# REaCHaLL, LLC

**Relevant Evaluation and Consultancy Hub about Lifelong Learning**

*Effecting transformational development*

# The STEM Guitar Project
## 2018-2019 Evaluation Report

April 30, 2019

*Prepared for:*

# Prof. Thomas Singer
# Sinclair Community College

**REaCHall, LLC**
2623 Morgan Ross Rd.
Hamilton, OH 45013
Tel: 513-403-9621; Fax: 513-738-0512
Email: reachall.ice@gmail.com

# The STEM Guitar Project
## 2018-2019 Evaluation Report

**Report Prepared by:**

Imelda R. Castañeda-Emenaker, EdD
Chief Executive Officer

**With the help of:**

Janet K. Matulis, PhD
Evaluation Consultant

*Suggested citation:*

Castañeda-Emenaker, I. R. (2019 April). *The STEM Guitar Project: 2018-2019 Evaluation Report*. Hamilton, OH: REaCHaLL, LLC.

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

# The STEM Guitar Project
## 2018-2019 Evaluation Report
## Table of Contents

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

# List of Tables

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

# List of Figures

# List of Appendixes

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

# The STEM Guitar Project
## 2018-2019 Evaluation Report

# Executive Summary

## Introduction

      This is the Executive Summary of the 2018-2019 evaluation report for The STEM (Science, Technology, Engineering, and Math) Guitar Project funded by the National Science Foundation Advanced Technological Education (NSF ATE Award #1700531). This evaluation report is prepared for Sinclair Community College in Dayton, Ohio, the primary institution involved with the project. The report covers the period from August 2018 through April 2019 and focuses on the formative and some summative aspects of the project evaluated within the context of the 2018-2019 program implementation, including overall lessons learned. The abbreviated versions of the limitations and the report conclusions, including recommendations, are included in this Executive Summary.

## Results

      The context for the 2018-2019 program evaluation includes the project background and the program evaluation approaches, design, and methods. The project background deals with the project's overall description, goals, objectives, and program theory, as well as the working structure. The project's goal is focused on increasing student interest, engagement, and learning of STEM principles, practices, and careers through guitar design and building. The program theory is based on the STEM Guitar Project's intent to mitigate the skills gap and need for technicians with advanced technical knowledge and hands-on experience made possible through its faculty professional development Guitar Building Institutes (GBIs). Starting 2018-2019, the Project works on three program tracks: (1) Acoustic Guitar Building Institute (AGBI), (2) Electronic Guitar Building Institute (EGBI), and (3) the Hybrid – Computer Numerical Control machining with Electric Guitar - Building Institute (HGBI).

      The program evaluation uses the mixed methods and developmental evaluation approaches; via evaluation capacity building, the Project Team develops its evaluative thinking to optimize use of evaluation results for continuous program improvement. Appropriate qualitative (e.g. thematic analysis) and quantitative (e.g. parametric and non-parametric statistics) analysis tools are used accordingly. The evaluation goals and questions are based on the project goals and focus guided by Guskey's five levels of evaluating professional development and the Project's program theory and philosophy. The five evaluation questions are based on: (1) diversity of participants, (2) program effects on faculty, (3) program effects on students, (4) the project's Applied Learning Community, and

REaCHaLL, LLC
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    i

(5) project extent and overall sustainability. To ensure a more systematic collection of student data, a single case study design was started in 2018. This design uses a quasi-experimental research approach with the pre-test post-test control group design involving prospective and retrospective cohort's longitudinal data.

The main evaluation results are organized by formative and summative results. The formative results include a review of the Project Team process, program implementation process, and the program output. The summative results include data showing evidence of the five evaluation topics noted above. Using Guskey's levels of evaluating professional development is helpful in facilitating structures and practices moving toward project outcomes.

The Project Team process showcased the project's collaborative participatory decision-making process involving the 22-member Project Team under the Lead PI and co-PI's as part of the Executive Committee. The established project documentation and tools and the regular bi-monthly team meetings facilitated the smooth flow of project operations. Technological advancements, the Project Team member's diverse expertise and experience, as well as the team's geographic distribution across the United States, were advantageous in reaching out to current and potential program participants.

The program implementation process includes project documentation process, on-boarding of team members, site selection, participant recruitment and selection, materials and curricular development (kit preparation; Modular Learning Activities (MLAs); video preparation, revision, vetting, and launch; manuals for GBI implementation and guide for faculty implementation), and preparation for the Institute implementation (including agenda and evaluation components). The Project Team expertise, program experience, learning from previous years' STEM Guitar project operations, and its openness to continuous program improvement facilitated the program implementation process and better handling of the expanding number of program tracks and of GBI participants. The program output continues to improve with the support of established infrastructure and team process. This includes production of STEM Guitar kits, production and vetting of modular learning activities (MLAs), videos, and other learning materials, continuous improvement of the Institute agenda including the preparatory webinars, and the collaborative development of the evaluation instrument. The program implementation process leads to the increased number of diverse faculty trained as the established recruitment and selection process innately includes diversity requisites.

In 2018, 87 faculty were trained. Decisions about acceptance of the 2019 faculty will be made in early May 2019. Based on the more than 150+ pool of qualified participants, the 2019 participants will likely exceed the 2018 participants. The diversity of the 2018 GBI participants was showcased by the following: about 30% female faculty, more than 25% non-white participants, over 50% from institutions with more than 50% free and reduced lunch, moderate to high poverty and eligibility for Pell Grants, and over 40% located in rural areas. and varied subject areas taught by faculty participants.

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    ii

The faculty reported learning STEM Guitar-related concepts and hard skills/employability skills, primarily model design and measurements, as they were involved with the actual build of the guitars. They also reported learning and honing their soft skills/attitudes toward STEM, the most notable of which is critical thinking and problem solving. After their attendance of the GBIs, the faculty reported increased confidence in implementing the STEM Guitar curriculum. With growing support from the Project Team and their administrators, faculty reported changes and improvement in their classroom practice that excite their students' attendance in class and STEM learning.

The program effects on students were indicated by faculty reports about student learning and behavior changes, as well as the student-self report of program effects on their behaviors and attitudes. The faculty noted that students learned STEM Guitar related concepts and hard skills/employability skills such as measurements and model development and design. Similar to the soft skills they learned, the faculty also reported that their students learned different soft skills, notably critical thinking and problem solving, as well as communication and collaboration. Other soft skills learned were: creativity and innovation, flexibility and adaptability, productivity and accountability, grit and self-direction, leadership and responsibility, and socio-cultural interactions. Initial data from the case study include student self-reports about their behavior and attitude toward STEM. The Wilcoxon signed rank tests indicated that the comparative data for both STEM Guitar and non-STEM Guitar students showed significant changes for their responsibility in their own learning. Both groups of students showed better post results but the results for the STEM Guitar students are better. Another area showing significant results was noted was on the non-STEM Guitar students' response to feedback regarding their work. They indicated greater negativity in their pre-post response about getting discouraged when given criticisms on their STEM projects work. There was no significant difference between the pre-post STEM Guitar student response on this same item but the rank level of their responses is much higher than that of the Non-STEM students.

Even in its second year, the current project, has the advantage of continuing and expanding from the previous two STEM guitar building related grants, attesting to its wider reach and sustainability. It is noteworthy that continuing effects of the previous grants filter through this current project. Some good examples of these are media exposure, the Project Team's continuing dissemination via conference presentations and publications, guitar kit sales, and development of partnerships with the industry, academic institutions, and the larger community. Efforts to stabilize the project's Applied Learning Community continue. Use of the project website and social media such as Facebook add to the project's wider reach. The Project Team is studying a more systemic use of social media through a new "app" that will be made available for the Project Team, faculty, and students via subscription. This will support the development of a more sustainable and replicable Applied Learning Community and allow for better data collection of STEM Guitar program effects. Project efforts to explore other community funding support and new grant proposals remains.

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    iii

Lessons learned from the formative and summative components of this report are included in this report. The lessons learned are framed around what has been working well in the project and areas of growth for each of the major sections of the report.

## Limitations

Classroom implementation and curricular integration of the STEM Guitar program are highly encouraged but some curricular implementation were conducted out-of-school or as limited program offerings like school extension classes; this evidences some affinity for informal STEM education Thus, systemic collection of direct student academic data and other outcome constructs (as behaviors and attitudes toward STEM) across implementing groups, remain a big challenge. Given the project reach and budget constraints, the general follow-up evaluation for participants is dependent on self-reports.

## Conclusions

The 2018-2019 STEM Guitar program evaluation showed fruitful and positive formative and summative results. Within the project background and context, the program evaluation focused on the worthy goal of the STEM Guitar project on increasing student interest, engagement, and learning of STEM principles, practices, and careers through guitar design and building. Conducting aspects of developmental evaluation, the External Evaluator helped the Project Team in developing their evaluation capacity and evaluative thinking for better evaluation use and continuous program improvement. For both formative and summative aspects of evaluation, the STEM Guitar Project indicated tested processes and outcomes supporting success of the program implementation. The Project Team - given its diverse expertise, experience, geographical distributions, and social media strategies – extends well to participants and partners across the United States, ensuring participation of diverse faculty and promoting reach and sustainability of the STEM Guitar program.

Indeed, the STEM Guitar project increased diverse faculty involvement and learning of STEM Guitar-related concepts and employability hard and soft skills through its professional development program – the STEM Guitar project-based learning project, with Summer Guitar Building Institutes (GBIs) as the mainstay and all corollary activities needed to make program implementation successful. The project promoted improvement in faculty classroom practices that results in students' learning of similar STEM Guitar related concepts and employability hard and soft skills. The Project Team's continuous efforts in project' dissemination through conference presentations and media exposure and development of its emerging Applied Learning Community are truly commendable efforts in improving the program. The Project Team energies exerted in developing, widening, and improving its reach to program partners in the industry, academic institutions, and larger community help a lot in promoting project support, both financial and in-kind, thus, enhancing its project's overall sustainability.

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    iv

## Recommendations

As the STEM Guitar Project has been very open to changes, emerging developments, and ideas, recommendations similar to last year's are offered since continuous program improvement is one of the trademarks of the STEM Guitar Project. The Project Team's continuous improvement/development efforts have been vital to the growth of the project. Thus, some of the things that the project is already doing are recommended for continued vital actions:

- Project Team's involvement in developmental evaluation and capacity building to further hone its evaluative thinking skills needed in critical program implementation;
- Project's collaborative and participatory decision-making process for greater Project Team buy-in;
- Development and improvement of the project's processes, structures, and documentations of the different aspects of the project for replicability and scalability;
- Regular team meetings and offering of specialty development meetings as the project need arises;
- Development and strengthening of the project outputs
- Development of new and maintenance of existing project partnerships;
- Efforts to disseminate project information via conference presentations/publications, and media exposure
- Study and potential use of a new "app" to improve the project's Applied Learning Community and process of data collection;

Explicit actions are recommended for areas of growth where the project is "emerging":

- Develop a management tool that can be used to improve lead time for response and feedback needed for action items raised during project team meetings;
- Be more proactive in marketing efforts for any project venture;
- Ensure that all teaching-learning materials needed for the program tracks are ready by no less than the schedule of the first Summer Institute; upload on the project website all MLAs and videos immediately after the vetting process;
- Follow-up with previous GBI faculty participants and guitar kit customer list to be more sensitive to the timing and needs of faculty and their institutions, and plan accordingly noting the ebbs and flows of the guitar kit orders;
- Model any data collection strategy expected of faculty participants during the Summer Institutes;
- Continue stabilizing the structures for program and administrative support for faculty implementation in their classroom; and
- Continue case study research and efforts to ensure robust data collection for the prospective and retrospective cohort along with their comparison groups.
.

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    v

# The STEM Guitar Project
## 2018-2019 Evaluation Report

## Introduction

This is the 2018-2019 evaluation report for The STEM (Science, Technology, Engineering, and Math) Guitar Project funded by the National Science Foundation Advanced Technological Education (NSF ATE Award #1700531). This evaluation report is prepared for Sinclair Community College in Dayton, Ohio, the primary institution involved with the project. The report covers the period from August 2018 through April 2019. This report focuses on the formative and some summative aspects of the project. Project Team members validated the different areas covered in this report. The report includes the executive summary, context for the 2018-2019 program evaluation, formative and summative results, conclusions, and recommendations.

## Context for 2018-2019 Program Evaluation

Context for this 2018-2019 program evaluation includes the project background and the program evaluation design/approaches and methods used in 2018-2019.

### The Project Background

The project background deals with the project overall description, goals, objectives, and program theory, as well as the working structure.

#### *Overall Description, Goals, Objectives, and Program Theory*

Sinclair Community College continues to collaborate with various industry partners and partners from community colleges, universities, K-12 institutions, two NSF ATE national centers, and other guitar manufacturers to conduct professional development Institutes for secondary and post-secondary faculty. The current project, in its second year, has the advantage of building on its successful NSF ATE STEM-Guitar building-related projects for the past eight years (NSF ATE DUE #1304405 & NSF ATE DUE #0903336); all are meant to continue increasing student interest, engagement, and learning of STEM principles, practices, and careers through guitar design and building. As in its first year, in addition to solid body electric guitar building, this current grant includes two additional components or program tracks: (1) acoustic guitar building and (2) CNC (Computer Numerical Control) machining in manufacturing guitar parts.

The STEM Guitar Project is meant to mitigate the skills gap and need for technicians with advanced technical knowledge and hands-on experience. This is made possible

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    1

through its faculty professional development Guitar Building Institutes (GBIs). The GBIs focus on guitar design and building skills while creating a clear linkage to broader STEM concepts, including access to a robust Applied Learning Community (the STEM Guitar Project's brand of Community of Practice), that allows faculty to maintain and cultivate newly-learned instructional practices.

The culmination of the STEM Guitar Project leads to students who are excited about making guitars and deeply engaged in science, mathematics, and engineering practices critically needed by employers. Additionally, the project supports and helps develop student academic gains and career interests in STEM. The intent is to help produce well-trained technicians, as well as recruit and retain students throughout the STEM pipeline. Doing so will help solve the critical STEM technician shortage.

The project espouses strategies to uphold the extent and sustainability of a successful current ATE project to promote its broader impacts. It intends to increase enrollment of populations traditionally underrepresented in STEM. Strategies include strengthening the collaborative manufacturing process and connections among national standards, job readiness/related skills, and guitar design and building activities. Facilitating the strong involvement of school administrators in systemic and broad dissemination of Institute lessons and laboratory experiences in schools and colleges is advocated. Dissemination of lessons learned is made possible via the project's online platform, which also supports sustainability and expansion of the project at participants' institutions and beyond.

## Project Team Working Structure

An important component of the STEM Guitar Project background is its Team Structure; a vital part of project implementation and evaluation. In the 2018-2019 project year, 22 talented and experienced Team members continue to work together collaboratively. The Executive Committee (EXECOM), composed of the Lead Project Principal Investigator (PI) and four co-PIs, has taken a more pro-active role in project leaderships and promotes more collaborative participation among Project Team members. The EXECOM organized project sub-teams around the three program tracks: (1) Acoustic Guitar Building Institute (AGBI), (2) Electronic Guitar Building Institute (EGBI), and (3) the Hybrid – Computer Numerical Control machining with Electric Guitar - Building Institute (HGBI). The EXECOM also organized another important sub-team around the issues of marketing and program promotions. The External Evaluator works closely with the standing Internal Evaluation Sub-committee, taken on by the Executive Committee as one of its main tasks. Technological advancements, diverse expertise and experience of Project Team members, as well as the team's geographic distributions across the United States, are advantageous in reaching out to current and potential program participants. Project Team members are pulled in and consulted for general internal evaluation concerns. The PI organizes specialty sub-teams as the occasion arises around short-term activities such as site selection, summit management, other special events involvement, etc. The Lead PI encourages Lead Trainers in various

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    2

planned 2019 summer GBIs to exercise more leadership and responsibilities in the Summer Institutes.

## Program Evaluation Approaches, Design, Methods, and Limitations

### Evaluation Approaches: Goals and Questions

This project has two overall evaluation goals for this project based on its overall goals: (1) to determine how well the project helped the faculty increase their students' interest, engagement, and learning of STEM principles, practices, and careers through guitar design and building; and (2) to assess the project's success in creating a replicable model for establishing and maintaining the STEM Guitar Projects' Applied Learning Community, the Project's brand of community of practice. Five evaluation questions addressing both the formative and summative components, are the bases for this project evaluation: (1) To what degree has the project increased the number of diverse secondary and post-secondary faculty trained in an interdisciplinary project-based approach to teach innovative inquiry-based learning techniques that are inspired by the STEM skills gap?; (2) How successful were faculty participants in increasing the number of secondary and post-secondary students that learn STEM concepts, as well as improve their attitudes and behaviors towards STEM, as a result of faculty training in this project?; (3) How successful has the project been in demonstrating improvement of student learning outcomes - knowledge (K), skills (K), and attitudes (A) - that relate to STEM principles, career skills, and aspirations? (4) To what extent has project facilitation of more interaction and collaboration among faculty participants resulted in a replicable and sustained Applied Learning Community? (5) How successful were the project's efforts to increase the number of institutions that formally adopt and establish standards and strategies for STEM Guitar project curricula resulting in wider reach and overall project sustainability?

