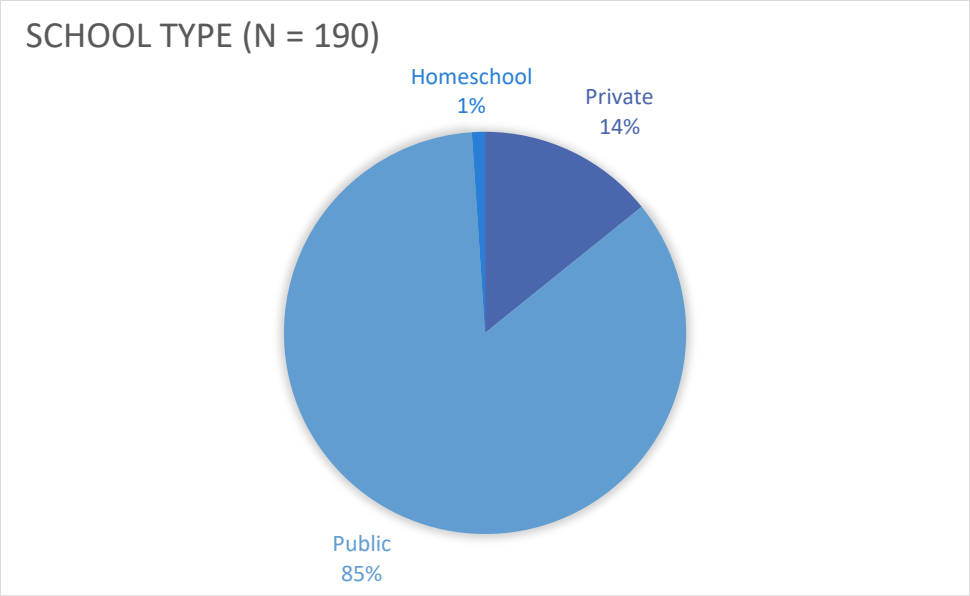


Figure 2 Respondent Breakdown by School Type

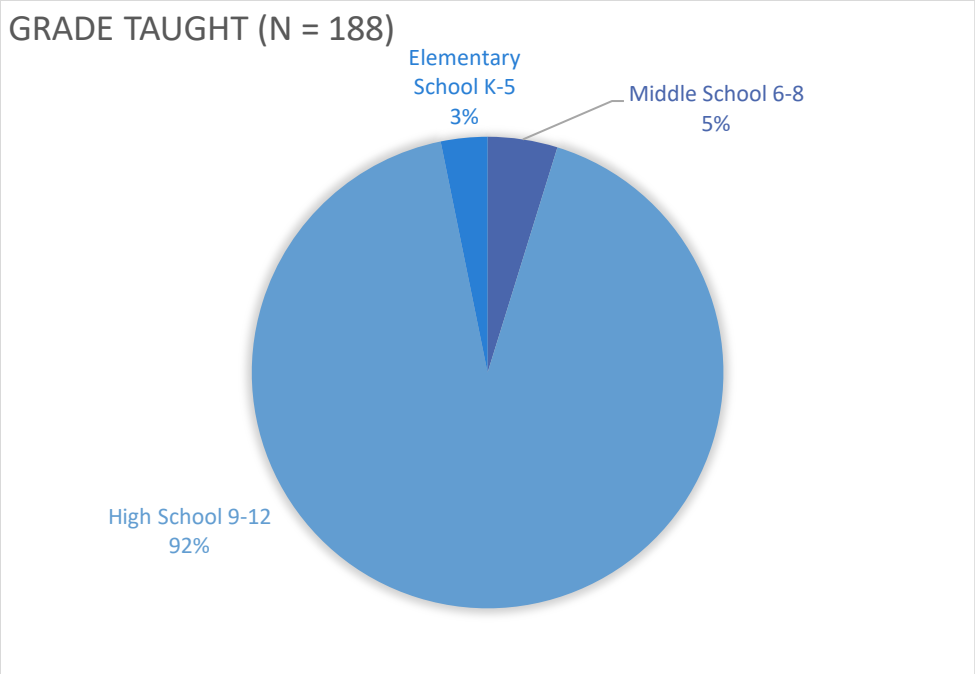


Figure 3 Respondent Breakdown by Grade Taught

All 190 respondents answered the question about what field/s they were teaching and they were permitted to choose more than one option, so those data do not equate to 100%, but rather they indicate the distribution of subjects taught by the teachers that answered the survey. The vast majority of them taught Chemistry and/or Physics as shown in Table 2. Additionally, an open-ended item on the survey asked what the educational background was for each respondent and the vast majority were trained in Chemistry or Physics with smaller numbers of Math and Biology degrees.

