An influence among influences: The perceived influence contribution scale development and use

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A B S T R A C T

Many youth programs seek [DW1] to understand their influence over time on participant outcomes. This paper offers a methodology for measuring a participant's perception of a program's contribution amid their perception of other youth influences such as those from family, school, peer groups, hobbies, and other organized activities. The instrument built on the large body of work on youth influences in order to capture the dominant factors in development of the item bank. In addition to item development, the paper documents face validity followed by content assessment of items using a research panel, a principal component analysis using a second panel, and a full pilot with older teens in other summer intensive programs. The scale's implementation for baseline and annual follow-up measures of an intensive summer research experience revealed stable and high relative contribution to older teen participants' academic and career decision making over time. The final scale includes 19 items in 6 factors of family & religion; interests organized by others; adult responsibilities; school; arts; and interests organized by self. The scale proved to be responsive to changes in influences while remaining stable over time

1. Introduction

For decades, high school-age youth have participated in intensive developmental experiences provided by camps, educational institutions, non-profits, and youth development organizations. As compared to one-time or occasional visits to an informal learning environment these more intensive experiences involve repeated contact over an extended period of time. Programs that provide these experiences tend to operate on assumptions and short-term evidence that participation will lead to positive youth development (Catalano, Berglund, Ryan, Lonczak & Hawkins, 2004) and longer-term academic and career path success (Dorsen, Carlson, & Goodyear, 2006; Kong, Dabney, & Tai, 2014). Connecting short-term outcomes to these longer-term impacts requires a process of contextualizing program influence amid many other factors that influence a young person's academic and career choices. This paper offers a methodology for measuring a participant's perception of a program's contribution amid other youth influences such as those from family, school, peer groups, hobbies, and other organized activities.

For older teens, the target for this paper which included youth16–18 at the time of engaging in the program and 16–22 at times of measurement, these intensive programs generally held during the summer

include bridge programs that focus on transitioning youth from high school to college. The programs can be remedial, and sometimes residential (see, for example, Kallison & Stader, 2012; Sablan, 2014; Strayhorn, 2010; Wathington, Barnett, Weissman, Teres, Pretlow & Nakanishi, 2011). These intensive summer programs also can be enrichment-focused, offering research opportunities in such areas as engineering (Zhe, Doverspike, Zhao, Lam & Menzemer, 2010), medicine and health (Labadie, Patel, Labadie, Hwang, Okhunov & Landman, 2017;), computing (Layer, Sherriff & Tychonievich, 2012), paleobiology (Heim, Saltzman & Payne, 2014) and general STEM. These programs' evaluation findings generally reveal increased interest in the science field, understanding of career goals, and confidence in ability to succeed in a career in the field. These undergraduate research intensives or summer research programs are often designed to support and integrate minority students into specific majors into specific majors (e.g. Howitt, Wilson, Wilson & Roberts, 2010; Kain, Hepworth, Bogossian & McTaggart, 2013; Klawe, 2013; Lopatto, 2004, 2007). Across the literature describing effects of intensive summer programs for older teens, except in a few studies that tracked enrollment into college and selected major (e.g. Cabrera, Miner & Milem, 2013; Sablan, 2014; Zhou, Islam, Cheng-Chang & Kumar, 2014), we found little evidence of

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contextualizing a specific program's effect on intended outcomes among other contributing or competing influences.

Understanding the degree of influence one of these intensive programs has on a youth's academic and career intentions has long been a desire for program developers and funders. A central issue in program evaluation (Patton, 2012) and by extension, in research on program design and implementation, has been to establish direct relations between a program and its outcomes. Most typically, ascribing attribution has depended on finding meaningful difference in the comparison between a group receiving an intervention and a control or counter-factual group not receiving the intervention. However, in many real-world contexts, this type of direct causality is non-existent or at least difficult to determine. Instead of direct effect, these programs work in concert with all kinds of life circumstances to contribute to a desired outcome rather than cause it (White, 2010). In these cases, alternatives to traditional counterfactual approaches need to be used (Befani & Mayne, 2014). Contribution analysis, one such alternative to attribution analysis, views programs as a part of causal 'packages' that assume the program of interest is working with other interventions and influences to lead to the changes in specific outcomes desired in the participants (Moreau & Eady, 2015; Van Melle, Gruppen, Homboe, Flynn, Oandasan, et al., 2017).