### Evaluation Design, and Methods

As in the previous year, the overall evaluation of the STEM Guitar Project uses the mixed methods (Creswell & Plano-Clark, 2011) and developmental evaluation (Patton, 2011) approaches. A mixed methods approach and analysis involve an optimum mix of qualitative and appropriate quantitative data collection and analysis techniques. They reflect, not only results in terms of numbers, but the perspectives that can be assembled from qualitative data to enhance the quantitative results when triangulated.

For the 2018-2019 project year, some aspects of developmental evaluation (DE) approach informed the project's process and formative evaluation. Team members were encouraged and involved in evaluative thinking enabling intentional process use (Patton, 2015, 2011, 2008) of evaluation feedback and findings for project continuous improvement, increasing Team members' sense of program accountability (Archibald, 2018; Carden & Earl, 2007; Schwandt, 2018). Each of the five evaluation questions has formative and

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    3

summative components. The formative components, which include team and program implementation processes, have implications and direct effects on expected outcomes being measured per the evaluation question.  DE is useful in the ongoing development and exploration of new pathways in the project's team processes and professional development implementation endeavors. DE activities and process-use are enhanced further as the Project Team becomes involved with capacity building (King, 2007; Preskill & Russ-Eft, 2016) activities led by the external evaluator.  As in the previous year, the external evaluator also acts as an evaluation coach (Grob, 2018) through the DE process. DE helps in examining how the project refines and streamlines its data collection process by adapting what has been learned from previous years to a more focused data collection effort targeting a small group of experienced ("Champion") faculty and newly-trained faculty. Deterding's and Solmeyer's (2018) ideas about involving practitioners in cumulative study add to relevance and applicability of results.

DE activities are instrumental in achieving the summative components. For this project being focused on professional development, the summative components draw from Guskey's (2000, 2002) five levels of evidence for evaluating the project's professional development. The outcomes are geared toward (1) the increased involvement of diverse secondary and post-secondary faculty, (2) effects on faculty regarding their practice effecting student outcomes (3) student learning about STEM concepts, behaviors and attitudes toward STEM, (4) the project facilitating a replicable and sustained Community of Practice, and (5) wider reach of the STEM Guitar Project and its overall project sustainability.

Data collection methods include pre-post Institute evaluation surveys, interviews of sampled faculty and Project Team members, observation of development meetings and guitar building curricular implementation, reviews of documents and archival data. A single case design (Ledford, 2018) study of a "champion's" high school, was be started in 2018-2019. This case study design uses a quasi-experimental research approach using the pre-test post-test control group design (Shadish et al., 2002) with prospective and retrospective cohort (Lamorte, 2017) longitudinal study integrated within the case study. Academic data and other STEM-related data for both the prospective and retrospective cohorts, are being collected. Continued efforts to collect program evidence of student effects are being explored with the use of high-tech, high touch assessment via available online apps, taking advantage of students' partiality to social media.

## Limitations

This project has an affinity with informal STEM education (National Research Council, 2010, 2015) in the sense that faculty involvement in the professional development is voluntary and curricular implementation varies from participant to participant. Although classroom implementation and curricular integration are highly encouraged, some curricular implementation were conducted out-of-school or as limited program offerings like school

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    4

extension classes. Thus, systemic collection of direct student academic data and other outcome constructs (as behaviors and attitudes toward STEM) across the implementing groups, remain a big challenge. This challenge was experienced in the previous grant as well. Thus, the use of a single case study design (as described above) was started in 2918-2019 to mitigate this issue and help ensure systemic collection of program evidence regarding effects on students. Given the project reach and budget constraints, general follow-up evaluation for participants is dependent on self-reports.

# 2018-2019 Formative and Summative Results

## Formative Results

Program formative results deal with the project team process, program implementation process, and product output that occurred during the 2018-2019 project year.

## The Project Team Process

The project team process includes project decision-making, tools used in the team process, and team meetings.

### Project Decision-Making

In general, the Project Team, as headed by the Lead PI, endorses a collaborative decision-making process. The Lead PI convenes the Project EXECOM to brainstorm and stream the general project direction that is then shared with the rest of the team during the regular conference call for further discussions and final decisions. Involvement of the Project Team allows for better project buy-in. While collaborative and participatory process have definite advantages, the project experiences some delays due to more project team "decision lead time". To mitigate this, needed critical immediate project decisions are done by the Lead PI, often in consultation with the Project EXECOM. This project decision-making process allows for more flexibility and opportunities to respond to Project issues accordingly.

### Tools Used in the Team Process

The dedication and full commitment of Project Team members to the STEM Guitar Project are evident in the quality of support and project team processes developed in improving the project. Everyone, having been introduced to evaluative thinking, is on "continuous improvement mode". Use of telephone and online platforms and tools has been critical in sharing information and making project decisions, with team members spread across the United States. Conference calls via Zoom have been useful in lieu of in-person meetings. With this platform, the Project Team becomes present to each other via video

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    5

images; additionally, sharing of documents for discussions during meetings is possible through this mode. "Google docs" is also a common platform used by the Project Team for almost all collaborative and participatory activities, shared project dissemination and media exposure activities, project-wide common work for general feedback and suggestions, as well as calendar for project-related activities and events. Additionally, "Google docs" was also used by the sub-teams working on their team-specialty concerns. Survey Monkey has been the preferred project platform for surveys used in host site selections, Institute applications, and Summer Institute evaluations. Spreadsheets for project activities are developed as the need arises, to facilitate better data sharing and collection. Many times, pivotal questions from the external evaluator steer this development (for example, project spreadsheets for sharing project media exposure and project dissemination through publications and conference presentations that remain current and useful for the Project Team).

## *The Project Team Meetings*

There are three types of project team meetings: (1) external evaluator consultation with the Lead PI, (2) Zoom meetings of the EXECOM and the bi-monthly Project Team calls, and (3) project specialty development meetings/trainings.

### External Evaluator Consultation Calls with the Project PI

The external evaluator continues consulting with the Lead Project PI (either face-to-face, via telephone conference calls or via email communication, usually one week or a few days before the bi-monthly Project Team's conference calls) to bring in program evaluation concerns. Special conference calls are also held outside of these regular schedules as needed. The External Evaluator shares via email with the Project EXECOM the general evaluation concerns that are discussed with the Lead PI. The Lead Project PI ensures that evaluation concerns are discussed with the Project EXECOM and included in the project conference call agenda, allowing for reflections and opportunities for program improvements.

### Zoom Meetings with the Project EXECOM and the Bi-monthly Project Team Conference Calls

Starting 2018-2019, the Project EXECOM plays a more pro-active role in setting the project directions and initiatives. The Project EXECOM meets via Zoom or regular telephone calls, and communicates via email as often as necessary. The Project EXECOM makes sure that the co-PIs are in agreement and have consistent stance in the agenda to be taken with the entire Project Team during its bi-monthly meetings.

The Project Lead PI facilitates the entire Project Team Zoom conference calls. There is full involvement of the Project Team (including the External Evaluator) during the Project Team Zoom conference calls. In these meetings, general project concerns are discussed per the formal agenda shared a few days to one week before the Zoom calls. The conference call provides opportunities for brainstorming, sharing of new ideas, project

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    6

concerns, decision-making, and calls to action. It is during these calls that program concerns are discussed and resolved - for instance, the decisions about program tracks and geographic locations of Summer Institutes. The project wants to ensure that targeted underrepresented populations across the 50 US states are reached. The conference calls also serve as checks for clarity and updates for project tasks. The External Evaluator listens in, provides input regarding evaluation-related issues, and answers questions raised about them. In 2018-2019, the project started with sub-team Zoom calls after the general assembly, to optimize meeting times and take advantage of the Project Team members' expertise in the specific project concentration areas. The sub-team areas are the acoustic guitar sub-group, the hybrid (electric guitar and CNC) sub-group, and the marketing/project promotions sub-group. The External Evaluator joins the marketing/project promotions sub-group. The entire Project Team reconvenes after the sub-team meetings to share highlights taken during each sub-team's concentration area meetings.

### Development Meetings/Trainings: Acoustic Guitar and Hybrid Training

Project development meetings are held to beef up Project Team capabilities related to new project initiatives. Unlike 2017-2018 where the entire Project Team met in-person at San Diego State University, in 2018-2019, the STEM Guitar Project conducted two specialty development meetings with in-person attendance of concerned Project Team members: (1) the acoustic guitar development meeting/training in October 2018 at Purdue University and (the) the hybrid (CNC) training in April 2019 at Sinclair Community College. During these development meetings/trainings, the Project ensured optimum use of Project Team members' in-person attendance by involving the team members, not only with the hands-on technical training, but also in the development of references and ideas for future project initiatives and directions. The external evaluator attended these specialty development meetings, entirely or in part, to better understand the context of these emerging project areas of concentration.

The acoustic guitar development meeting/training was conducted at Purdue University on October 5-8, 2018. Based on the External Evaluator's observation of this development meeting/training, an informal report perspective was shared with the Project EXECOM and Project Team in early November 2018. It provided insights about how the summit was conducted and what lessons were learned based on observations and informal talks with participants. These were meant to help the planning and implementation of the 2019 Summer AGBI (Acoustic Guitar Building Institute) to stimulate more thinking about the acoustic guitar building program. The development meeting/training affirmed how the acoustic guitar building program would help attain not only the technical skills (workforce transferable skills to industry) but also the non-technical skills identified in the previous year's program efforts (communication and collaboration; creativity and innovation; critical thinking and problem solving; flexibility and accountability; productivity and responsibility; leadership and adaptability; grit, initiative, and self-direction; and social and cross-cultural skills). As a result of this development meeting/training, instructional materials and do's and don'ts in implementing the AGBI were developed by the AGBI sub-team. The sub-team is now getting ready for a full-scale AGBI in summer 2019.

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    7

The hybrid (CNC) development meeting/training was held at Sinclair Community College on April 11-14, 2019 in preparation for the offering of a Hybrid (electric guitar and CNC) Guitar Building Institute (HGBI) in summer 2019. Part of this development meeting/training was the brainstorming regarding future project directions/potential grant to pursue facilitated by the Sinclair Community College Grants personnel. The External Evaluator attended part of this development meeting/training. Additionally, the External Evaluator facilitated the discussion about future data collection from GBI participants. Participants of this development meeting/training completed an after-training feedback/reflection suggested by the External Evaluator posted via Survey Planet with the help of the Lead PI. This feedback/reflection indicated that Team Member participants definitely learned CAM processing skills with Fusion 360 and affirmed that collaboration team efforts, Instructional Technology (IT) and support of a technical "expert" in the area are important components of this program. As one of Team member said,

> *I have confidence that we can achieve our objective of having participants add tool path to their design and generate appropriate G code.*

Participants also suggested additional preparations and background materials needed prior to the summer training.

> *Help people get around from template to custom shape and get toolpaths programmed to machine guitar body*

> [We need] *PowerPoint presentation with screenshots of CAM toolpath programming. The illustrations in the spreadsheet no doubt took a long time to collate...however screenshots alone don't tell you what you are doing or why and as such don't make as good a tutorial reference as a PowerPoint with caption text. PowerPoint, not power paragraph. 10-15 words per slide, no more.*

> [We need] *Access to a completed file to open sketches, extrusions, profiles, pockets to dissect the right way to do things.*

## The Program Implementation Process

The Project Team is open to a wide variety of things to help improve project implementation. The program implementation process includes the project documentation, on-boarding of team members, site selection, recruitment and selection of participants, materials and curricular development process (kit preparation; Modular Learning Activities (MLAs); video preparation, revision, vetting, and launch; manuals for GBI implementation and guide for faculty implementation), and process preparation for the institute implementation (including preparation of agenda and evaluation components).

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    8

## *Project Documentation Process*

Documentation is very important in pursuing program initiatives of the STEM Guitar Project. As such, project documentation process, both for formative and summative purposes, have been established to ensure adequate documentation of program accomplishments. The external evaluator's discussions with the Project Team regarding the importance of sharing with others the project's process led to many project documentations started and accomplished to date. Typically, the documentation process occurs immediately before and after events and activities. Many documentation processes have been continued from previous grants on this current grant. The Lead Project PI assigns specific team members to concentrate on leadership and documentation of critical project aspects and tasks within the sub-areas of the project throughout the grant life, including concerns about the project sustainability. These project aspects and tasks are "living" documents as they are started and continued as they develop; some may still be in "idea stage". Formative processes are documented with use of rolling agenda notes (for continuity and easy follow-up for calls to action), email communication records, and notes, highlights, and/or feedback about development meetings and trainings. What is new to this current grant is Zoom meetings and recordings. Documents and products resulting from formative processes are described in the product output below. Summative processes are documented via data collection tools and results included in reports documenting the project and program effects on the STEM Guitar Project as a whole, Project Team, faculty, and students. Summative products are included in reports regarding project outcomes.

## *On-boarding of Team Members*

Part of the on-boarding process for team members is the formal training and actual exposure to the GBI site implementation. In general, site team members are composed of the site leader trainer (a senior team member who is more experienced with specialty knowledge of the concentration area) and one or two junior team members. Junior team members get exposure to the concentration area by being part of the implementation team for at least one year; preferably two or more years. As the need arises, Project leadership proposes specialty "development meetings" (e.g. the Acoustic Guitar and Hybrid Training Development meetings) to help beef up Project Team members expertise and capabilities.

## *Site Selection*

Site selection begins with a solicitation, published on the home page of the project website (www.guitarbuilding.org) and on the site location intended for administrators (http://www.guitarbuilding.org/workshop-details-for-admins/).  Team members invite and encourage personnel in-charge of various institutions within US regions where STEM Guitar Institutes have not been held yet. Interested proponents are encouraged to apply as site host for the Summer Institute via the application survey posted in Survey Monkey. The host site application survey was developed and published by project leadership with the Site Selection sub-team. Completed site applications are then reviewed by the project Site Selection sub-team. Site selection bases used in determining the 2018 Institute hosts

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    9

remain as the major bases for Institute sites henceforth. These are: potential for collaboration/partnerships, appropriate facilities, likelihood of the Institute filling the optimum number of participants, logistics of participant travel, and level of institutional commitment to the goals of the STEM Guitar Project. Sites are also asked to provide further information, including photos of the spaces that would be used for the Institute.  Additional emphasis on intuitional computer and electronic technical support is included in the 2019 selection criteria.

## *Recruitment and Selection of Participants*

Recruitment and selection processes for the STEM Guitar Project are undertaken for the three-program concentration or program tracks: Acoustic Guitar Building (AGB), Electronic Guitar Building (EGB), and Hybrid Computer Numerical Control [CNC] and Electric Guitar Building (HGB)

Established and improved recruitment and selection of faculty participants help the project in reaching out to its targeted participants – underrepresented populations. The project's primary definition of underrepresented population is primarily based on the National Science Foundation (NSF) identified concern about underrepresentation of women, persons with disabilities, and race/ethnic groups (such as blacks, Hispanics, and American Native Americans) in science and engineering education and employment. The STEM Guitar Project extends its definition of "persons with disabilities" beyond physical disability and includes "economic disability", thus, prioritizing the involvement of institutions serving a greater proportion of students in "free and reduced" lunch as important to the project.

Faculty recruitment starts with the project contact list representing diverse underrepresented populations for all three program tracks, as recommended by the Project Team. Faculty Institute participants are recruited through various modes but the three most prevalent sources of participants are: word-of-mouth advertisement by previous participants, direct email to individual potential participants, and solicitations posted on the home page of the project website (www.guitarbuilding.org) and on the site location meant for teachers (http://www.guitarbuilding.org/workshop-details-for-teachers/). Recruited Institute participants are invited to complete an online application (via Survey Monkey), The application survey was developed by the External Evaluator in consultation with the Project Team. The application survey includes demographic information that will help determine the project's target population - underrepresented populations. The survey also included questions to tease out applicants' intent about use and implementation of the program as well as facilitating program-related experiences and support for hands-on learning in the applicants' classroom and academic institutions. Selection criteria are recommended by the specialty sub-teams for the program tracks. Completion of the Electric Guitar Building Institute or an extensive experience in building electric guitars is part of the requirements for Acoustic Guitar Building Institute applicants. Members of the Project Team volunteered and/or were assigned to be either lead or support trainers for the Institutes, with everyone in the team having in at least one Institute. Usually the more experienced and senior team member ends up leading Institutes.

**REaCHaLL, LLC**
*Relevant Evaluation and Consultancy Hub about Lifelong Learning*
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    10

There will be Institutes for the three program tracks ([Acoustic Guitar Building Institute (AGBI)], [Electric Guitar Building Institute (EGBI)], and Hybrid Computer Numerical Control (CNC) machining and Electric Guitar Building Institute (HGBI) ]) planned for summer 2019 in eight different sites: **two AGBIs** (one on July 29, 2019 through August 2, 2019 at Hanford High School in Richland, Washington State and one in Pennridge High School in Pennsylvania on August 12-16, 2019); **three EGBIs** (one will be held on May 4-10, 2019 at the Santa Fe Community College in Gainesville, Florida, one at Ivy Tech in Fort Wayne, Indiana on June 24-28, 2019, and another one at Stuyvesant High School in New York on July 15-19, 2019); and **three HGBIs** (one for the TXRX Maker Space at Houston, Texas on June 24-28, 2019, one in Bozeman High School at Bozeman, Montana on July 22-26, 2019, and one at Forest Scientific Training Center in Phoenix, Arizona on June 10-14, 2019). Marketing/ promotions of the GBIs is critical to date; there is a greater chance for all, if not most, of the applicants to be selected as teams try to consider the optimum number of participants in Summer Institute sites.