Table 2 Distribution of Subjects Taught

Subjects Taught	Percentage of respondents
Physics	**45%**
Computer science	8%
Math	10%
Chemistry	**62%**
Other tech/engineering	15%
General science	23%

Interest and Participation in STEM Activity Opportunities

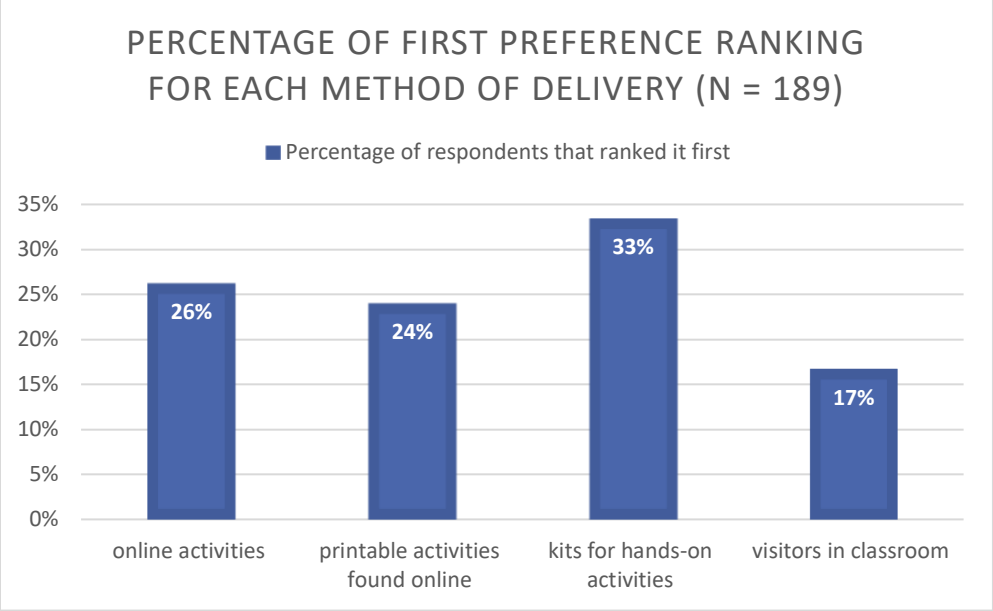
In order to better assess what types of curricular materials teachers were interested in using to supplement their regular teaching plans teachers were asked about specific fields using the language: "How interested are you in integrating some activities from each of the following fields in your classroom?" The findings indicate that teachers are most interested in materials and information pertaining to data science where the mean is slightly higher. However, overall, the teachers expressed moderate interest (mean scores between 4 and 5) in these types of teaching activities where 4 = neutral and 5 = somewhat interested (Table 3).

Table 3 Interest in Activities by Field

Interest (where 1 = very uninterested and 7 = very interested)	N	Min	Max	Mean
Data Science	181	1	7	4.97
Quantum information Science (if you have heard of it)	183	1	7	4.70
Learning about Artificial Intelligence (not AI assisted learning)	188	1	7	4.90

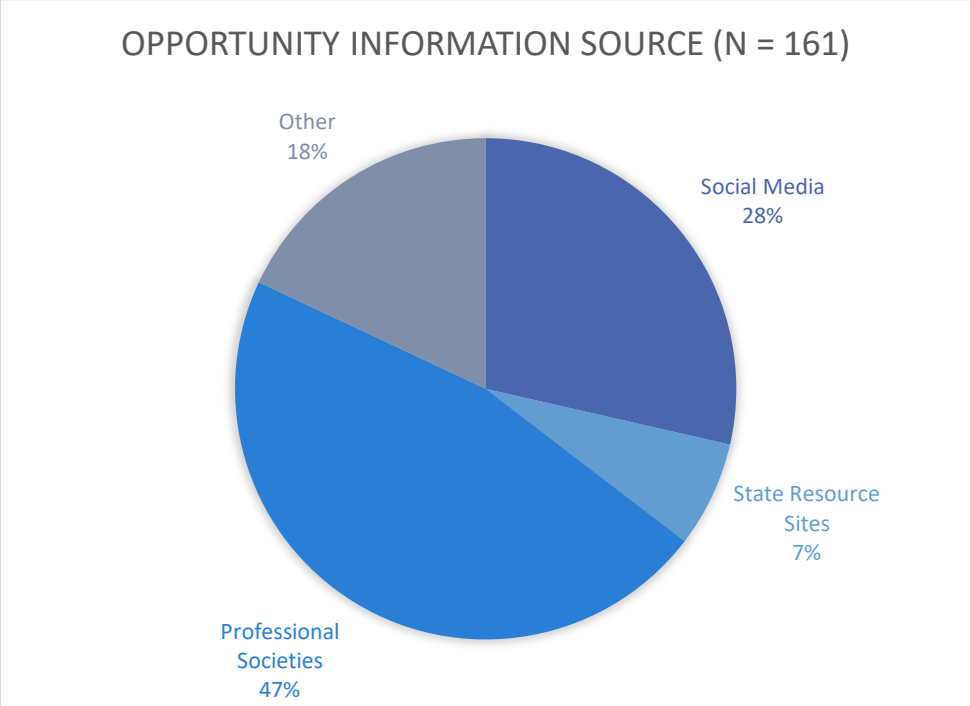
The next survey item asked teachers to rank their preferred methods of delivery for information used when supplementing their curricula. The data show that materials/kits provided for in-class, hands-on activities was the most preferred method. This is commensurate with the findings of the feedback survey from last year regarding QuanTime activities, where participants also favored hands-on activities via mailed kits.