Studies have shown that youth development outcomes result from these packages or multiple factors. For example, influences on Science, Technology, Engineering, and Math (STEM)-related academic and career direction have been shown to include contributions from educators, family members, and peers (Nugent et al., 2015). Indeed, a strong body of theory-based evaluation literature, e.g., in the areas of theory of change; realistic evaluation (Rolfe, 2019); evolutional evaluation (Lerner, Lerner, Urban & Zaff, 2016) and contribution analysis (Mayne, 2011) reflects research on evaluation models that account for influences outside of program activities that support or hinder the achievement of a program's intended outcomes. No program exists in a vacuum. A young person's family, school, and peer circumstances all can affect that person's program experience. So too can such factors as involvement in other programming, hobbies and more.

Of these approaches, contribution analysis (Mayne, 2011, 2012) provides guidance for recognizing how multiple contextual programs, events, and life circumstances work in concert with a program to jointly contribute to or even alternatively explain those outcomes. Causality is inferred from four key steps involving logic and evidence. First, the intervention is based on reasoned theory of change and the chain of results and underlying assumptions are plausible and sound, informed by existing research and literature, and supported by key stakeholders in the intervention. Secondly, activities of the intervention were implemented as outlined by the theory of change. The theory of change is then verified by evidence that the chain of expected results occurred and the assumptions held. Finally, external factors that influence the intervention are assessed and either shown not to have made a significant contribution, or if they did, the relative contribution is recognized (Mayne, 2012).

Despite these guidelines, the contribution analysis literature has provided little data collection methodology for conducting the last, data-driven, step (Lemire, Nielsen, & Dybdal, 2012). Some researchers have suggested approaches for closing this gap. Lemire et al. (2012) developed a "Relevant Explanation Finder" as a qualitative framework for conducting the last two steps. Their system aggregates multisource data (e.g. observation, interview) into systematically coded and valued categories to determine competing and relative contribution to achieved outcomes. Befani and Mayne's (2014) process-tracing method provides an in-depth method for explaining cause by describing how the process occurs. Wimbush, Montague and Mulherin (2012) also have furthered contribution analysis by applying it to participatory evaluation and multiple accountabilities.

In a proscription for applying contribution analysis to competency-based medical education, Van Melle, Gruppen, Homboe, Flynn,

Oandasan et al. (2017) listed five questions to guide gathering existing evidence. Each question addressed a different step of the logical theoretical steps in a model from intervention to outcome, advising that multiple methods may be necessary for answering these questions. The first of these questions, the most general, asked "What do pathways look like for individual [participants] as they progress toward competence?" The work presented here provides one methodology for answering this first question which necessarily involves gathering evidence of relative competing influences, the topic of this paper. In other words, in relation to achieving an intended outcome, some youth program participants may consider family to be as influential as the program. Others might describe school, family, and the program as equally influential while still others might consider the only school and family to be influential and not the program.

Developed for the research on a summer intensive STEM internship program, the Influence inventory provides one methodology for understanding participant perceptions of relative program contribution to a program's intended outcomes. In this paper, we present the tool, how it was used in the program, and recommendations for future use and testing. Development and use of the Influence Inventory was nested in a larger research study of the impact of Project TRUE (Teens Researching Urban Ecology), an NSF-funded (DRL-1421017 and DRL-1421019) collaboration between the Wildlife Conservation Society (WCS) and Fordham University. Project TRUE is an urban ecology summer research mentoring program in New York City. In this tiered peer mentoring youth development program, students entering their final year of high school conduct urban ecology research with undergraduate, graduate, and informal science educator mentors. A selection process results each year in a group of approximately 50 high-functioning teens from populations under-represented in the science professions (e.g. African Americans, American Indians/Alaska Natives, Native Hawaiians/Pacific Islanders, Latinx, and women). Divided into smaller groups, each assigned to one of the Wildlife Conservation Society urban zoos, these young people spend 7 weeks working in groups of two or three teens, each with a near-peer undergraduate mentor, all working on a research team with a zoo educator and a graduate student project leader who has chosen a topic of interest for urban, ecological research. Pre-college student research projects tend to focus on the correlation between environmental factors, and measures of species composition such as the association between canopy cover and small mammal richness. The undergraduate mentors use a guided-inquiry approach to emphasize the process of science and to help the high-school students develop research questions, methods, and analysis plans. At the completion of the 7-week summer program, each team of high-school students produces a conference-quality research poster to present at a public symposium.