## Materials and Curricular Development Process

Materials and curricular development processes include the guitar parts and kit preparation; the development, revision, vetting; and launching of the Modular Learning Activities (MLAs) and educational videos; and preparing the GBI manuals.

### Guitar Parts and Kit Preparations and Sales

The Sinclair Community College (SCC) Manufacturing/Production Team has been involved with guitar kit parts and preparation. Apart from producing and cutting solid guitar body parts, this production team has been involved in canvassing and soliciting economically salient sources of the different parts used in the guitar kit that are not produced at Sinclair. It is this team that made the guitar kits used in the implementation of the electric guitar building in different educational institutions feasible. With the new program track coming into play, there are other groups involved in the guitar parts/preparation mix. Import of economically feasible wood from other countries is being explored. Taylor Guitar from San Diego is one major supplier of guitar kit parts for the acoustic guitar and sends these kits to Sinclair. The Sinclair Community College Manufacturing/Production Team continues to handle and distribute all guitar parts and kits to different program participants and implementers.

### Collaborative Process in MLA and Educational Video Development

Collaborative development of the Modular Learning Activities (MLAs) and educational video is a practice continued from the very first STEM guitar project grant. In 2018-2019 much of the efforts in the production of program educational materials have been focused in organizing, sorting, and vetting of all existing materials. The EGB sub-team worked on more than 60 MLAs that were produced in the previous years of the STEM Guitar project. The CNC and the AGB sub-teams are working within their groups to make available

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*                    2018-2019 STEM Guitar Eval Report    11

at least 10-12 MLAs with relevant videos for the 2019 summer participant. Previous videos created are now being vetted and reorganized to conform with the five-minute segment requirement for the different program tracks. Video materials seem to be given premium by the Project Team members and past program participants. The Project Team is reviewing the inventory of video materials and is preparing for video production of any necessary aspects of the program track build that needs more video educational support. The Project Team is in agreement that existing educational materials are good starters for program participants. Less focus will be made on MLA production during the Summer Institute. The Project Team recognizes the need for program participant reflection and preparation for actual program implementation starting off with available program materials.

## Process for Preparing the GBI Manuals

GBI manuals of implementation that were started from previous project years are being reviewed and adapted and/or modeled in production of manuals for the three program tracks. There is a plan for Project Team Institute trainers to guide program participants to produce their own portfolio before participants leave the Institute; tracking the implementation process before participants leave the Institute so they have their own instructional materials useful in their program implementation.

## *Process Preparation for the Institute Implementation*

Preparation for program implementation is the project's process that facilitates and models guitar-building program implementation for Institute participants. This is meant to help Institute participants in increasing their students' learning and acquisition of guitar-building STEM-related learning. The project's training practices provide the structure and backbone for participants' guitar-building program implementation. These are reflected in the Institute agendas, that include not only the week-long Institute activities, but also preparations for the webinar and participants homework, about a month prior to actual activities in Institute sites. Extra time for the preparatory webinar is necessary to ensure saving optimum time for modelling program implementation in the week-long Institute. Obviously, guitar building implementation in the participants' institutions will take more than one week. During the webinar, the project background, previous program results, and project expectations, pre-readings, homework and incentives for participants are shared. The webinar also provides opportunities for participants to ask questions and clarifications about program expectations. The Summer Institute agendas serve as the guide for Institutes' preparations and week-long activities, not only for the participants, but for Trainers. The agendas are generally prepared by the Project Team prior to the Institute and made available to the accepted participants before the webinar.

Part of the preparation for Institute implementation is development of the Institute evaluation to ensure the overall quality of training and the fidelity of Institute implementation. The External Evaluator prepares the draft of the two Institute evaluations (one for participants and one for trainers), which are highly influenced by Guskey's (2002) evaluation of professional development. The instrument for Institute participants is meant to collect data

REaCHaLL, LLC
Relevant Evaluation and Consultancy Hub about Lifelong Learning
Effecting transformational development
2018-2019 STEM Guitar Eval Report    12

about participants' reactions about the Institute, what they learned, their plans for classroom implementation, as well as get their perspectives about any areas of growth. The instrument for Institute Trainers is meant to get Trainers' perspectives about the overall Institute program and quality of Institute program implementations. Currently, the Project Team is still in the process of providing feedback about the instruments. The Project Team is able to match evaluation points against the Institute agenda and ensures that the main concerns about the Institute are included in the evaluation. This process is part of the instrument construct validity check.

## Program Output

Program output includes STEM Guitar kits, modular learning activities (MLAs), videos, and other learning materials, the Institute agenda, the evaluation instrument, and the actual number of faculty trained.

### The STEM Guitar Kits

In past STEM Guitar grant years, the Sinclair Community College Manufacturing Team has always worked, and continues to work even in the current grant, as an independent/self-sufficient group not funded by the STEM Guitar grant. However, this group is an integral part of the STEM Guitar program. The Lead PI continues to provide oversight of this team as part of his administrative and academic role at Sinclair Community College. Starting the 2018-2019 project year, one of the Production Team members is being partly funded through the project in his capacity as a technical support staff for the HGBI, particularly in implementation and use of Fusion 360. STEM Guitar kits are available through the Sinclair College Manufacturing Team's effort. Finished products are advertised on the STEM Guitar website "Storefront" (http://www.guitarbuilding.org/store/#!///c/0/offset=0&sort=normal). From January 2017 through April 2019, close to 9,000 guitar kits were sold, 95% of which were sales for classroom use. The SCC Manufacturing/Production handled close to a million guitar kit sales for the 28-month period (January 2017 through April 2019). Different guitar kits and supplies are listed on the Storefront with the following url addresses:

- Classroom Guitar Pack kits
http://www.guitarbuilding.org/store/#!/Classroom-Pack-Guitar-kits/c/22671276

- Individual Guitar Kits
http://www.guitarbuilding.org/store/#!/Individual-Guitar-Kits/c/22006028

- Body Blank and Partially Milled Guitar Kits
http://www.guitarbuilding.org/store/#!/Body-Blank-and-Partially-Milled-Guitar-kits/c/22671282

- Guitar Hardware Kits

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    13

http://www.guitarbuilding.org/store/#!/Guitar-Hardware-kits-plus-Neck-and-Fret-board-Options/c/23151741

- Guitar Tools and Supplies
http://www.guitarbuilding.org/store/#!/Guitar-Tools-and-Supplies/c/22671272

## *Vetted MLAs and Videos and Other Learning Materials/References*

As noted above, the Project Team continues to develop, revise, improve, and vet STEM Guitar MLAs, videos, and learning materials. The Electric Guitar Building Manual has been developed and the Acoustic Guitar Manual is still in process. Below are url addresses of available STEM Guitar Project learning materials as part of the project output to date. The Project Team continues to improve and add to these learning materials. At this time, most of the materials are applicable for the EGBI, and HGBI. More materials for HGBI and new ones for AGBI are still being vetted by the Project Team.

http://www.guitarbuilding.org/institute/modular-learning-activities/

http://www.guitarbuilding.org/teaching-syllabus/

http://www.guitarbuilding.org/downloads/

http://www.guitarbuilding.org/videos/

## *Actual Institute Agenda and Agenda for Preparatory Webinars*

The actual summer Institute agenda and related activities will be updated on the project website (http://www.guitarbuilding.org/institute/) soon before the 2019 Summer Institute. To date, the previous years' agendas are listed and provide examples of what has to come for the 2019 summer Institutes.

## *Program Evaluation Instrument*

The program evaluation instruments (2019 Summer Institute Evaluation, 2019 Summer Institute Trainer Team Reflection) are considered part of the project output since these are products of collaborative work among the Project Team members. The External Evaluator starts off with the draft of instruments but final instruments are vetted by the Project Team.

The actual training of participants during Summer Institutes is the heart of the STEM Guitar Project implementation. Thus, evaluation questions for participants and reflections for the Project Team include not only actual knowledge and skills gained and elements of

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*
2018-2019 STEM Guitar Eval Report    14

implementation but also suggestions for areas of growth. Currently, the Project Team is in the process of reviewing the 2019 Summer Institute evaluation. Unlike the previous year where daily surveys were done with Institute participants, the proposal this time is to go back to pre-post survey implementations conducted in prior years. This year's evaluation focus is on hard and soft skills learning of participants. For the reflection by the Project Team, the focus is on issues about fidelity of implementation. It is important to have shared meanings in any tasks undertaken, especially during program implementation. With the help of the external evaluator, a list of questions around elements of implementation (Dusenbury, et.al., 2003; Mihalic, 2004). was prepared for the Project Team to reflect on. These include concerns regarding clarity of different elements of STEM Guitar Project implementation (see below). The Project Team is encouraged to think in terms of: adherence to the program, quality of delivery, KSAs (including participants' reactions and engagement), dosage, and program differentiation.

    a. <u>Adherence to the program</u> – Is the program delivered the way it was it designed and written? [A check on "quality of delivery" is an overlap of this element.] How did the team members know?

    b. <u>Quality of delivery</u> – Are there any prescribed/required techniques needed in guitar building implementation that are "absolutely" necessary for everyone implementing the project to follow?

    c. <u>Knowledge, (Hard) Skills and (Soft Skills) Attitudes [KSAs], including participant reactions and engagement</u> – As a Project Team, how do members see the KSA alignment with employability skills in the project? What specific KSA(s) is(are) considered absolute priorities for inclusion in the Institute agenda and project based-learning (integration of MLAs into hands-on guitar building) that were emphasized? How do team members know they are successful in imparting these priority KSA(s)?

    d. <u>Dosage</u> – In the project proposal, the team identified 40 hours as the required guitar-building work hours/exposure – What are the team's ideas about the Institute schedule vis-a-vis the Institute's essential coverage?

    e. <u>Program differentiation</u> – There have been several ways of program implementation [in class, out of school; summer program, etc.]. Are the program "essential elements" that should be included (regardless of differentiated manner of implementation) taken up in the Institute?  How are issues of dosage handled? How are the learning materials introduced to help with implementation across the program tracks and the different ways of program implementation?

## *Trained Faculty*

There were 87 trained faculty in 2018. As of this date, there are about 150 faculty 2019 Summer Institute applicants to choose from. The Project Team will make final decisions by the first week of May 2019. Letters of acceptance have been sent to some qualified applicants who completed the application process and requirements early on. A final list of faculty participants will be generated after the Project Team's final decision. A clean list of participants will be on hand after the summer Institutes; a number of times, there are "no shows" during the Institute. The final list of participants will confirm if the STEM Guitar Project has indeed increased the training of diverse unrepresented population of secondary and post-secondary faculty.

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    15

## Summative Results: The Project Moving Toward Outcomes

Even in its second year, the current project, has the advantage of continuing and expanding from the previous two STEM guitar building related grants. It is noteworthy that continuing effects of the previous grants filter through this current project. Some good examples of these are the media exposure the project gets, as well as guitar kit sales.

The 2018-2019 outcomes are geared toward (1) increased involvement of diverse secondary and post-secondary faculty, (2) effects on faculty regarding their practice effecting student outcomes (3) student learning about STEM concepts, behaviors and attitudes toward STEM, (4) the project facilitating its brand of a replicable and sustained Community of Practice in terms of its Applied Learning Community, and (5) wider reach of the STEM Guitar Project and its overall project sustainability.

## *Increased Involvement of Diverse Secondary and Post-secondary Faculty*

### *Diversity of Institute Participants*

Faculty applications and likely program participants' acceptance for the 2019 eight summer Institutes will definitely be greater than 87 participants in the six Institutes in summer 2018. To date, greater than 150 2019 Summer Institute participants are under review. Accumulated data and comparison of the 2018 and 2019 Summer Institutes will be submitted in the next report to show evidence, if any, of increased involvement of diverse secondary and post-secondary faculty in the program.

Meanwhile, per the 2018 Summer Institute Highlights reported in August 2018, there were 87 participants but evaluation data came only from 86 participants: 100% response rate from the EGBI participants (N=59); only 96% from the Computer Numerical Control machining Institute (CNCI) participants (n=27).

Diversity of participants is seen in terms of their geographical distribution, educational attainments, ethnicity, gender, affiliation with the military, institutional poverty as expressed in terms of percent of school population receiving free & reduced lunch, institutional location, and subject areas taught. All United States Census Regions (Region 1-Northeast, Region 2-Modwest, Region 3-South, and Region 4-West) are represented with CNCI participants coming from seven states and the EGBI participants coming from 18 states across the USA. Faculty participants have a variety of educational backgrounds. Majority of the faculty have Master's Degree (>50%) and teach different grade levels. More than half of them, though, teach high school students and reach more than 100 students each in their classes. Of those responding to the "military participation" question, 18% of 27 CNCI and 13% of 53 EGBI participants have been in the military.

The following data highlight the inclusion of underrepresented populations that participated in the 2018 Summer Institutes held:

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    16

- About 30% female for EGBI; 11% female for CNCI.
- More than 25% non-white participants for both EGBI and CNCI.
- More than 50% of faculty participants in both EGBI and CNCI belong to institutions with more than 50% free and reduced lunch (moderate to high poverty and eligibility for Pell Grants.
- Among those who reported the location of their institutions (n=53 for EGBI and n=25 for CNCI), >48% of EGBI faculty institutions and >21% of CNCI faculty institutions are located in rural areas.
- Many of the CNCI faculty participants are teaching engineering and technology and genera/integrated STEM; most EGBI faculty participants are teaching science, math, and general/integrated STEM.

## *Faculty Learning and Change of Practice Effecting Student Outcomes*

Faculty teaching-related background was reviewed first to provide the context for any evidence of faculty learning and change of practice effecting student outcomes. The evidence is shown by data collected from 2018 Summer Institutes in terms of faculty self-report about STEM-related learning, as well as plans and confidence in implementing the STEM Guitar curriculum. Comparative follow-up faculty data from Faculty Champion participants of the 2018 Summit validated effects of the Institutes on faculty.

### *Faculty Participants' Teaching-Related Background*

The 2018 GBI and Summit participants' teaching-related background is reviewed in terms of their level of education, subject areas they taught prior to the Institutes, and MLA STEM-related subjects they learned and taught during (for the GBI participants) and after (for the Summit participants) the Institutes. It appears that the greatest percentage of all participants for both the 2018 GBIs and 2018 Summit are within those with Bachelor's degrees or higher. See Table 1 for highest level of education background of the 2018 GBI and the 2018 Summit participants.

**Table 1. Highest Level of Education**

| Degrees | CNCI (n=28) | EGBI (n=59) | 2018 Summit (n=16) |
|---|---|---|---|
| Asso. degree or some college credits | 18% | 10% | 0 |
| Bachelor's degree | 32% | 27% | 56% |
| Master's degree or higher | 50% | 63% | 44% |

Technology and engineering are subject areas that seemed to be commonly taught by the GBI (prior to the Summer Institutes) and the Summit participants where they implemented the STEM curriculum after the Institutes (see Table 2).

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    17

**Table 2. Subjects Taught Prior to and After Institutes**

| Subject Areas | CNCI (n=25) | EGBI (n=53) | 2018 Summit (N=16) |
|---|---|---|---|
| Science and Math | 0 | 26% | 8% |
| Technology, CAD, Mech Design, Computer Mfg, Metal Technology | 20% | 15% | 25% |
| Engineering | 12% | 6% | 25% |
| Social Sciences (Other Non-STEM) | 4% | 11% | 8% |
| General/Integrated STEM subjects | 64% | 42% | 8% |

All 2018 GBI participants reported the three major MLA STEM-related subjects taught during the Summer Institutes. 2018 Summit participants reported teaching in all three major MLA STEM-related subjects (see Table 3). There is one CNCI alumni among the sixteen 2018 Summit participants. Among 2018 Summit participants, six reported they started implementing the STEM Guitar curriculum within the following school year after they attended their Summer Institute. This includes the one CNCI alumni. Three 2018 Summit participants implemented the STEM Guitar curriculum after one school year. The four trained in 2010 or earlier reported implementing within two years of training and the rest (3 of 16) did not report their implementation year.

**Table 3. MLA STEM-related Subjects**

| MLA STEM-related Subjects | Learned During Institutes | | Taught After Institute |
|---|---|---|---|
| | CNCI | EGBI | 2018 Summit |
| Math-related subjects | 38% | 37% | 25% |
| Engineering-related subjects | 32% | 41% | 19% |
| Technology-related subjects | 30% | 22% | 19% |
| Other (non-STEM) | 0 | 0 | 13% |
| Not identified | 0 | 0 | 24% |

## *Effects on Faculty*

### Overall Effects

Part of the overall important effects of the STEM Guitar program on faculty participants are reported by the 2018 Summit faculty. More than 80% of the 2018 Summit faculty improved their classroom practice and improved their STEM knowledge and attitudes toward STEM to a great and greatest extent (see Table 4).