Table 4 Delivery Method Preferences



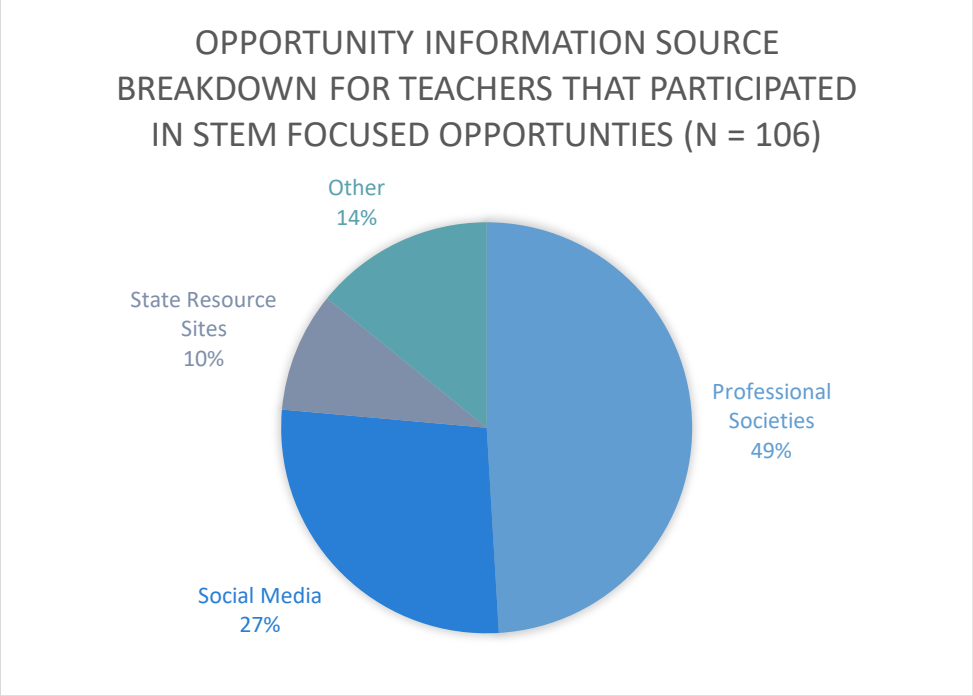
The teachers were asked through which channel are they learning about (and deciding to participate in) "STEM focus actitivity opportunities" such as "National Chemistry Week, Pi Day, Hour of Code, International Years, Career Days, etc." The survey offered three choices as well as an "other" option. Overwhelmingly, teachers replied that they learn about and/or decide to participate in such events based on information from "professional societies."

Table 5 "How did you hear about STEM activity opportunities."



Immediately following this question about the ways in which they learned about STEM focused activities, the survey asked if they had ever actually participated in any of these programs. For this question there were 189 responses and of those, 106 (56%) confirmed participation in STEM focused programs. These data were explored to see if the teachers that participated in STEM focused programs were using the same sources of information as the respondent pool at large and the findings show the same distribution of sources Table 6.

Table 6 STEM Activity Participants Only



Finally, participants were asked if they had ever heard of Quantum Science and 95% said yes (N = 182 of 190).