For this study, *influence* referred to extra-program life contextual factors that affect students' life decisions and therefore included their choices about academic and career paths. The identified extra-project influences were placed on an Influence Inventory as part of a larger scale development process. As part of this larger effort, the influence scale was designed to provide insight into a sustained program influence into college and to observe the hypothesized decreased impact of program's influence over time.

Because the perception of influence can change over time (Lerner *et al.* 2016), in addition to learning how the perceived program influence compared with the other perceived influences, we also sought to learn how perception of these influences changed over time. One reason for measuring influence over time is that post-program reports often reflect what education programmers recognize as a post-program 'high,' or 'afterglow,' resulting from a unifying effect, collaborative or personal success, and high achievement (Ehlman, Ligon, & Moriello, 2014; McCold, 2008; Woodland, 2018). Such a feeling can be a reaction to an experience without necessarily having a longer-term effect (Sisley, Weiss, Barber & Ebbeck, 1990) but can also mark a particular time as physically and intellectually significant in that individual's life (Wright, Gannon, Moustakim & Stoilescu, 2009). Such a reaction, however, may

also lead to bias attrition on selection into a study and as a threat to validity (McCold, 2008).

A second reason for measuring influences over time is the commonly accepted notion that there is a decay in knowledge and skills learned if the learner stops using the knowledge or skills or feels challenged in their use (Arthur, Bennett, Stanush & McNelly, 1998). What is the importance of the intensive experience once the youth has the distance of time and maturation from the experience and from the cohort of youth with whom they shared that experience? Our intention was to explore the possible decay in influence as youth finished high school and moved into college.

The instrument helps to locate a program's influence as relative to other youth influences. With its application, we were able to compare these external influences and compare them to perceived influence of the program itself both at the time of the program and again a couple of years after the program. We employed the instrument as a way to understand the relative influence of this program on the participating youth, and to explore how that and other influences might change over time. While the instrument can be focused on any outcome, we directed it broadly toward contribution to a academic, career, and life direction.

No studies or literature we found clearly provided a way to measure a program's relative influence in relation to other influences, nor how that influence fared over time especially in relation to the other influences. For our purposes, we needed to know both. Thus, we set out to create an inventory of relevant influences on decision making about career and academic intentions and activities.

2. Influences on youth: prior studies

To build our initial item bank we looked at broader studies of influences on youth's future decisions (Dworkin, 2007) to build our item bank. In the literature, some studies are focused on specific influences as they relate to academic, career, or interest while others examine the same influences but through a positive youth development lens. Some of these studies retrospectively identified multiple influences including personal characteristics while others prospectively or comparatively examined single influence such as family, religion, religious community, negative experience, leisure experiences, friends, out of school activities, and creative endeavors. Each of these literatures, briefly named below, affected our initial item bank of influences.

Of especial interest were measures of program influences related to longer-term academic and career-related outcomes. Short-term academic and career outcomes have usually involved intention or interest (Quimby, Wolfson & Seyala, 2007) with interest linked as a longer-term academic and career pathway influence (Maltese & Tai, 2011; Nugent et al., 2015). Longer-term studies tend to be retrospective or reflective studies of adults and many of these focus on parental influence (Sonnert, 2009). These key findings informed the ways we asked about influences to use them to contextualize Project TRUE's influence on academic interest and intent.

Many of the studies reveal a variety of positive benefits to youth being highly engaged across a range of out-of-school-time activities (Hansen, Larson, & Dworkin, 2003). Participation in structured out-of-school activities and constructive leisure activities including such things as creative endeavors, participation in youth programs, and engagement with religious communities collectively influence youth (Morrissey & Werner-Wilson, 2005). Following are factors various studies have included regarding short and longer-term potential influence on academic preparation and career choices.