**REaCHaLL, LLC**
*Relevant Evaluation and Consultancy Hub about Lifelong Learning*
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    18

**Table 4. Program Effects on Faculty**

| Effects on faculty re: | Percent of 2018 Summit (Teacher reporting (N=16) |
|---|---|
| Improved STEM knowledge and curricular inclusion in the STEM subject area | 81% |
| Improved attitudes toward STEM | 81% |
| Improved classroom practice | 75% |

## STEM Concepts and Hard Skills Learned

The EGBI was focused on assembly of electric guitars and CNCI participants came away with concepts of what were involved with CAD/CAM. For both CNCI and EGBI participants, learning about measurements is among the top skills they learned. Refer to Table 5. The STEM concepts and hard skills ranked by the 2018 GBI participants as most important are the following.

**Table 5. Faculty Learned STEM Skills**

| Specific STEM Hard Skills Learned | Most Important Learning Ranked by the 2018 Participants… | |
|---|---|---|
| | CNCI | EGBI |
| Measurements in fabrication, & set-up | 1st | 1st |
| Model development & design | 2nd | - |
| CNC code creation | 3rd | - |
| Mechanical preparation; separating and joining process | 4th | -3rd |
| Running parts | 5th | - |
| Safety & tool usage | - | 2nd |
| Electronics & soldering | | 4th |
| Finishing & quality control | - | 5th |

## Soft Skills Learned by Faculty

Both the 2018 GBI and CNCI participants noted and ranked the most important soft skills (per the eight 21st century soft skills categories (P21 Partnership from 21st Century Learning, 2015) identified in the Institute evaluation: communication and collaboration, creativity and innovation, critical thinking and problem solving, flexibility and adaptability, productivity and accountability, grit, initiative and self-direction, leadership and responsibility, and social and cross-cultural skills) that they learned and honed during Summer Institutes. The Project Team categorized and grouped specific STEM-related attitudes according to the

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    19

21st Century Skills Framework - Career and Life Skills that were aligned with the GBI and NSF competencies or employability/technician skills (refer to Appendix 1). Table 6 shows a comparative rank selection of soft skills learned and honed by participants. This table shows that both the CNCI and EGBI participants were consistent in reporting greater importance of learning critical thinking and problem-solving during Summer Institutes.

**Table 6. Faculty Learned and Honed Soft Skills**

| P 21 Century Soft Skills Categories | Most Important Learning Ranked by the 2018 Participants… | |
| --- | --- | --- |
| | CNCI | EGBI |
| Communication and collaboration | 3rd | 5th |
| Creativity and innovation | 3rd | 5th |
| Critical thinking and problem solving | 2nd | 2nd |
| Flexibility and adaptability | 5th | 3rd |
| Grit, initiative and self-direction | 4th | 3rd |
| Productivity and accountability | 5th | 3rd |
| Social and cross-cultural skills | 1st | 5th |

## *Plans and Confidence in Implementing the STEM Guitar Curriculum*

Among Summer Institute participants who reported their level of confidence in teaching concepts learned in the Institutes, a greater percentage of CNCI participants indicated "high confidence" in teaching the concepts they learned compared with the EGBI participants; the combined percentages for moderate and high confidence among the CNCI and EGBI participants were above 90% (see Table 7).

**Table 7. Faculty Teaching Confidence**

| Institutes | No Confidence | Slight Confidence | Moderate Confidence | High Confidence |
| --- | --- | --- | --- | --- |
| EGBI (n=58) | 0% | 6.9% | 55.2% | 37.9% |
| CNCI (n=25) | 0% | 8.0% | 28.0% | 64.0% |

While no direct questions about confidence in teaching the concepts learned in the Institutes were asked of 2018 Summit participants, they affirmed this high level of confidence through their remarks about their actual teaching experience. One comment by a 2018 Summit Faculty Champion is a good example affirming this confidence.

*It's changed the way I teach STEM in my classroom. Now,*
*I always try to relate the guitar building techniques to real-world*
*examples students may encounter on a day-to-day basis.*

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    20

The Project Team continues to think about and prepare for different ways of supporting the STEM Guitar program implementation. As part of capacity building and honing of the team's innate evaluative thinking, the Project Team is encouraged to reflect on this phase of the program, ask more questions, and help establish the necessary supportive project structures and practices. Some initial plans are being laid down for the 2019 Summer Institute. The Project Team is working on the guidelines and process for participants' in-depth Institute participation, as well as making available learning/teaching materials participants can take with them immediately after the Summer Institute. This could come in terms of a faculty participants' portfolio or an Institute build and implementation documentation. These learning/teaching materials are meant to affirm participants' learning, as well as help them in their classroom implementation. There was reference to the work of one of the project co-PIs as a possible model for this learning/teaching materials.

### Institute Agenda Structures and Established Practices

Along with thinking about elements of implementation, some questions are raised for reflection. These are meant to facilitate the development and process for establishing guidelines, structures and important practices that can be replicated.

- What particular experiential learning activities are "musts" during the Summer Institutes" to help participants experience critical aspects of the program and demonstrate implementing guitar project with fidelity?
- What common implementation guidelines and processes have been established (or will be established) by the Project Team to help participants implement with fidelity the guitar building project-based learning even at different levels *(middle school, high school, college, 4-year university, mixed levels)* and different ways *(in-classroom full year, in-classroom semester, in-classroom term, out-of-school or alternative school within school year, out-of-school summer, etc.)* of implementation? How are variances in school resources, facilities, and program support taken into account?

- What project practices are in place (or will be established) to account for the varying levels of participants' guitar building and teaching experiences to support them in actual program implementation?

Establishing these project guidelines and structures, and ensuring adherence to established practices, will help showcase how well participants use what they learned from the guitar program; as well as effects of the program. With actual program implementation, gathering data facilitated by these structures and established practices are indicative of Guskey's (2002) 4th level of evaluating professional development.

### Academic Institution Support for Faculty Implementation

The third level of Guskey's evaluation of professional development has something to do with support for faculty program implementation, most especially, data indicating organizational support and change. Data about this were relatively limited. Initial data were

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    21

generated from some discussion, trainers' and evaluators' observations and participant-reported ideas about organizational support [e.g. discussions from the Applied Learning Community; open communication, personal connections among the participants; plans for teacher implementation support, and social media for student outcomes]. The practice of getting the formal signed administrators' support during the application continues. The planned webinar for administrators in late summer or early fall 2019 is meant to encourage more support from administrators and efforts to include the STEM Guitar program as an integrated part of the institutions' curriculum.

## Student Effects: Toward Determining Student Outcomes

The STEM Guitar program effects on students are indicated by teacher-reported learning and student self-reported learning. Data provided by 2018 Summit participants are follow-up data since they have been trained and have implemented the STEM Guitar curriculum. The sixteen 2018 Summit participants reported impacting 4,382 students as a result of their STEM Guitar program implementation. Specific STEM concepts, hard and soft skills are also reported by these summit participants. The case study students noted improvement in their persistence.

### STEM Concepts and Hard Skills learned

The 2018 Summit participants noted that model development & design, measurements & set up, safety & tool usage are the top concepts and skill students learned as they implemented the STEM Guitar curriculum (see Table 8).

**Table 8. Specific STEM Skills Learned by Students**

| STEM Skills Learned | Per 2018 Summit Participants' Rank Report in Importance |
|---|---|
| Model development & design | 1st |
| Measurements in fabrication, & set-up | 2nd |
| Safety & tool usage | 3rd |
| Finishing & quality control | 4th |
| CNC code creation | 5th |

Seventy-five percent of the 2018 Summit participants noted that students learned important soft skills and more than 50% of them noted that students learned general STEM knowledge and STEM-related technical skills (see Table 9).

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    22

**Table 9. Faculty Reported Student Effects**

| Student effects re: | Percent of 2018 Summit (Teacher reporting (N=16) |
| --- | --- |
| STEM-related soft skills | 75% |
| STEM-related hard/technical skills | 56% |
| Knowledge about STEM careers | 50% |

## Soft skills learned by Students

In the previous program year, the Project Team categorized and grouped the specific STEM-related attitudes according to the 21st Century Skills Framework - Career and Life Skills (P21 Partners for 21st Century Learning, 2015) that were aligned with the GBI and NSF competencies or employability/technician skills (refer to Appendix 1). 2018 Summit participants reported student learning, behaviors, and attitudes toward STEM. They identified critical thinking and problem solving, as well as communication/collaboration, as the most important soft skills that their students learned as they implemented the STEM Guitar curriculum (see Table 10).

**Table 10. Soft Skills Learned by Students**

| Soft Skills Learned | Per 2018 Summit Participants' Rank Report in Importance |
| --- | --- |
| Critical Thinking and Problem Solving | 1st |
| Communication and Collaboration | 2nd |
| Productivity and Accountability | 3rd |
| Grit, Initiative, and Self-direction | 4th |
| Leadership and Responsibility | 5th |

## Results: Case Study and Pre-post survey

The single case study design using a pre-post posttest control group design (Shadish, et, al. 2002) with a longitudinal retrospective and prospective study of cohorts {Lamorte, 2017) in a high school in Washington state started in 2018-2019 school year. The study includes examining comparative student attitude toward STEM, as well as academic data that may have been affected by students' involvement in the STEM Guitar project. The bulk of these data are being gathered and organized but Initial data from this study were generated from a pre-post survey administered during the 2018-2019 school year. The survey is about students' persistence and attitudes toward STEM. Sunny's (2018) Attitude and Persistence towards Science, Technology, Engineering, and Mathematics (APT-STEM)

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    23

Instrument/Questionnaire was used to gather this information about STEM Guitar students and the comparison Non-STEM Guitar group of students (those not involved with the STEM Guitar program). A more detailed presentation of the case study will be included after the 2019-2020 school year, including analysis by demographics and background differences.

Wilcoxon signed comparison test, a non-parametric statistical test, was used in analyzing survey results because of the small sample and ordinal nature of the data. (STEM Guitar class, n=14; Non-STEM Guitar class, n=18). A reliability check for the survey was taken yielding an Alpha =.90. Overall, there were no significant changes in both the STEM Guitar and non-STEM guitar students regarding their behaviors/attitude toward STEM. There was a significant change for both STEM Guitar group of students and non-STEM group regarding their persistence, specifically relating to their responsibility for their own learning and experiences. The STEM Guitar class improved much more than the non-STEM class in terms of taking responsibility for their learning (refer to Table 11).

**Table 11. Responsibility for Learning**

| Measures | STEM Class (n= | | Non-STEM Class (n= | |
| --- | --- | --- | --- | --- |
| | Pre | Post | Pre | Post |
| Median | 3.7.0 | 4.5 | 4.0 | 4.0 |
| Variance | 1.344 | .500 | .761 | .261 |
| Significance | Z = -2.264, p = .024 | | Z= -1.979, p = .048 | |

Only the Non-STEM student group showed significant difference in not being discouraged by criticism while working on science or mathematics projects. This seems to indicate that the non-STEM class are more discouraged by constructive criticism while working on their science or mathematics projects (see Table 12).

**Table 12. Discouraged by Constructive Criticism**

| Measures | STEM Class | | Non-STEM Class | |
| --- | --- | --- | --- | --- |
| | Pre | Post | Pre | Post |
| Median | 3.5 | 4.0 | 3.0 | 4.0 |
| Variance | 1.170 | .835 | .941 | .853 |
| Significance | Z = -.975, p = .329 | | Z= -2.364, p = .018 | |

## *Applied Learning Community*

The STEM Guitar Project is facilitating its brand of a replicable and sustained Community of Practice with its Applied Learning Community. In 2018-2019, the most organized and formal part of the STEM Guitar Applied Learning Community is the STEM

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    24

Summit. The STEM Summit is an endeavor engaged in by the project in the past year but has been consciously brought into the current and future project years as a systematic way of following up with faculty participants who serve as "champions" in implementing the STEM Guitar curriculum. During the 2018 Summit, participants presented and shared teaching practices, lessons, ideas, and techniques. The 2018 Summit participants may be considered as a good sample and a microcosm of the GBI participants as they share similar characteristics and background. The 2018 Summit participants shared the following implementation information: six out of 16 implemented the program within the following school year, most of whom were trained in the last two years.; three out of 16 implemented the program one school year after their training; four out of 16 who were trained in 2010 or earlier implemented the program within two years of training; one participant did not report implementation year. In this report, most of the data reflecting the project effects on students came from the 2018 Summit participants. More strategies of gathering data through the Summit is being studied by the Project Team. Emerging in its practice is the involvement of participants and other STEM Guitar enthusiasts in the STEM Guitar Facebook (FB). The STEM Guitar FB has been an informal mode of engagement. Although FB analytics has been gathered, these data gave ideas more about project reach with some impressions without clarity of the nature and quality of interaction. An online "app" is being reviewed at this time to be able to systematically capture the project participants' meaningful interactions. Once finalized, this will need the subscription of the Project Team and program faculty and student participants in order to gather just-in-time data during the Institutes and follow-up data after the institutes. Making this process more formal and operative would strengthen the STEM Guitar's Applied Learning Community.

## Wider Spread of the STEM Guitar Project and Overall Project Sustainability.

Narratives about the STEM Guitar Project extent are expressed in terms of the project extent across the United States, span of implementation, and coverage and magnitude of interests in the project. The project's sustainability efforts involve promoting the supply chain as well as encouraging program media exposure, attendance in STEM-related/guitar-building/music-related events and conference presentation/ publications, and building academic, business/industry and community partnerships. Relationships with academic, professional associations, business/industry, and the larger community promote project buy-in, acceptance, relevance, crowd-sourced funding, and more visibility for project promotions and funding support. Currently, the Project Team is also reviewing the potentials for other funding support.

### Project Spread Across the United States

Census regions and divisions of the United States (see Figure 1) are brought in here to plot the wide extent of the STEM Guitar Project, not only by states, but by regions across the country.

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    25

**Figure 1. US Census Regions and Divisions**
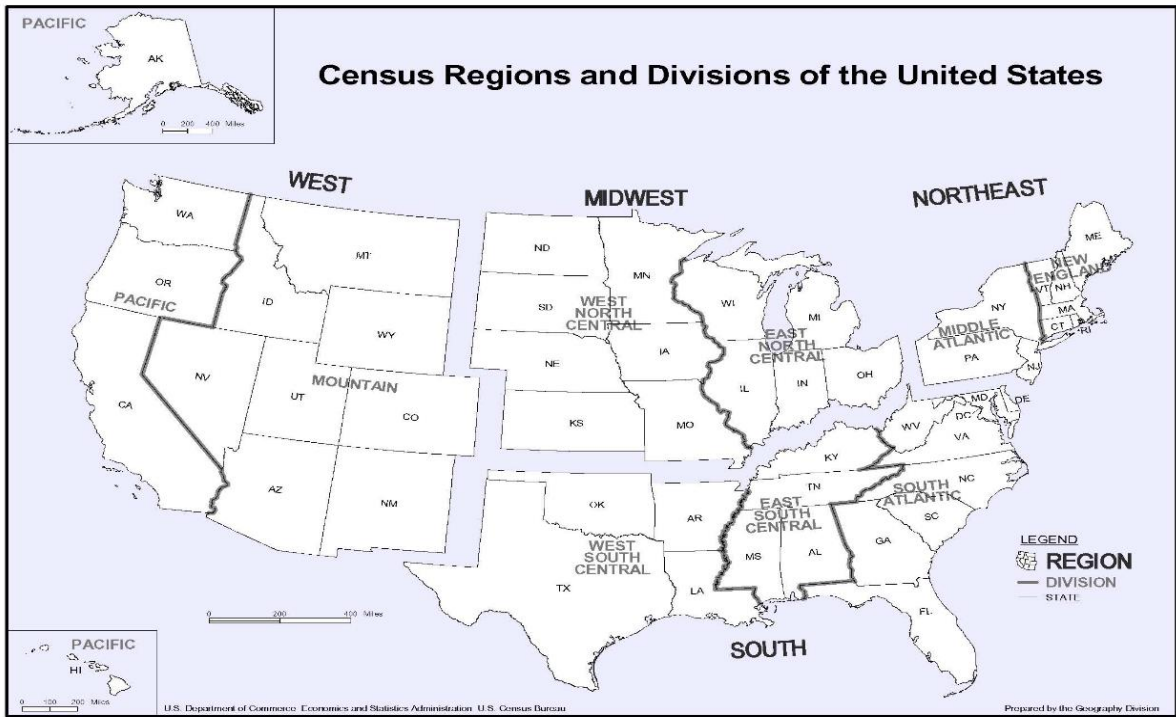


Source: https://en.wikipedia.org/wiki/List_of_regions_of_the_United_States

Table 13 indicates that STEM Guitar program participants in 2018 came from different US states representing the four major UC census regions

**Table 13. Distribution and Regional Representation of Participants**

| Regions | Regional Descriptions | 2018 Summer CNCI (N=28 | 2018 Summer EGBI (N=59) | 2018 Summit (N=16) |
|---------|----------------------|------------------------|-------------------------|--------------------|
| Region 1 | Northeast [Division 1-New England & Division 2-Mid-Atlantic] | 12 | 7 | 2 |
| Region 2 | Midwest [Division 3-East North Central, Division 4- West North Central] | 2 | 9 | 4 |
| Region 3 | South [Division 5-South Atlantic, Division 6-East South Central, Division 7-West South Central] | 2 | 22 | 6 |
| Region 4 | West [Division 8-Mountain, Division 9-Pacific] | 12 | 21 | 4 |

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    26

The STEM Guitar Project has reached 48 US states (refer to Figure 2) and all four census regions and divisions of the United States, not to mention a province in Canada, and a school in Colombia. This chart includes all implementing schools since the start of STEM Guitar project implementation 10 years ago.