Qualitative Data

The survey included several open-ended questions that allowed participants to supply their own answers and that generated useful qualitative data. The first open-ended item asked participants to share what they found useful about their prior STEM-focused activities experience/s. For this item there were 98 responses and the data suggested that the most useful aspect was related to the "hands-on" nature of the activities. Specifically, teachers discussed how the activity increased student interest and/or engagement with science and with new concepts in science such as coding. The word cloud below highlights the most utilized words in the data describing teacher experiences with STEM focused activities, in general.

The next item asked teachers to describe any challenges they faced when implementing these STEM focused activities. The majority of respondents indicated that time was an issue where 72 of 94 (77%) responses mentioned lack of time as a challenge. The theme of "lack of time" was situated within the context of state-mandated curriculum. Many teachers discussed that the amount of information that they are required to cover in a school year is such that they do not have additional time for supplemental lessons. To combat this, some teachers suggested making the materials more flexible so that they could more easily be applied or adapted for their current lesson plans. The final theme to emerge from the data was regarding the level of the material. Many of the high school teachers reported that materials were often not advanced enough for their students, especially AP teachers while elementary and middle school teachers had the opposite problem, stating that the materials were too advanced. This led to the emergence of a related theme of "flexibility" where teachers indicated a desire to have access to more detailed explanations of the concepts that allowed for more flexibility when implementing it to a broad age range of students.

Similar themes emerged from the question "We are seeking to design instructional materials for new science fields (like quantum, data science and AI). What would you like us to know so that we can better

meet your needs for new curriculum materials?" Many teachers used this question to reiterate the need for the supplemental materials to align with (or be easily adaptable to) mandated science curricula. Here again they overwhelmingly reported that time was a hinderance to successfully implementing supplemental STEM focused activities in their classrooms. They reported that efforts to generate curricular activities that are flexible enough to be aligned with current classroom topics and that come with adequate teacher preparation is the best way to meet teacher's needs. Many teachers reported that the activities do not come with answer keys and/or with adequate materials for the teachers to "teach" the material. This inadequacy makes the activity even more time consuming for the teachers and makes them even less likely to utilize such opportunities.

Finally, the teachers were asked where they look for new materials to use in their classrooms. The responses generated the following list, where the items at the top were the most mentioned in the data.

1. Online (google, amazon, free online resources)
2. Teachers Pay Teachers (many respondents stated that they used this resource because the things included there had already been tested and used by other teachers)
3. NSTA (National Science Teacher Association)
4. Professional Societies
5. Flinn Scientific (supplier of materials)
6. Social Media

Recommendations

Continue Use of Hands-on Activities

Teachers overwhelmingly reported a desire to have access to hands-on activities and they further reported that their students engaged more with this type of activity opportunity.

Make Efforts to Incentivize Math and Computer Science Teacher Participation

The data reflect that most of the respondents are from the physical sciences, which could factor into the preference for hands-on activities. As such, it is recommended that efforts are made to promote the participation of teachers from math and computer science. It is further recommended that the program leaders continue to include online resources and activities which are accessible to all teachers.

Align Future QuanTime Activities with Mandated Science Standards

Based on the feedback from this survey, the project leaders of the Q2Work program are likely to find increased implementation of QuanTime activities if efforts are made to align the activities with mandated science standards as much as possible. While teachers wanted to see alignment to their curriculum, it is not feasible for Quantum education developers to identify and align to all curricula. Therefore, it is recommended that QuanTime leaders make efforts to show alignment to national standards like Next Generation Science Standards and to national curriculum initiatives like OpenSciEd.

Improve Instructions and Teacher Guidance

The data indicate that teachers would benefit from answer keys, included with materials as well as teaching guides that offer some explanation of the scientific concepts in the activities. This would reduce the time that teachers need to spend preparing to incorporate QuanTime activities and therefore increase the likelihood of implementation, since lack of time was cited as the number one hurdle to implementation of STEM focused, supplemental activities.

Improve Grade-level Flexibility of Materials

Based on this survey data, supplemental, STEM focused activities are most utilized by upper grade level teachers. However, lower grade level teachers that used the activities with their students expressed a desire to have access to more grade-level flexible materials with improved teacher instructions. As such, it would be useful to design a version of the activities for lower-level grades so as to further broaden access to Quantum learning for students of all ages and to clearly identify the grade level focus of the activities.

Target Marketing of Future QuanTime Efforts

Based on the data from this survey, teachers are going online to look for resources. Beyond basic online searches, teachers are using two specific sites to guide their efforts. They are going to the Teachers Pay Teachers (TPT) and the National Science Teachers Association (NSTA) for resources and the data indicate that teachers feel trust in both of these sources. Finally, teachers are using various professional science societies as sources of materials and information. It is recommended that efforts are made to partner with these organizations to promote future QuanTime activities.