General youth development. Various experiences and influences have been shown to contribute to achieving the types of youth outcomes desired by the types of youth development programs mentioned above. Most studies by their nature as program evaluation isolated influence of the program on either single or multiple outcomes often related to the five "C's" of positive youth development (confidence, competence, connection, caring, and character) and these studies were used to look

for consistent categories of influence on youth in general.

As program evaluations, most of the studies focused on more specific influences (i.e. the program) and attempted to isolate ways or degrees in which each contributed to the object of the youths' development, usually career, interest, behavior, or identity. Some focused on singular types of influence:

- *Adults.* (Dick & Rallis, 1991) and (Kniveton, 2004) examined parental influence while others looked at parents with some other identity element (e.g. Meeus, Oosterwegel, & Vollerbergh, 2002). Others focused on teachers and other supportive adults in the lives of the youth (Halpern, 2005; Jarrett, Sullivan, & Watkins, 2005; Rhodes, 2004).
- *Personal characteristics.* Some of the many personal characteristics studied as influences on youth were specific to certain conditions or contexts such as birth order (Kniveton, 2004) and negative experiences (Dworkin, 2007). Other studies looked at passive, physical engagement which includes such things as watching TV, movies, or engaging with video games and their influences on youth (Bundick, 2011; Lens, Lacante, Vansteenkiste & Herrera, 2005; Przybylski, 2014; Zarrett & Lerner, 2008).
- *Public and private identities.* Youth development literature makes a distinction between internal (private) and public (social) identities as important in understanding what might influence the temporal versus longer-term behaviors or outcomes. Moreover, socialization strategies in the broader community e.g. friends, media, and social pressures on how or what to engage may be more influential than how youth perceive their families (Whiston & Keller, 2004). This suggests motivations for and benefits from activities in the larger community are complex and likely not linear (Sonnert, 2009).

- *Religion and religious community.* Although religion and religious community most often have been separated in studies, both have revealed similar influences on youth (Furrow, King, & White, 2004; King & Furrow, 2008; Larson, 2000; Leffert, Benson, Scales, Sharma, Drake & Blyth, 1998; Luhtanen & Crocker, 1992). The insight from these studies is that either can contribute to both social and private identity of the youth (Hansen, Larsen & Dworkin, 2003).
- *Volunteering, hobbies, and outdoors.* Volunteering (Arnett & Tanner, 2006), engagement in hobbies, and being outdoors or in nature have all been found as contributors to both internal and public identity of the individual (De Jong, Visscher, HiraSing, Heymanns, Seidell et al., 2013; DeJong & Jackson, 1998; Flanagan, Levine, & Settersten, 2007; Larson, 2000).

- *Out-of-School Activities.* OOS activities are seen as an important contributor to youth development (Eccles & Barber, 1999) including organized sports (e.g., Kishton & Dixon, 1995; Lens et al., 2005; Lerner & Castellino, 2002; Lerner et al., 2016; Ramsing & Sibthorp, 2008; Stuart & Ebbeck, 2016). Many of these studies focused on the influence related to outcomes such as self-perception, productive behavior, social approval, and social identity. Only one study looked at influence of engagement in sports between youth and professionals (Hill, 1993).
- *Creative endeavors.* Social identity is influenced by creative endeavors (Leffert et al., 1998) including visual and performing arts (Hansen, Larsen & Dworkin, 2003; Larson, 2000).

Youth clubs. Participation in youth groups or clubs also has been shown to be a positive influence in youth development (Dworkin, 2007; Fredrickson, Roberts, Noll, Quinn, Twinn et al., 1998; Hansen, Larson & Dworkin, 2003; Larson, 2000; Leffert, Benson, Scales, Sharma, Drake et al., 1998; Quinn, 1999).

- *What one is paid.* Some studies also found influences tied to identity in one's pay (Dick & Rallis, 1991) and in the work they do (Lens et al., 2005).

As a component of the larger study, decision to include influences on youth both in the short term and over the transition from high school into college, it was important to the project to broadly consider influences and the contributions of the intervention in the lives of the youth. As noted, the intention was to explore the anticipated decay of the specific program's influence. The goal was to develop a measure that would capture the range of influences and to determine how to do this in a way that would ensure reliable and stable data within the youth from communities that are traditionally underserved and underrepresented in science, especially conservation science.