**Figure 2. The STEM Guitar Map of Program Implementation**



Source: STEM Guitar Project website

In Figure 2, there are two US states (North and South Dakota) without schools implementing the STEM Guitar curricular program. However, a review of the two-year STEM Guitar website usage indicated that there are STEM Guitar program enthusiasts across all 50 US states. Figure 3 summarizes the website users across the four US census regions. Appendixes 2, Appendix 3, and Appendix 4 shows website users, new users, and the number of users with session access from all 50 US states where specific data are shown for both North and South Dakota. [North Dakota (Users = 38, New Users = 28, and Session access = 41) and South Dakota (Users = 39, New Users = 38, and Session Access = 49)].

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    27

**Figure 3. Regional Location of STEM Guitar Website Users**



Figure 3. Regional Location of STEM Guitar Website Users showing a bar chart titled "STEM Guitar Website Users by US Census Regions April 1, 2017 through March 31, 2019" with categories R1 with 9 States, R2 with 12 States, R3 with 17 States, R4 with 13 States, and a legend for Users, New Users, Sessions.

## *Coverage and Interests in the Project*

### Website Usage

A review of the STEM Guitar website daily usage for the past two years (refer to Figure 4 & Figure 5) provides insights into the ebbs and flows of interests in the STEM Guitar project across the two-year period. Similarly, Facebook (FB) analytics seem to indicate about the same peak periods for seemingly greater interests about the project (refer to Figure 7, Figure 8, Figure 9, and Figure 10).

For the period April 1, 2017 through March 31, 2018, there was an average of 59 individual daily views; the range of views were from 0 -147 views. For the period April 1, 2018 through March 31, 2019, there was an average of 55 individual daily views; the range of views were from 27 -110 views. Promotion in use of the website came about sometime in May 2017. For both years, the noticeable picks in September and November indicates timelines significant in the academic school year. September is usually the time used for more intensive preparation for implementation after classes started and are more or less organized. November is a good month for follow-up studies and getting additional information. Some schools choose to implement in the latter part of the year starting February. Peak points during the summer months are dates close to the Summer Institutes. Figure 6 shows the comparative monthly website views.

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    28

**Figure 4. Website Views: April 1, 2017 through March 31, 2018**



STEM Guitar Website Views for the Period
April 1, 2017 through March 31, 2018
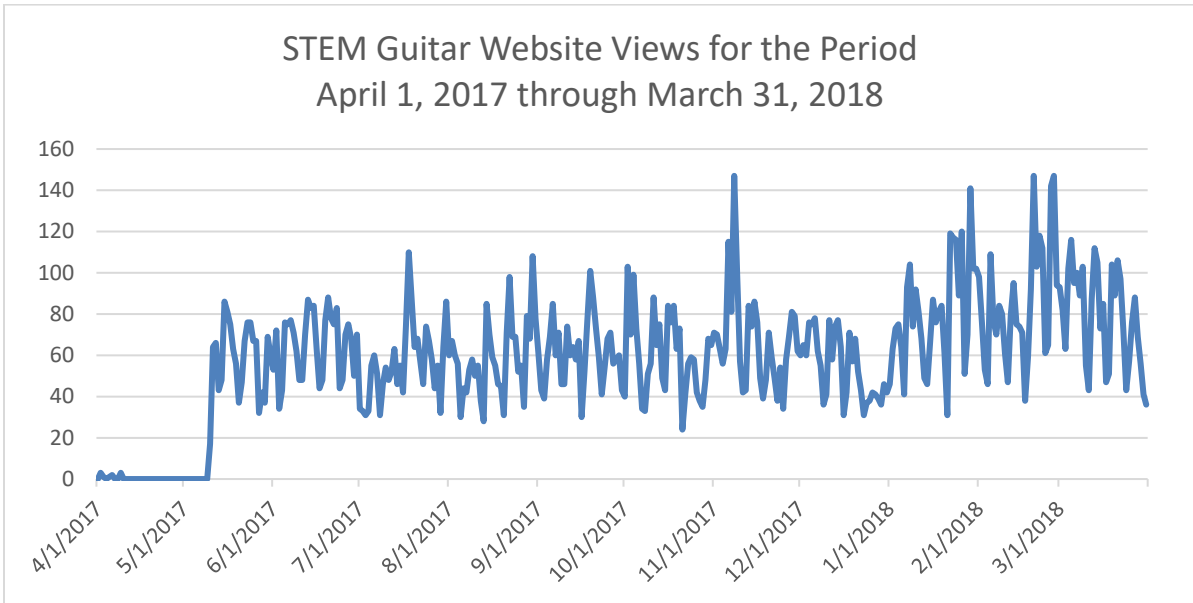
**Figure 5. Website Views: April 1, 2018 through March 31, 2019**



STEM Guitar Website Views for the Period
April 1, 2018 through March 31, 2019
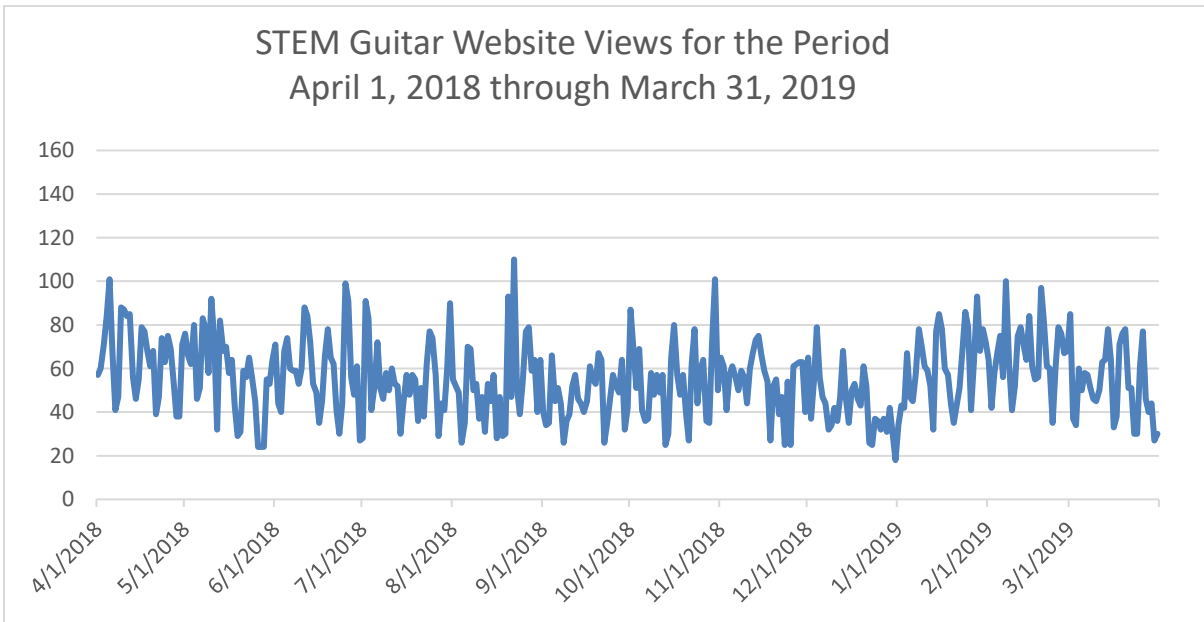
**Figure 6. Monthly Average STEM Guitar Website Views**



Monthly Average STEM Guitar Website Views
For the Period April 2017 through March 2019
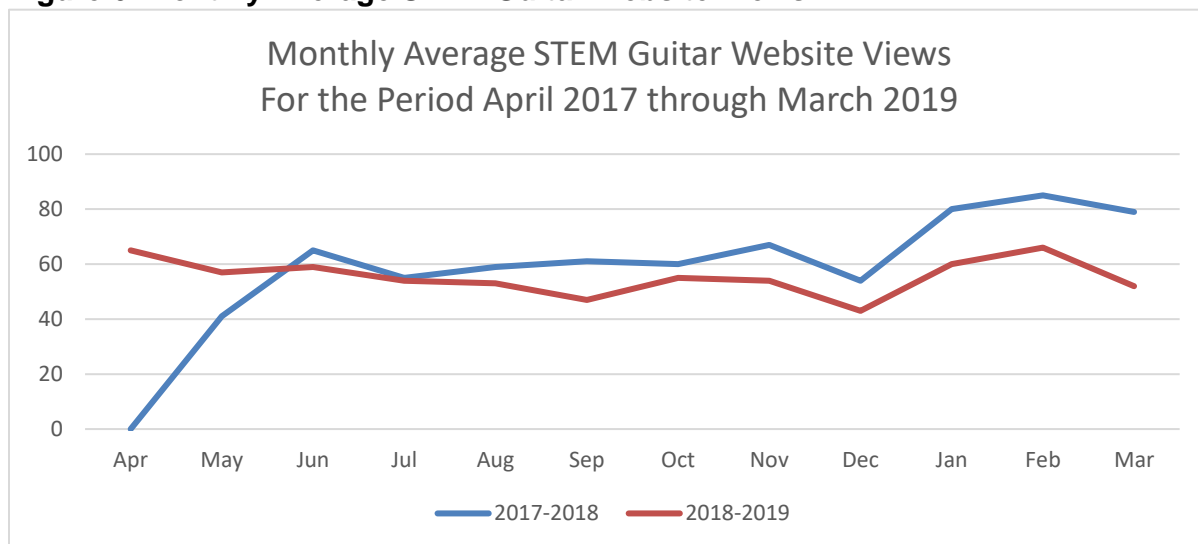
## Facebook Analytics

STEM Guitar Project team members and program enthusiasts have been active on Facebook in the year 2018-2019. Facebook (FB) data analytics were generated for the period April 2018 through March 31, 2019 to have a sense of how this social media platform affects the STEM Guitar Project. Data mining of the gathered data analytics was performed. Focus is turned on the FB's defined monthly (28 days) "reach" and "impressions". The variable definitions about "reach" and "impressions" provided by Facebook (refer to Appendix 5) and York (2019) served as guide in making sense of data. Per York's (2019) definition it may be inferred that "reach" is the count of people who may have seen the STEM Guitar Project Facebook (FB) content when the page or post enters the audience's screen. "Impressions" are the total number of times STEM Guitar FB content is shared with other audiences by different people through different posts, and check-ins about the page and posts. "Reach" and "impressions" are termed as **organic** as they refer to the number of unique people who see the STEM Guitar page/post content in the News Feed, without any paid advertisements. Both become **viral** when other people interact or engage with the page or post, share this with social information; also includes liking the page, following and checking into the page, sharing a photo of the page., commenting about the page. Thus, the numbers for "impressions" are usually higher than the numbers for "reach". Often times for both "reach" and "impressions" the "total" and "organic" data are about the same; the viral data are usually less than the "organic" data. The viral data though are the most interesting data since these are the ones that indicate engagement and interactions about the page and/or posts. The "reach" and "impressions" data are reviewed for patterns that cut across all the variables considered. It appeared like certain times of the year in relation to the academic schedule, school vacations, the season, and the time of the STEM Project Institutes affect the volume of "reach" and "impressions" FB access.

Figure 7 shows the average high FB 'reach" access, both for the regular "reach" and

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report     30

the "reach" of page posts, Figure 8 shows the period with the high average FB audience "impressions". There are two high FB 'reach' and "impressions" periods: (1) the winter period between January 23rd through March 31st; (2) the summer period immediately after the GBIs from June 27th through August 15th.

.

**Figure 7. Average High FB "Reach" Access**
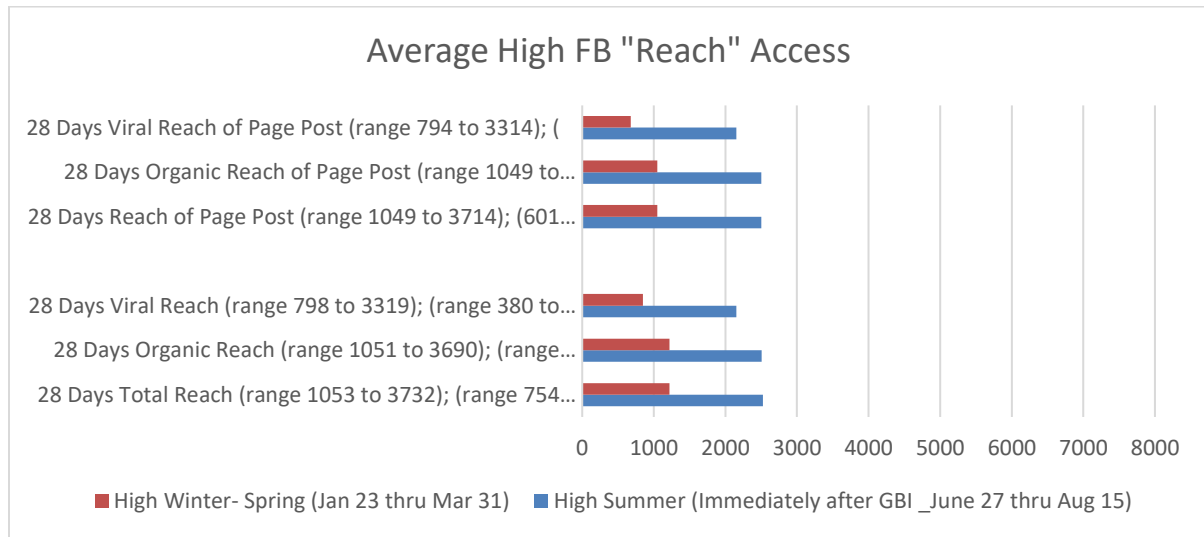


**Figure 8. High Average FB "Impressions"**
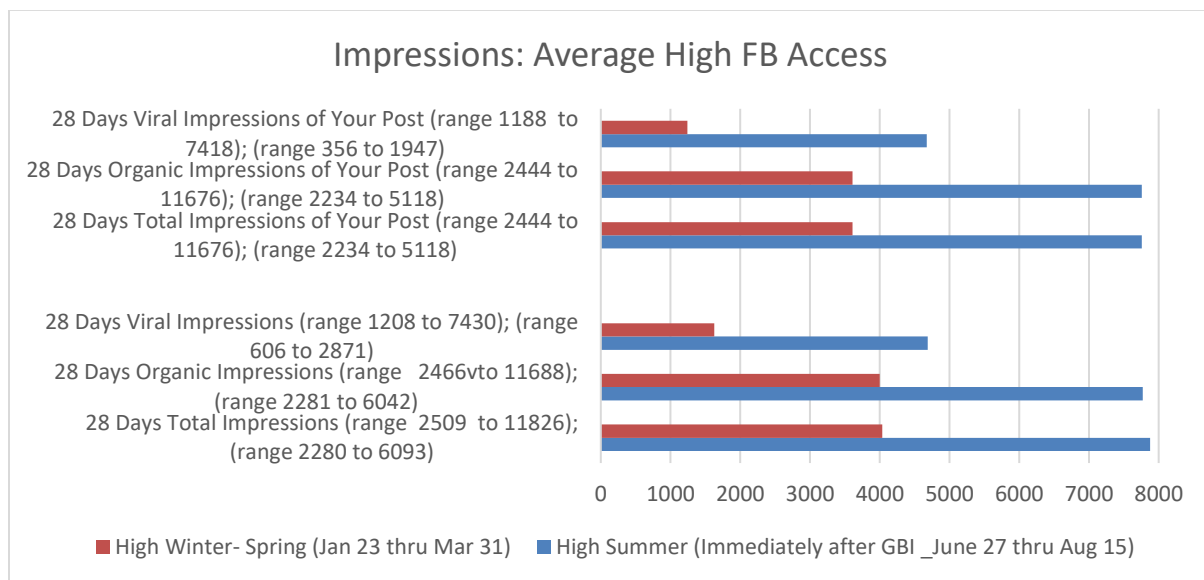


Figure 9 shows the average low FB 'reach" access, both for the regular "reach" and the "reach" of page posts, Figure 10 shows the period with low average FB audience "impressions". There are two low FB 'reach" and "impressions" periods, the time when there seems to be a lull in FB activities among the STEM Guitar program enthusiasts: (1) the

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    31

winter right after the holiday vacation between January 5th through January 22nd; (2) the early school year period from September 18th through October 25th.

