The Journal of Extension

Volume 61 | Number 1 Article 13

5-4-2023

The Condensed STEM Survey as a Tool for Extension Educators

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Abstract. One Extension Specialist implemented a STEM pilot robotics program across three middle school settings. A program evaluation to provide guidance and recommendations for future development, implementation, and continued evaluation was conducted as part of a larger study. This process led to the development of a condensed STEM survey that can be used by Extension professionals on STEM dispositions among middle school youth.

INTRODUCTION

The fields of science, technology, engineering, and mathematics (STEM) influence social progress and economic growth, as well as improve individual lives (Sanchez & Usinger, 2019; Wiest et al., 2021). Ongoing calls to build a STEM workforce have largely persisted and implementation of STEM within schools across the United States has become a priority (Dillivan & Dillivan, 2014; Soergel, 2017). One state's federal grant, the Gaining Early Awareness and Readiness for Undergraduate Programs (GEAR UP), implemented STEM learning, and our team recognized the need to include an Extension partner. The partnership was particularly important as Extension programs are designed to support national efforts at local levels (Barron & Bell, 2015; Schmitt-McQuitty, 2014). As such, an Extension Specialist led a STEM pilot robotics program, and we designed an adapted version of an existing survey to measure students' beliefs and attitudes in STEM as a tool of the trade to more easily be used by Extension professionals to save time, money, and energy while getting optimal programming results.

EXTENSION'S STEM TOOL

The Extension STEM tool supported the state's evaluation needs for the pilot robotics program, all of which aligned with maintaining evaluation as an essential component of Extension programming (Wise, 2017). We designed an adapted version of the Students' Motivation Towards Science Learning (SMTSL) survey by Tuan et al. (2005) to examine students' beliefs and attitudes about STEM fields. The SMTSL contains 26 questions with a 5-point Likert-type scale (1= *Strongly Disagree* to 5 = *Strongly Agree*), which was used alongside semi-structured interviews with select students and all program leaders at each site for the pilot robotics program (see Sanchez & Usinger, 2019).

Although the SMTSL survey was initially used, there were quite a few issues with the use of the instrument. For example, with Extension supporting numerous rural school sites, there were concerns over Internet bandwith to provide online survey access, so the instrument needed to be adminstered via paper and pencil. It also required an additional demographics section (i.e., school ID, participant age, gender, race/ethnicity, and program site) to be added. During initial pilot efforts, the paper and pencil option was manageable with under 50 students, but with expansion to groups over 100 students, this became much more difficult to manage. Additionally, the student response time was much longer than anticipated, especially with varied student literacy levels. This was especially concerning in settings where pre-post testing was aimed during in-class time, with instructional time being supplanted by survey completion. One solution was having graduate students read the questions to maintain pacing among student participants, but it still created extensive time demands with subsequent manual entry and matching of pre-post responses among students. Additionally, Tuan's (2005) survey targets college students, which was reflected in the vocabulary, so the adapated survey includes wording changes to better meet middle school reading and comprehension levels. Needless to say, the pilot study project was instrumental in experiencing these challenges to identify some solutions for improved implementation efforts.

ADAPTED SURVEY AND ITS USE

After implementation of the adapted survey, we conducted a factor analysis to determine whether the modifications to the SMTSL changed the underlying structure through a principal component analysis (PCA). The PCA was used to identify seven components that had eigenvalues greater than one, which explained 29.88%, 9.45%, 7.92%, 6.56%, 5.34%, 4.76%, and 4.05% of the total variance, respectively. There were 115 (35%) non-redundant residuals with absolute values greater than .05, and the majority of values were less than .05 (65%), indicating a good model (Field, 2009). Cronbach's alpha indicated a high level of internal reliability (Cronbach, 1951). In brief, Table 1 shows, the results of the factor analysis after reviewing factor loadings and internal reliability.

Given the focus of the measures in the adapted survey, Extension specialists may readily use this in other STEM-related programs. This tool can be used not only to measure baseline perspectives regarding STEM, but also to capture student change in dispositions after engaging in Extension programming and interventions. For example, the survey may be used for the 4-H STEM Challenge, 4-H Science, and numerous Extension youth development programs.

THE CONDENSED STEM SURVEY

The factor analysis revealed important areas from the adapted survey, while the implementation process demonstrated that our youth struggled to complete the lengthy 26-question survey. Coupling the results of the analysis and participants' apparent survey fatigue, the Extension Specialist created a condensed STEM survey and retained measures and its internal reliability (**α** =.89) in subsequent years of implementation, as follows:

1. I am planning on attending a college/university or tech school in the future.
2. I am planning on taking STEM courses as part of my college/university/tech program.
3. I am planning on majoring in a STEM field at a college/university/tech school.
4. I believe attaining a STEM degree is worth the effort.
5. I think that learning STEM is important.
6. I take STEM classes to get a higher paying job in the future.
7. I take STEM classes to get an important job.
8. I am comfortable working with people who are different from me.
9. I take STEM classes to get a good job.
10. I am comfortable working on a team.

With the survey having a 5-point Likert-type scale (1= *Strongly Disagree*, 2 = *Disagree*, 3 = *No Opinion*, 4 = *Agree*, and 5 = *Strongly Agree*) for each statement, it can be used for either overall feedback at the completion of an activity or baseline and follow-up feedback endeavors (e.g., pre-post-post analyses). Analyses with the data can occur in many ways, such as by creating overall scores among scales or treating the data as continuous and then conducting demographic group comparisons (e.g., *t*-tests as a parametric analysis for groups differences by overall scores). The responses may also be treated as interval data to explore specific changes in improvements per survey statement over an extended period of time (e.g., Sign test as a non-parametric analysis to identify specific shifts in option responses). Similar to our previous efforts, the survey data may also be accompanied by qualitative findings to triangulate participant and program information regarding STEM. Finally, general descriptive statistics and outcomes that provide overall response data can be reported with ease (e.g., overall percentages, frequencies, and item ratings).

Table 1. Factor Analysis Related Questions and Measures

Factor	Survey Items	α	Measure
1	Q15–18, Q24	.88	Achievement Goals in STEM
2	Q2–4, Q6	.79	Postsecondary Goals
3	Q7–8, Q10, Q23	.78	Importance of STEM
4	Q5, Q11, Q13–14	.64	Why STEM
5	Q21–22, Q25–26	.53	Support toward STEM
6	Q1, Q12, Q20	.55	Resilience
7	Q9, Q19	.59	(Lack of) Motivation

DISCUSSION AND CONCLUSION

Extension professionals have noted that, when there is alignment across evaluation efforts, a systemic process can support long-term methods of measurement and ongoing national impacts (Wise, 2017). The use of this survey emphasizes the importance of not recreating the wheel, but improving existing efforts. For example, this tool can augment 4-H Commons Measures for complementary feedback toward program improvement and student outcomes. Additionally, reporting data in a more simplistic manner is typically and largely appealing to sponsors and the public, which is of great value for Extension professionals. After our many adaptations and revisions on this survey for the STEM pilot robotics program, I hope that those in Extension will consider using the *condensed* STEM survey for related evaluations (e.g., Hill & Sanchez, 2021). This simple tool could, in turn, save time and resources in order maintain a focus on successful STEM programming for our youth.

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