3. Influence scale construction and testing

This section will move through the process of scale construction to the testing of the full instrument. This discussion begins with the item development and face validity of items. This is followed by content assessment of items using a research panel, a principal component analysis using a second panel, and a full pilot with youth in other summer intensive programs. Following this development process, the scale was then used for baseline and annual measures as part of a much larger instrument which will be reported in the next section.

Item development and face validity. The framing of the scale was initiated by brainstorming with project team and advisors based on a brief listing of dominant themes found in the literature described above. Brainstorm contributors included the expanded project team consisting of the PI, project manager, lead program developer, evaluator, two research team members, and the Research Oversight Committee. The ideas generated constructs that formed the basis of a literature search for extant scales.

A second issue affecting scale construction was that of negative and positive responses. As we were seeking to learn about mutual contribution to an outcome and not barriers, advisors and researchers together chose to measure positive contribution only, assuming that negative contribution would be considered "no contribution" (1 rating). With advice from the research advisory committee, we ended with an item bank of 19 items as shown in Table 1.

3.1. Content assessment

We tested the 19 items for influence scale with 400 anonymous youth/young adult respondents between the ages of 18 and 23 (reflecting the age of participants who would be responding to the final survey which we estimated would be 16–18 at time of engagement and 16–22 at points of measurement). The content assessment questionnaire presented respondents with the following explanation and instruction: "We are creating a list of the conditions that positively influence young people's interests and decisions. These conditions can either enhance or get in the way of students pursuing their interest in science. How much do you agree or disagree that each of the following items belongs on the

Table 1
Influence items for testing.

Parents/guardians	Being in nature/being outside
Friends	Work/my job
School classes	Having to support myself
School teachers	Living on my own
Religious groups/religious education	Extra—curricular activities (school clubs)
Visual arts	Volunteering
Performing arts	Other adults in my life
After-school programs	Family expectations for school
Organized sports (including school)	Family expectations for career
Hobbies	

list? And a reminder "REMEMBER: We do NOT want to know if these items influence your decisions personally. Instead we want to know how much you agree or disagree that these items might affect people your age."

Response options for each item ranged on a five-point scale from "strongly disagree" to "strongly agree." Respondents had the opportunity to include any items they deemed missing from the list. Next, they reviewed the same items for how easy or difficult each item would be to answer. Response options ranged on a five-point scale from "very easy" to "very difficult" to answer. The mean across all items in terms of appropriateness revealed very strong agreement ($\bar{X}$ = 4.45), and no item was offered as missing. All items were considered appropriate with an ANOVA of 4 = F57.032, p < .001. In terms of difficulty in answering no item was 3.0 or higher on the 5-point difficulty scale ($\bar{X}$ = 2.39) with a range of scores from 1.94 - revealed very strong agreement ($\bar{X}$ = 4.45), and no item was offered as missing. All items were considered appropriate with an ANOVA of 4 = F57.032, p < .001. In terms of difficulty in answering no item was 3.0 or higher on the 5-point difficulty scale ($\bar{X}$ = 2.39) with a range of scores from 1.94 to 2.93.

In this first round of item testing, five items minimally increased overall reliability if removed: (1) Religious groups/religious education; (2) Visual arts; (3) Performing arts; (4) After school programs; and (5) Work/my job. For these five items we examined means, standard deviations, inter-item correlations, and the Chronbach's alpha after deleting the item. All five items had means below the average for all items ($\vec{X}$ = 4.45) and slightly-elevated to moderately-elevated deviations. However, means on these five ere each above the mean score for organized sports (including school) which is a standard item for inclusion on measures of contributions to youth development. The standard deviations were slightly elevated, but less than the item "living on my own" (respondents included high school seniors and individuals just entering college or the workforce so the item's relevance was inconsistent across the sample) which suggested the items were acting in a similar way of forcing bi-modality, i.e., an important influence for some youth and not at all for others. This was confirmed by examining the raw data to see patterns of response where the arts did cluster when scored as an important contribution. As such we retained all 19 items for the principal component analysis.

Findings of the principal component analysis. A second round of testing with a new Qualtrics panel (n = 370) presented respondents with the following instruction for responding:

> Think of the many conditions that positively influence your interests and decisions. For each of the following, how much did each of these positively influence who you are today on a seven-point scale from "1 -not at all" to "7 - very much."