**Figure 9. Average Low FB "Reach" Access**
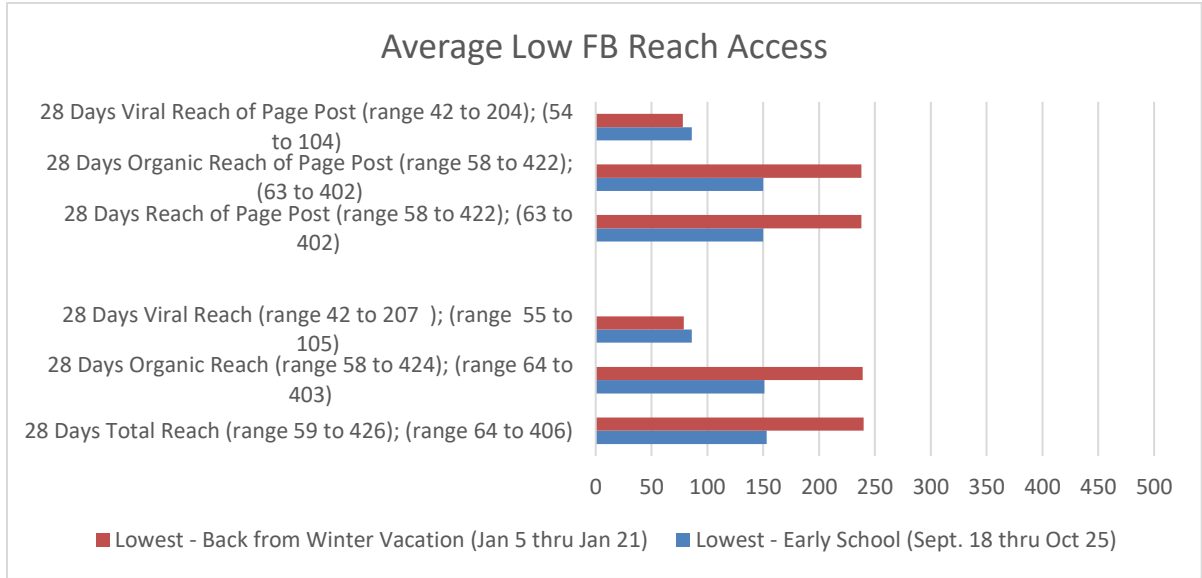


**Figure 10. Low Average FB "Impressions"**
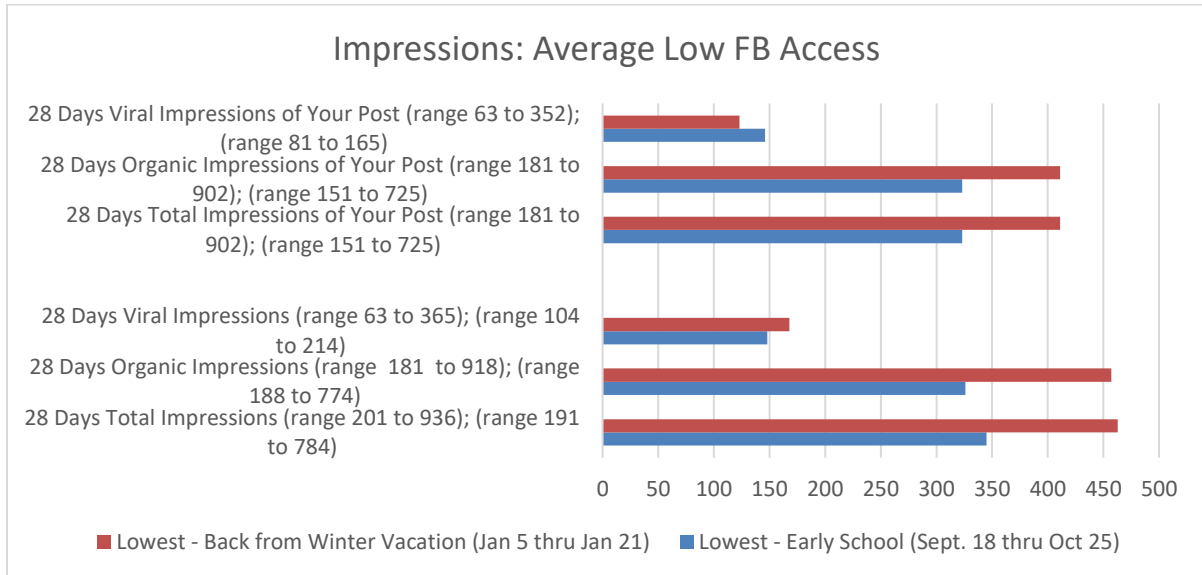


There was an average of 165 daily FB engagement (range of 66 through 581views) with STEM Guitar postings for the year. The average daily total consumers are 127 (range from 1 through 457). The average daily page consumption views are 330 (range from 13 through 1596).

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    32

The Guitar kit sales indicate, through the sales volume, the potential classroom implementations and through the sales timing, the ebbs and flows of the STEM Guitar Project implementation (see Figure 11). It is interesting to see how the STEM Guitar website usage and FB analytics may have any connections with the guitar kit sales season.

**Figure 11. Guitar Kit Sales Season**
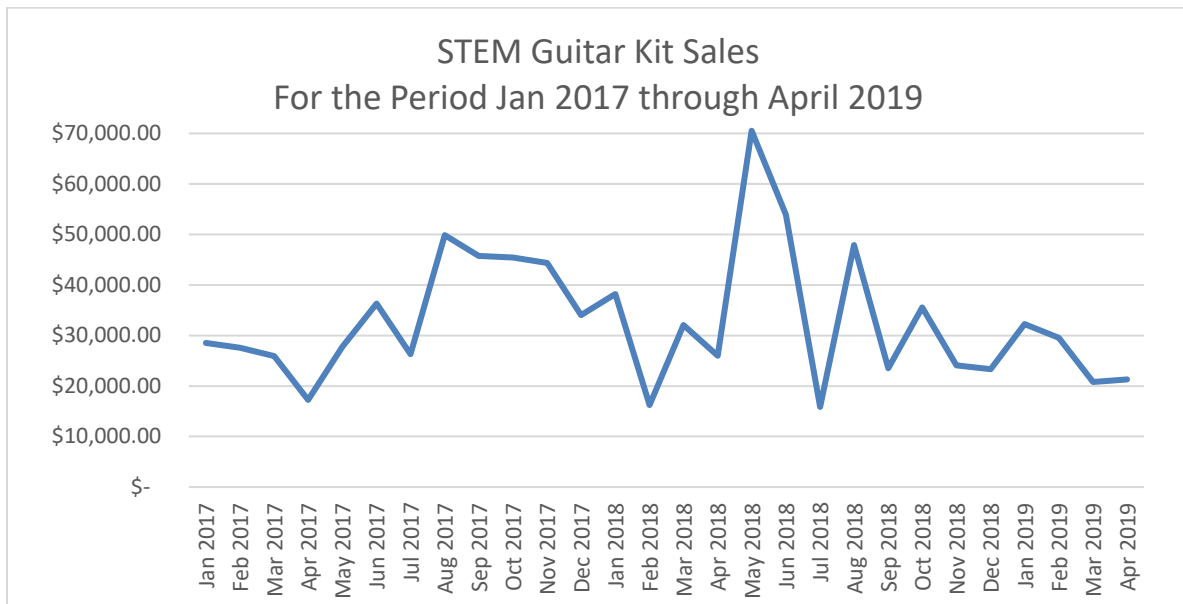


Figure 12 shows the two- year comparative STEM Guitar kit sales (April 2017-March 2018; April 2018 through March 2019) in order to examine the trends in guitar kit sales and understand the seeming plateau and/or downward trend in sales in the last five months. This time period was considered for a possibility of comparison with the website hits and Facebook analytics within the same period to see if this Project extent has any connections with the guitar kit sales at all. It appears that the guitar kit sales for the two-year period has about the same downward trend from November through March, picking up in summer, probably correlated with the conduct of the Summer Institutes. More follow-up to understand this trend is being considered. The summer "high trend" for the guitar kit sales seems to correlate with high website views and FB analytics during this summer period.

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    33

**Figure 12. Guitar $ Kit Sales: Volume and Timing**



STEM Guitar $ Kit Sales
For the Period April 2017 through March 2019
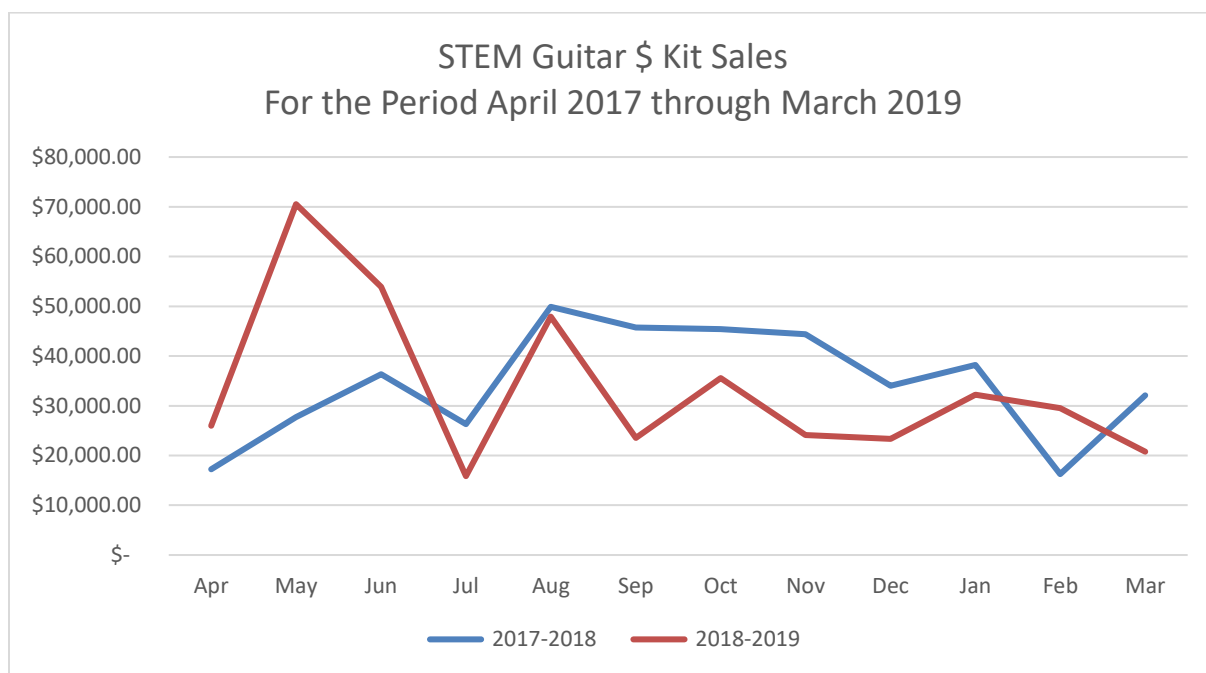
*Project Dissemination and Media Exposure*

**Project Dissemination**

The STEM Guitar Project encourages Project Team members' professional development by attending and presenting in professional association meetings, as well as doing professional publications. Among the professional associations and conferences that continue to be within the project's radar are national association conferences such as that of: M-STEM (Materials in STEM) Conference, National Science Teachers Association (NSTA), American Association of Physics Teachers (AAPT), High Impact Technology Exchange Conference (HI-TEC), Conference for Industry and Education Collaboration (CIEC), American Society for Engineering Education (ASEE), National Council of Teachers of Mathematics (NCTM), National Association of Music Merchants (NAMM), and the NSF PI Conference. The Project Team also explores regional educational institutions and venues for presentations. In the past, some Project Team members reached out to the Wells County Chamber of Commerce and other regional association conferences such as the Maine Science Teachers Association, Technology Education and Engineering Association of Pennsylvania (TEEAP), the Washington Association of Education Alternatives and the Washington Technical Education Association. Two Project Team members were awarded academic recognition/awards for their different efforts to connect the STEM Guitar in their own classrooms.

For the period August 2018 through MARCH 31, 2019, nine Project Team members have been involved in seven conference presentations/publications, promotions of the

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    34

STEM Guitar related materials and curricula to professional associations and academic environment during the period; three of these were presented in national conferences (AAPT winter conference, NSF ATE PI meeting, American Evaluation Association conference) and four of them in regional conferences. One team member has been involved in three of these endeavors; three other Project Team members have been involved in two. The Google docs link below serves as the repository of the Project Team's conference/publication and media exposure initiatives. This is a "living" document as Project Team members continue to update their project-related activities for conference/publication and media exposure immediately after holding event(s). Other Project Team members are still working on a book and curricular manuals not yet updated in this list. One thing definite, the Project Team members are experienced hands-on project-based learning (PBL) faculty and continuous learners, as well as prolific academics that take care of the balance of the STEM Guitar Project's curricular integration within this PBL.

https://docs.google.com/spreadsheets/d/1CpibIBHP1y_eiXW91bgJ_PLcFlyrglZ0zbx3GnqhbGY/edit?ts=5aa7e4eb#gid=306443905

## Media Exposure

One of the Project Team members continues to lead the STEM Guitar Project media exposure recognizing the necessity for a consistent presence in the academic world, as well as the community. Program participants are encouraged to reach out to media outlets in their region, or make their own program efforts more media news worthy, participants get localized media attention. The media guidelines have been developed and are available on the project website (www. guitarbuilding.org), making these guidelines readily available to all participants and others who may be interested. A format for project photos, video, and media exposure upload is made available via the url below:

http://www.guitarbuilding.org/share-your-guitar-building-photos-videos-and-mediapress-exposure/

The Project Team added five groups of media exposure categories to the list within the url address :below:

https://docs.google.com/spreadsheets/d/1CpibIBHP1y_eiXW91bgJ_PLcFlyrglZ0zbx3GnqhbGY/edit?ts=5aa7e4eb#gid=306443905

Within this url address are other url address of the different STEM Guitar media exposure via television and newspapers (see below). The most prominent among these are the STEM Guitar Project exposures during the implementation of its extension project at Edmonds Community College (November-December 2018) teaching veterans how to build guitars. This program was named "Heroes' Build".

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    35

https://myedmondsnews.com/2018/11/veterans-build-electric-guitars-and-new-skills-in-edmonds-cc-stem-workshop/#comment-160922

https://komonews.com/news/local/veterans-spending-the-weekend-building-electric-guitars-from-scratch

https://www.king5.com/video/news/local/washington-veterans-build-guitars-lynnwood-workshop/281-8310304

https://www.youtube.com/watch?v=Ll4KJKsZWoY&feature=youtu.be

http://www.guitarbuilding.org/press/

## Overall Project Sustainability

Concerns for overall project sustainability and overall sustainability efforts were part of the project activities since the beginning of the grant. These activities involve the development of the supply chain, the development and maintenance of project partnerships with the academic institutions, the business/industry, and the larger community, including exploring other funding support.

## The Supply Chain

There has been an exponential increase in demand for guitar kits in past years, although there seems to be a plateau in guitar kit orders in the last few months. Guitar kit development and preparation has even been more complex due to the three program tracks that need guitar kits and supplies. Thus, the need for a more concerted effort to develop the supply chain. Most of guitar kit demand has been supplied by the guitar kit Manufacturing/Production Team at Sinclair Community College (SCC), a self-sustaining entity not included in the grant expense budget. There is stability with the current guitar kit manufacturing at SCC; it has developed its infrastructure, process and practice. The SCC Manufacturing/Production Team started since the first grant and now has six lab technicians and one fulltime production manager. The guitar kits, as ordered, are distributed to different educational institutions around the US by the SCC Manufacturing/Production Team.  SCC has given the guitar kit Manufacturing/Production Team a bigger and more permanent venue. The STEM Project Team continues to exert more efforts to grow its schools supply chain, which remains a big challenge, even in the second year of this current grant. The Project Team continues to reach out to participating institutions who may have facilities that can handle the manufacturing and preparation of guitar kits. Potential groups are those institutions with facilities and capabilities and where there are Faculty Champions dedicated to implementing the guitar-building problem-based learning program. The Project Team continues to explore other sourcing possibilities like local manufacturing, which may be interested in making guitar kits, as well as importing materials that may help optimize costs.

## Project Partnerships with Academic Institutions

The project continues to experience wider span of academic partnerships as more

REaCHaLL, LLC
Relevant Evaluation and Consultancy Hub about Lifelong Learning
Effecting transformational development

2018-2019 STEM Guitar Eval Report    36

and more participants around the US states and other countries such as Australia, Canada, and Colombia are becoming involved in the project. Curricular integration of the STEM Guitar program is critical to realizing the project goals. As such, reaching out continuously to academic administrators become part of the primal part of the STEM Guitar program. Apart from the solicitation of administrator support through the signed participation agreements submitted by Institute applicants, the Administrator Institute is planned for the current grant. Initially, it was planned to involve in-person administrator attendance. However, getting feedback about busy schedules and differences in school year timelines of various institutions, a virtual Institute through a webinar is now being scheduled in late summer 2019. This forthcoming Administrator Institute will promote a greater chance of program implementation in more academic institutions. Emerging Faculty Champions also serve as the best ambassadors to academic institutions as they model the STEM Guitar curricular project-based learning implementation in their institutions. They are able to show positive program effects in their classroom practice and their students. Most of these are shown in the students' school performance, learning more about STEM concepts, gaining STEM-related hard and soft skills, and improving students' attitudes and interest toward STEM and STEM careers.

Partnerships with professional associations through the team members' professional conference presentations, and for some members, memberships in these associations, are continued and pursued. Additionally, the project maintains its connections with different NSF Advanced Technological Education (ATE) Centers such as the National Center for Manufacturing Education (NCME) and Materials Education (MatEdU); these centers are committed in providing up-to-date information on manufacturing processes and information on various materials needed to make a guitar (e.g., metal, wood, polymers, etc.) and the properties of each of those materials.

## Continuing Business and Industry Partner Development

As part of its sustainability efforts, the project is able to explore and develop continuing business and industry partnerships. with existing business/industry connections, together with its Advisory Board, as well as the larger community. Relationships with the academic, professional associations, business/industry, and the larger community promote project buy-in, acceptance, relevance, crowd-sourced funding, and more visibility for project promotions and funding support.

A list of some of the project's corporate partners include All Parts, Black Diamond Strings, D'Addario, Fender, Forest Scientific Corporation, FML (Frank Miller Lumber), Indasa, ShopBot, Stewart MacDonald, Martin & Company, and Taylor Guitar Company - partners that continue to support the STEM Guitar Project in various ways. They provide various supports for participants in terms of personnel expertise and in-kind support. In some cases, like for some regional participants, financial support through crowd-sourced funding is extended. Boeing Company remains to be a major partner, especially for the Washington state participants. Boeing provided input regarding employability hard and soft skills that are important to consider in developing the guitar building curriculum. Continued

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*                    2018-2019 STEM Guitar Eval Report    37

project efforts in exploring project connections with employability technical and soft skills were spearheaded by this initial partnership with Boeing and the support of the NSF funded MatEdU Center in Edmonds Community College located in Washington State. Taylor Guitar Company in San Diego, California, continues to provide a key role in supporting the current grant's new acoustic guitar building track by way of technical support and potentially supplying the educational guitar kit materials for the project's acoustic guitar build.

## Building Partnerships with the Larger Community

Continuous communication and sharing of information with partners are key in developing new and maintaining existing project partners. Expert guitar builders and music celebrities, who have been oriented to the project, remain the best project supporters in the community. Apart from the authentic merit of the project, these celebrities attract more attention, publicity, and media exposure to the project.

The popularity and viability of the STEM Guitar Project enables it to continue its outreach program and other program activities without the use of the NSF grant fund. Among these activities are:

- The international STEM Guitar outreach at the University of Medellin in Colombia, through the initiatives of one of the original project Trainers, in collaboration with and support from his University (Purdue University) - This is the second year that this activity is extended in Colombia where students build guitars and learn the engineering behind them.

- The project implementation of its third STEM Guitar Building Institute (GBI) outreach with wounded veterans (Heroes Build) through the Phoenix Patriot Foundation in Edmonds Community College in Washington state - This Heroes Build provided opportunities for the STEM Guitar Project to validate its program with another group of participants. The veterans that participated in this program learned technician hard and soft skills through the construction of an electric guitar. This activity also provided a way for the veterans to build their self-confidence and help them deal with their post-traumatic stress. There were 15 participants in this third GBI outreach; The 15 participants represented mixed demographics related to branch of service, ethnicity, gender, age groups, and level of education: six of 15 (40%) are Navy veterans; eight of 15 (53%) are white; 14 out of 15 (93%) are male; nine of 15 (60%) are older than 45 years old; and seven out of 15 (47%) have college or higher educational attainments. Data from trainers' observations and interviews, interviews with participants and the program evaluation survey, as well as the media coverage of this Heroes Build indicated that the veteran participants learned STEM-related concepts, including hard and soft skills. All the participants expressed appreciation of the program and reported the program effect on the improvement of their self-confidence.

- The continuing operation of the STEM guitar Manufacturing/Production Team at

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    38

Sinclair College – As reported in the "Guitar Kit" section of this report, this manufacturing operation produced over 9,000 guitars and registered almost a million sales. It is important to reiterate the self-sufficiency of this endeavor without needing any NSF funds.

## Exploring Future Grant Opportunities and Other Funding Support

The Project Team continues to generate ideas for new programs and/or STEM Guitar-related program expansion (new ideas for related guitar-building/music project-idea as an expansion of the current guitar-building based-learning such as building music drums, etc.) exploring potential grant opportunities that may fund these endeavors. The Project Team also continues to explore possible partnership with a group that is willing to help the team in organizing a possible foundation. This foundation is meant to help with the promotion and funding solicitation for the project.

# Lessons Learned

Lessons learned from the formative and summative components of this report are included in this section. Using Guskey's levels of evaluating professional development is helpful in facilitating structures and practices moving toward project outcomes.

## Areas of Growth for the Formative Aspects

The major components of the of the formative process include the Project Team process, the program implementation process, and the program output.

### Lessons learned from the Team Process

- The Project Team members' expertise, varied experience, and geographic locations made possible reaching out to all program participants and project implementation even beyond the Institute training.
- Regular meetings, as part of the project established processes, have been helpful in team communications and completion of project tasks.
- Project proactive leadership facilitates project tasks to completion and allows for team members' professional development.
- Developmental, collaborative, and participatory work processes, with continuous development of capacity building and evaluative thinking are essential to team buy-in and team's professional development leading to program improvements.
- Firming up processes, structures, and documentations of the different aspects of the project are important for project replicability and scalability.
- While the online connections and communications of the Project Team are an advantage, response turn around for team responses/feedback on issues raised during

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    39

the Project Team conference calls can be improved.
- Early program marketing efforts are necessary in critical aspects of the project.
- Comfortable lead time and determining the "critical path" for different project components is necessary for planning any project's envisioned program of activities

## *Lessons learned from the Implementation Process*

- Targeted underrepresented participants may likely have limited geographical access; thus, careful site host selection that has potential reach to underrepresented populations is very important;
- There the need for a more extensive recruitment and targeted marketing process to ensure the selection of diverse participants.
- Collaborative work and getting the perspectives of different team members are always advantageous in any aspect of the project work.
- There is a need to acknowledge and reflect on the elements of implementation within program tracks modelling this for Institute participants, especially in varying scenarios, context, and ways of implementation.

## *Program output*

- The established infrastructure and processes developed for guitar kit production and development, especially without needing extra funding from the grant, are critical to the STEM Guitar program implementation.
- It is necessary to follow-up on the guitar kit orders to understand the decreasing trend or plateau in sales.
- There is a need for adequate lead time to finish program materials (e.g. vetted MLAs video recordings) to be ready for the Summer Institutes.
- Preparatory webinar continues to prove useful in maximizing time for the week-long Summer Institutes.
- It is important to have continuous review of Institute processes and documentations of project-oriented concepts and "musts" to develop more meaningful learning materials for GBI participants.
- Project Team involvement in finalizing program evaluation for continuous learning and improvement is important.
- It is exciting to have more participants but this stretches the capacity and availability of the Project Team and Institute trainers.

## Lessons Learned from the Summative Results

The major areas of the summative/outcomes portion of this report include the outcomes related to faculty program effects, program effects on students, the STEM Guitar Applied Learning Community, the STEM Guitar project extent and overall sustainability endeavors.

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    40

## *Faculty Program Effects*

- Concerted and targeted marketing efforts would help ensure recruitment and involvement of diverse faculty program participants.

- The STEM Guitar Project has a lot of potential variances in implementation (e.g. styles and methods, school resources, support, and facilities) that have to be taken into account to help GBI trainees with successful program implementation.

- The GBIs help faculty learn STEM Guitar related concepts, hard skills, and soft skills that that are practical and useful in their professional and personal lives.

- Going through the actual STEM Guitar project-based learning program helps build faculty confidence in teaching the concepts in their classrooms.

- The GBIs can affect faculty change of classroom practice as they integrate what was learned in the Summer Institutes.

- It is important to set structures and practices to guide participants in program implementation, in supporting them towards successful implementation, and in promoting change of practices in adopting the guitar building problem-based learning strategies.

- The GBI faculty need the Project Team's support in order to access meaningful STEM Guitar program teaching-learning materials that they can successfully integrate into their curriculum.

- Administrative support is needed by the STEM Guitar faculty trainees in order to make an institutional change and curricular integration of the STEM Guitar program into their institutions' curricula.

## *Program Effects on Students*

- Faculty who are experienced and trained in the STEM Guitar project-based learning are able to help students learn STEM Guitar related concepts, STEM-related hard and soft skills.

- Students' behaviors and attitudes toward STEM can be influenced by the STEM Guitar curriculum.

- The GBI faculty change of classroom practice motivate students in learning more about STEM.

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    41

- It takes a commitment of just one champion to spearhead an in-depth study to produce reliable and longitudinal project outcomes.

- Having comparison studies of STEM Guitar and non-STEM guitar class provide a stronger case for adopting the STEM Guitar program in teaching STEM-related concepts and helping students gain meaningful hard and soft skills.

## *Applied Learning Community*

- The STEM Guitar Project can sustain and develop a fruitful learning community through the STEM Guitar Project's emerging Applied Learning Community.

- The Guitar Summit is a successful way of facilitating faculty involvement in the STEM Guitar program.

- The Guitar Summit provides a systematic way of gathering STEM Guitar program implementation data affecting the faculty and students.

- Involving the Project Team in getting perspectives about the project ways of learning, interacting, and collaborating within and with the program participants drive the discussions closer to the direction and clarity of the project's emerging Applied Learning Community.

- The Project Team's continuous efforts in improving the Applied Learning Community through the use of "apps" that could facilitate better faculty and student interactions is very useful for sustaining the Applied Learning Community and provide structures and processes that could lend to this community's replicability.

## *Project Extent and Overall Sustainability*

- Plotting the STEM Guitar project extent and visualizing the project spread via the US Cents Regions and the map of implementing schools help in marketing the program and providing motivation to current and potential program supporters and enthusiast.

- Analyses of website usage and FB analytics along with the trends of Guitar kit sales help in making sense of the projects ebbs and flows that could help in further program planning and continuous improvements.

- Conference presentations, publications, and media exposure provide a wealth of program dissemination.

- Regional and local project media exposure can happen if strategically planned and local participants' involvement is encouraged and facilitated.

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    42

- Business/Industry, academic institutions, and community partnership development takes consistent concerted efforts in reaching out and sharing information with partners.

- Continuous efforts on supply chain development could be a major project challenge but has to be attended to ensure availability of materials for the three program track participants implementing the program.

- The popularity and viability of the STEM Guitar Project enables it to continue its outreach program and other program activities without the use of the NSF grant fund.

- Team effort toward sustainability (e.g. soliciting funding sources and support from foundations, grants, etc.) is a continuous project endeavor.

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    43

# Conclusions and Recommendations

## Conclusions

The 2018-2019 STEM Guitar program evaluation showed fruitful and positive formative and summative results. For both the formative and summative aspects of evaluation, the STEM Guitar Project indicated tested processes and outcomes supporting the success of the project, even at this stage of the grant, within the context of the program evaluation.

To start with, the worthy goal of the STEM Guitar project regarding increasing student interest, engagement, and learning of STEM principles, practices, and careers through guitar design and building was focused within the project background and context. The External Evaluator ensured that the evaluation approach, design, and methods are compatible with and useful to the Project Team's program theory and operational philosophy. Technological advancements, the diverse expertise and experience of the Project Team members, as well as the team's geographic distribution across the United States, provide added advantage in reaching out to current and potential program participants.

The project has been successful with its established structures and processes that promoted the project's favorable formative results. These are evidenced by the project's collaborative and participatory decision-making processes, the tools and guidelines used in Project Team involvement and decision-making process, and the practice of having regular team meetings and additional specialty development meetings as needed to beef up the Project Team's capabilities and improve their project experience.

The project's program implementation processes have been the product of continuous learning experience and concerted efforts of the Project Team in making them work. The project documentations bear witness to these as the effective on-boarding of team members is systematically done. Institute-related activities (e.g. teaching-learning materials development, site selection; recruitment-selection of participants, preparatory webinars, actual implementation of the Summer Institutes) are conducted well. Worthy program outputs (such as guitar kits, vetted STEM Guitar MLAs and videos, Institute agendas and evaluation instruments) are produced. Increased number of diverse faculty are trained.

The STEM Guitar Project has been moving toward favorable summative outcomes as the grant project years move on. There are evidences for successful effects on the faculty, the students, and the STEM Guitar Project as a whole.

The STEM Guitar GBI applications ensured the inclusion of questions that would yield information regarding the project's definition of "diverse population". There is a strong likelihood that the number of 2019 GBI trainees will be greater than the 87 trained in 2018.

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    44

There are more than 150 potential and qualified applicants for the 2019 Summer Institutes; thus, there is a strong likelihood more diverse faculty to be trained after the processing of the 2019 GBI applications in May 2019. Additionally, the Project Team checks the faculty diversity in terms of geographical location of applicants and those implementing the program, as well as ensures wider reach of the program. Plotting participants' location by the US census regions and by states has been helpful as the Project Team targets site locations to facilitate participation of faculty across the United States.

The faculty reported learning STEM Guitar related concepts, and hard skills/employability skills during the summer Institutes. The faculty also reported learning and honing their soft skills, the most notable of which is critical thinking and problem solving. They noted improved confidence in teaching and implementing the STEM Guitar program that motivated students and got them excited about learning; thus, effecting favorable student outcomes.

The 2018 Summit faculty, who implemented the STEM Guitar program, reported that their students learned STEM concepts, hard skills/employability skills, as well as soft skills. Like the faculty, the most notable soft skills students learned with the implementation of the STEM Guitar program is critical thinking and problem solving. The initial results of the case study showed that the STEM Guitar students had better sense of responsibility for their learning and were not easily discouraged by constructive criticisms as they work on their projects compared with the non-STEM Guitar students.

Even in its second year, the current project has the advantage of continuing and expanding upon the previous two STEM guitar building related grants, affecting the project's wider reach and sustainability. It is noteworthy that continuing effects of the previous grants filter through this current project. Some good examples of these the media exposure the project gets, the continuing involvement of the Project Team in project dissemination through conference presentations and publications, the guitar kit sales, and the development of partnership with the industry, academic institutions, and the larger community. Efforts in stabilizing the project's Applied Learning Community continue. Use of the project website and social media such as Facebook add to the project's wider reach. The Project Team is studying a more systemic use of social media through the use of a new "app" that will be made to the Project Team, faculty, and students via subscription. This will support the development of a more sustainable and replicable Applied Learning Community and allow for better data collection of the STEM Guitar program effects. Project efforts to explore other community funding support and new grant proposals remains.

## Recommendations

As the STEM Guitar Project has been very open to changes, emerging developments, and ideas, recommendations similar to last year's are offered since continuous program improvement is one of the trademarks of the STEM Guitar Project. The Project Team's continuous improvement/development efforts have been vital to the

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*
2018-2019 STEM Guitar Eval Report    45

growth of the project. Thus, some of the things that the project is already doing are recommended for continued vital actions:

- Project Team's involvement in developmental evaluation and capacity building to further hone its evaluative thinking skills needed in critical program implementation;
- Project's collaborative and participatory decision-making process for greater Project Team buy-in;
- Development and improvement of the project's processes, structures, and documentations of the different aspects of the project for replicability and scalability;
- Regular team meetings and offering of specialty development meetings as the project need arises;
- Development and strengthening of the project outputs
- Development of new and maintenance of existing project partnerships;
- Efforts to disseminate project information via conference presentations/publications, and media exposure
- Study and potential use of a new "app" to improve the project's Applied Learning Community and process of data collection;

Explicit actions are recommended for areas of growth where the project is "emerging":

- Develop a management tool that can be used to improve lead time for response and feedback needed for action items raised during project team meetings;
- Be more proactive in marketing efforts for any project venture;
- Ensure that all teaching-learning materials needed for the program tracks are ready by no less than the schedule of the first Summer Institute; upload on the project website all MLAs and videos immediately after the vetting process;
- Follow-up with previous GBI faculty participants and guitar kit customer list to be more sensitive to the timing and needs of faculty and their institutions, and plan accordingly noting the ebbs and flows of the guitar kit orders;
- Model any data collection strategy expected of faculty participants during the Summer Institutes;
- Continue stabilizing the structures for program and administrative support for faculty implementation in their classroom; and
- Continue case study research and efforts to ensure robust data collection for the prospective and retrospective cohort along with their comparison groups.

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    46

# Appendixes

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    47

# Appendix 1. STEM Guitar Project Soft Skills (Attitudes)

## Communication and Collaboration (C & C)
- Work in teams
- Help others with a problem
- Working collaboratively in a group

## Creativity and Innovation (C & I)
- Emotional connection to wood patterns and colors
- CNC - positive feelings of seeing something made from design
- Craftsmanship
- Openness to learning/intellectual curiosity/appreciation for the sense of discovery

## Critical Thinking & Problem Solving (Ct & Ps)
- EGB / AGB - guitar setup, engineering; neck, bridge, neck relief, bridge choice, installations, & critical thinking skills
- Brainstorming a fix to a mistake or problem (teamwork, confidence, perseverance) **– also in G, I, & Sd**
- Develop scientific, logical world view
- Brainstorming to fix a mistake
- Methodical
- Openness to learning/intellectual curiosity/appreciation for the sense of discovery **- also in S & Cc**
- Problem solving

## Flexibility and Adaptability (F & A)
- First algebra success or relevance for many students (fret equation)
- Pretty cool how we were able to figure out fret spacing with math. Didn't know you could do that.
- Digital-age/information literacy
- Multi-tasking

## Productivity & Accountability (P & A)
- Quality mindset
- Finishing a project to completion
- Attendance frequently increases
- EGB- 100% of students who start build, finish build
- Responsibility/sense of Accountability

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    48

## Grit, Initiative, and Self direction (G, I, & Sd)

- Grit
- Persistence
- Perseverance
- Confidence; self-confidence
- Initiative/self-directive/asking for help when needed
- Attentiveness
- Assuming attention to detail
- EGB- 100% of students who start build, finish build

## Leadership & Responsibility (L & R)

- Pride
- Respect for tools, careful use, storage, organization
- Ethical reasoning

## Social Cross-cultural Skills (S & Cc)

- Openness to learning/intellectual curiosity/appreciation for the sense of discovery
- Inter-cultural skills

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    49

# Appendix 2. STEM Guitar Website Users by States

| Region | Users | R1=9 | R2=12 | R3=17 | R4=13 |
|---|---|---|---|---|---|
| (not set) | 283 | | | | |
| Alabama | 147 | | | 147 | |
| Alaska | 50 | | | | 50 |
| Arizona | 366 | | | | 366 |
| Arkansas | 117 | | | 117 | |
| California | 2417 | | | | 2417 |
| Colorado | 267 | | | | 267 |
| Connecticut | 396 | 396 | | | |
| Delaware | 154 | | | 154 | |
| District of Columbia | 168 | | | 168 | |
| Florida | 653 | | | 653 | |
| Georgia | 407 | | | 407 | |
| Hawaii | 35 | | | | 35 |
| Idaho | 213 | | | | 213 |
| Illinois | 1022 | | 1022 | | |
| Indiana | 549 | | 549 | | |
| Iowa | 89 | | 89 | | |
| Kansas | 235 | | 235 | | |
| Kentucky | 313 | | | 313 | |
| Louisiana | 105 | | | 105 | |
| Maine | 312 | 312 | | | |
| Maryland | 235 | | | 235 | |
| Massachusetts | 756 | 756 | | | |
| Michigan | 510 | | 510 | | |
| Minnesota | 348 | | 348 | | |
| Mississippi | 74 | | | 74 | |
| Missouri | 215 | | 215 | | |
| Montana | 152 | | | | 152 |
| Nebraska | 101 | | 101 | | |
| Nevada | 230 | | | | 230 |
| New Hampshire | 127 | 127 | | | |
| New Jersey | 469 | 469 | | | |
| New Mexico | 107 | | | | 107 |
| New York | 731 | 731 | | | |
| North Carolina | 630 | | | 630 | |
| North Dakota | 28 | | 28 | | |
| Ohio | 1569 | | 1569 | | |
| Oklahoma | 318 | | | 318 | |

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    50

| | | | | | |
|---|---|---|---|---|---|
| Oregon | 1027 | | | | 1027 |
| Pennsylvania | 1377 | 1377 | | | |
| Rhode Island | 48 | 48 | | | |
| South Carolina | 145 | | | 145 | |
| South Dakota | 39 | | 39 | | |
| Tennessee | 385 | | | 385 | |
| Texas | 954 | | | 954 | |
| Utah | 249 | | | | 249 |
| Vermont | 28 | 28 | | | |
| Virginia | 1022 | | | 1022 | |
| Washington | 1372 | | | | 1372 |
| West Virginia | 73 | | | 73 | |
| Wisconsin | 466 | | 466 | | |
| Wyoming | 60 | | | | 60 |
| **Total** | **21860** | **4244** | **5171** | **5900** | **6545** |
| **average** | **429** | **472** | **431** | **347** | **503** |

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    51

# Appendix 3. STEM Guitar Website New Users by States

| Region | New Users | R1=9 | R2=12 | R3=17 | R4=13 |
|---|---|---|---|---|---|
| (not set) | 278 | | | | |
| Alabama | 124 | | | 124 | |
| Alaska | 50 | | | | 50 |
| Arizona | 365 | | | | 365 |
| Arkansas | 118 | | | 118 | |
| California | 2380 | | | | 2380 |
| Colorado | 260 | | | | 260 |
| Connecticut | 387 | 387 | | | |
| Delaware | 144 | | | 144 | |
| District of Columbia | 137 | | | 137 | |
| Florida | 642 | | | 642 | |
| Georgia | 383 | | | 383 | |
| Hawaii | 35 | | | | 35 |
| Idaho | 210 | | | | 210 |
| Illinois | 1000 | | 1000 | | |
| Indiana | 538 | | 538 | | |
| Iowa | 88 | | 88 | | |
| Kansas | 233 | | 233 | | |
| Kentucky | 299 | | | 299 | |
| Louisiana | 103 | | | 103 | |
| Maine | 307 | 307 | | | |
| Maryland | 226 | | | 226 | |
| Massachusetts | 740 | 740 | | | |
| Michigan | 495 | | 495 | | |
| Minnesota | 335 | | 335 | | |
| Mississippi | 70 | | | 70 | |
| Missouri | 201 | | 201 | | |
| Montana | 149 | | | | 149 |
| Nebraska | 100 | | 100 | | |
| Nevada | 222 | | | | 222 |
| New Hampshire | 124 | 124 | | | |
| New Jersey | 453 | 453 | | | |
| New Mexico | 105 | | | | 105 |
| New York | 717 | 717 | | | |
| North Carolina | 614 | | | 614 | |
| North Dakota | 28 | | 28 | | |
| Ohio | 1539 | | 1539 | | |

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    52

| State | | | | | |
|---|---|---|---|---|---|
| Oklahoma | 310 | | | 310 | |
| Oregon | 1018 | | | | 1018 |
| Pennsylvania | 1360 | 1360 | | | |
| Rhode Island | 45 | 45 | | | |
| South Carolina | 146 | | | 146 | |
| South Dakota | 38 | | 38 | | |
| Tennessee | 379 | | | 379 | |
| Texas | 934 | | | 934 | |
| Utah | 241 | | | | 241 |
| Vermont | 28 | 28 | | | |
| Virginia | 1002 | | | 1002 | |
| Washington | 1364 | | | | 1364 |
| West Virginia | 73 | | | 73 | |
| Wisconsin | 456 | | 456 | | |
| Wyoming | 58 | | | | 58 |
| **Total** | **21373** | **4161** | **5051** | **5704** | **6457** |
| **average** | **419** | **462** | **421** | **336** | **497** |

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    53

## Appendix 4. STEM Guitar Website Sessions by States

| Region | Sessions | R1=9 | R2=12 | R3=17 | R4=13 |
|---|---|---|---|---|---|
| (not set) | 284 | | | | |
| Alabama | 244 | | | 244 | |
| Alaska | 120 | | | | 120 |
| Arizona | 518 | | | | 518 |
| Arkansas | 158 | | | 158 | |
| California | 3705 | | | | 3705 |
| Colorado | 386 | | | | 386 |
| Connecticut | 854 | 854 | | | |
| Delaware | 421 | | | 421 | |
| District of Columbia | 227 | | | 227 | |
| Florida | 941 | | | 941 | |
| Georgia | 561 | | | 561 | |
| Hawaii | 37 | | | | 37 |
| Idaho | 360 | | | | 360 |
| Illinois | 1509 | | 1509 | | |
| Indiana | 997 | | 997 | | |
| Iowa | 97 | | 97 | | |
| Kansas | 334 | | 334 | | |
| Kentucky | 597 | | | 597 | |
| Louisiana | 143 | | | 143 | |
| Maine | 757 | 757 | | | |
| Maryland | 309 | | | 309 | |
| Massachusetts | 960 | 960 | | | |
| Michigan | 637 | | 637 | | |
| Minnesota | 544 | | 544 | | |
| Mississippi | 107 | | | 107 | |
| Missouri | 278 | | 278 | | |
| Montana | 275 | | | | 275 |
| Nebraska | 161 | | 161 | | |
| Nevada | 511 | | | | 511 |
| New Hampshire | 256 | 256 | | | |
| New Jersey | 537 | 537 | | | |
| New Mexico | 151 | | | | 151 |
| New York | 940 | 940 | | | |
| North Carolina | 1056 | | | 1056 | |
| North Dakota | 41 | | 41 | | |
| Ohio | 3348 | | 3348 | | |
| Oklahoma | 479 | | | 479 | |
| Oregon | 2079 | | | | 2079 |

**REaCHaLL, LLC**
*Relevant Evaluation and Consultancy Hub about Lifelong Learning*
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    54

| State | Total | | | | |
|---|---|---|---|---|---|
| Pennsylvania | 2574 | 2574 | | | |
| Rhode Island | 60 | 60 | | | |
| South Carolina | 228 | | | 228 | |
| South Dakota | 49 | | 49 | | |
| Tennessee | 503 | | | 503 | |
| Texas | 1235 | | | 1235 | |
| Utah | 400 | | | | 400 |
| Vermont | 67 | 67 | | | |
| Virginia | 1307 | | | 1307 | |
| Washington | 2820 | | | | 2820 |
| West Virginia | 116 | | | 116 | |
| Wisconsin | 819 | | 819 | | |
| Wyoming | 68 | | | | 68 |
| **Total** | **36165** | **7005** | **8814** | **8632** | **11430** |
| **average** | **709** | **778** | **735** | **508** | **879** |

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    55

# Appendix 5. Facebook Definition of Data Variables

**<u>Reach</u>**

- Total Reach 28 Days: The number of people who had any content from your Page or about your Page enter their screen. This includes posts, check-ins, ads, social information from people who interact with your Page and more. (Unique Users).

- Total Organic Reach 28 Days: The number of people who had any content from your Page or about your Page enter their screen through unpaid distribution. This includes posts, check-ins, social information from people who interact with your Page and more. (Unique Users).

- Total Viral Reach 28 Days: The number of people who had any content from your Page or about your Page enter their screen through with social information attached. As a form of organic distribution, social information displays when a person's friend interacted with you Page or post. This includes when someone's friend likes or follows your Page, engages with a post, shares a photo of your Page and checks into your Page. (Unique Users).

- Total Reach of Page Posts - 28 Days: The number of people who had any of your Page's posts enter their screen. Posts include statuses, photos, links, videos and more. (Unique Users).

- Total Organic Reach of Page Posts - 28 Days: The number of people who had any of your Page's posts enter their screen through unpaid distribution. (Unique Users).

- Total Viral Reach of Page Posts - 28 Days: The number of people who had any of your Page's posts enter their screen with social information attached. As a form of organic distribution, social information displays when a person's friend interacted with you Page or post. This includes when someone's friend likes or follows your Page, engages with a post, shares a photo of your Page and checks into your Page. (Unique Users)

**<u>Impressions</u>**

- Total impressions - 28 Days: The number of times any content from your Page or about your Page entered a person's screen. This includes posts, check-ins, ads, social information from people who interact with your Page and more. (Total Count).

- Total organic impression - 28 Days: The number of times any content from your Page or about your Page entered a person's screen through unpaid distribution. This includes posts, check-ins, social information from people who interact with your Page and more. (Total Count).

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    56

- Total Viral Impressions- 28 Days: The number of times any content from your Page or about your Page entered a person's screen with social information attached. Social information displays when a person's friend interacted with you Page or post. This includes when someone's friend likes or follows your Page, engages with a post, shares a photo of your Page and checks into your Page. (Total Count).

- Total Impressions of the Page Post - 28 Days: The number of times your Page's posts entered a person's screen. Posts include statuses, photos, links, videos and more. (Total Count).

- Total organic impressions of your Page post - 28 Days: The number of times your Page's posts entered a person's screen through unpaid distribution. (Total Count).

- Total Viral Impressions of your page posts - 28 Days: The number of times your Page's posts entered a person's screen with social information attached. Social information displays when a person's friend interacted with you Page or post. This includes when someone's friend likes or follows your Page, engages with a post, shares a photo of your Page and checks into your Page. (Total Count).

- Total Engagement 28 Days: 28 Days: The number of people who engaged with your Page. Engagement includes any click or story created. (Unique Users).

- Total Consumers 28 Days: The number of people who clicked on any of your content. Stories that are created without clicking on Page content (ex, liking the Page from timeline) are not included. (Unique Users).

- 28 Days Page Consumptions: 28 Days: The number of clicks on any of your content. Stories generated without clicks on page content (e.g., liking the page in Timeline) are not included. (Total Count).

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    57

# References

Archibald, T., Sharrock, G., Buckley, J., & Young, S. (2018). Every practitioner a "knowledge worker": Promoting evaluative thinking to enhance learning and adaptive management in international development. In A.T. Vo & T. Archibald (Eds.) *Evaluative Thinking. New Directions for Evaluation*, 158, 73-92.

Carden, F & Earl, S. (2007). Infusing evaluative thinking as a process use: The case of the International Development Research Centre (IDRC). In J.B. Cousins (Ed.) *Process use in theory, research, and practice. New Directions for Evaluation*, 116, 61-74.

Creswell, J.W. & Plano Clark, V.L. (2011). *Designing and conducting mixed methods research* (2nd ed.). Thousand Oaks, CA: Sage.

Deterding, N. M. and Solmeyer, A. R, (2018). Building evidence in challenging contexts: Introduction to the special section. *American Journal of Evaluation. 39 (1), 24-41.*

Dusenbury L, Brannigan R, Falco M, Hansen W. (2003). A review of research on fidelity of implementation: Implications for drug abuse prevention in school settings. Health Educ Res. 2003; 18:237–256. doi: 10.1093/her/18.2.237.

Grob, G. F. (2018). Evaluation practice: Proof, truth, client relationships, and professional growth. *American Journal of Evaluation. 39 (1), 123-132.*

Guskey, T. R. (2002). Does it make a difference? Evaluating professional development. *Educational Leadership*. 59 (6), pp. 45–51.

Guskey, T. R. (2000). *Evaluating professional development.* Thousand Oaks, CA: Corwin Press.

King, J. A. (2007). Developing evaluation capacity through process use. In J.B. Cousins (Ed.) *Process use in theory, research, and practice. New Directions for Evaluation,*

Lamorte, W.W. (2017). Prospective and retrospective cohort studies. Boston: Boston University School of Public Health. Retrieved from http://sphweb.bumc.bu.edu/otlt/MPH-Modules/EP/EP713_AnalyticOverview/EP713_AnalyticOverview3.html April 20, 2018.

Ledford, J. R., (2018). No randomization? No problem: Experimental control and random assignment in single case research. *American Journal of Evaluation. 39 (1), 71-90.*

MatEdU, Edmonds Community College (2016). *Core competencies pocket reference*. Washington D.C.:National Science Foundation.

Mihalic S. (2004). The importance of implementation fidelity. *Emotional & Behavioral Disorders in Youth*. 4:83–86. and 99–105.

National Research Council. 2015. *Identifying and Supporting Productive STEM Programs in Out-of-School Settings*. Washington, DC: The National Academies Press.

REaCHaLL, LLC
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    58

https://doi.org/10.17226/21740.

National Research Council. 2010. *Surrounded by Science: Learning Science in Informal Environments*. Washington, DC: The National Academies Press. https://doi.org/10.17226/12614.

P21 Partnership from 21st Century Learning. Framework for 21st Century Learning. (2015 May). Washington DC. Retrieved from: http://www.p21.org/about-us/p21-framework. February 28, 2018.

Patton, M. Q. (2015) Qualitative research & evaluation methods. (4th ed.). Thousand Oaks, CA: Sage.

Patton, M. Q. (2011). *Developmental evaluation*. NY: Guilford Press.

Patton (2008). Utilization-focused evaluation (4th ed.). Thousand Oaks, CA: Sage.

Preskill, H. & Russ-Eft, D. (2016). *Building evaluation capacity*. Thousand Oaks, CA: Sage.

Queen, K.H. (2018. Narrowing the Skills Gap. Smart Manufacturing Magazine. Retrieve from http://www.sme.org. April 10, 2018.

Schwandt, T. A. (2018). Evaluative thinking as a collaborative social practice: The case of boundary judgment making. In A.T. Vo & T. Archibald (Eds.) *Evaluative Thinking. New Directions for Evaluation*, 158, 125-138.

Shadish, W. R., Cook, T. D., and Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference*. New York: Houghton Mifflin Co.

Stabback, P. (2016). What makes a quality curriculum? In Progress Reflection No. 2. Current and Critical Issues in Curriculum and Learning. Geneva, Switzerland: IBE/2016/WP/CD/02. Retrieved from: http://unesdoc.unesco.org/images/0024/002439/243975e.pdf. April 10, 2018.

Sunny, C. E. (2018). *Stakeholders' conceptualization of students' attitudes and persistence towards STEM: A mixed methods instrument development and validation study.* (Electronic Thesis or Dissertation). Retrieved from https://etd.ohiolink.edu/

York, A. (2018). Analytics engagement, *Sprout Social (Blog)* in https://sproutsocial.com/insights/reach-vs-impressions/, retrieved 4/19/2019.

**REaCHaLL, LLC**
Relevant Evaluation and Consultancy Hub about Lifelong Learning
*Effecting transformational development*

2018-2019 STEM Guitar Eval Report    59