Principal component analysis revealed six clusters of activities we believed might be cohesive subscales: family/religion; interests organized by others; adult responsibilities; community and environment; arts; and interests organized by self (see Table 2). To explore possible outlier items within the subscales, an item analysis was conducted. All items had distributions across all 7 scale points and had very slight to moderately inflated standard deviations. For baseline responses, the items that stood out for tracking over time to determine item functioning within the subscale were Friends, Organized sports, Religious groups/ religious organization, and to a lesser degree, Family expectations for career.

Although we found the items did fall into general categories, they were developed from a broader swath of literature reviewed above. Although the subscale of *Interests organized by self* did not perform well in terms of reliability with this test audience, the items did load clearly into a category, and the strength of the scale as intact led us to choose to retain them. This provided us with the scale to be used for sub-scale summative means for inclusion in the full instrument pilot test.

Pilot Testing. Finally, 280 youth in educational summer experience

Table 2
Factor loads and reliability of subscale.

Factor	Reliability	Item	Load
Family & religion	$r = 0.666$	Parents/guardians	0.450
		Religious groups/religious education	0.414
		Family expectations for school	0.837
		Family expectations for career	0.851
Interests organized by others	$r = 0.628$	After-school programs	0.698
		Organized sports (including school)	0.710
		Hobbies	0.472
		Extra-curricular activities	0.666
Adult responsibilities	$r = 0.627$	Work/my job	0.682
		Having to support myself	0.812
		Living on my own	0.678
School	$r = 0.600$	School classes	0.803
		School teachers	0.806
		Other adults in my life	0.430
Arts	$r = 0.657$	Visual arts	0.831
		Performing arts	0.790
Interests organized by self	$r = 0.119$	Friends	0.468
		Being in nature/being outside	0.723
		Volunteering	0.524

$N = 280$.

programs in New York City were used to test the larger research instrument mentioned above including the influences scale. A scale reliability measure (Kuder-Richardson 21) was run on the influence items. The scale had an intact reliability measure of.883 for the 19 items. A rotation revealed that there was no item for which removal would result in a stronger reliability. Using an ANOVA, F= 57.032 with a significance < 0.001 between items, we found there was differentiation in the items even as they held together as a scale (see Table 2).

Application. The scale referred to as the Perceived Influence Contribution Scale (PICS) was used as baseline (T_0); immediately post-program (T_1); and then annually (T_2 through T_4) for observing changes over time. Central tendencies and descriptive statistics were used on the subscales. Due to inconsistencies in respondents across the years, we measured the change scores against the group, not individuals. For the analysis overall, we combined times 2, 3 and 4 across cohorts. Comparisons between the subscales were made for all time points.

In order to have the influence of the program (Project TRUE) for comparison related to contribution, three comparison items were added at the bottom of the scale: (1) My participation in Project TRUE; (2) My Project TRUE mentor; and (3) My Project TRUE field work. Scale reliability for these three items on a similar 7-point scale together across times yielded Chronbach's alphas of.81 at T_1, immediately post program,.78 at T_2,.65 at T_3, and.72 at T_4 for the annual follow-up study.

4. Findings using the measure

Ultimately, 182 Project TRUE participants responded to the follow-up surveys. Table 3 shows cohort responses at each time period. Because respondents were inconsistent across time periods, time series analyses became impossible. Because responses across the many measures in the total survey did not statistically differ across cohorts, we combined cohorts in our time period analyses. We also ran post-hoc reliabilities (Chronbach's alpha) on the PICS and reliabilities ranged from alpha= 0.076 at T_0 to 0.86 at T_4.

We also recognized the potential for selection bias and to detect it, we compared respondent and non-respondent T_1 responses (which had 100% participation). Between these two groups, at each of the three follow-up periods (T_2. T_3. And T_4), there were no significant T_1 (immediate post-program) differences in demographics, program satisfaction, science interest, or other program outcomes.

As shown in Table 3, at baseline, Participants reported that, prior to and outside of Project TRUE, activities organized by self (e.g., hobbies,

friends, and volunteering) most influenced their decision making. Following activities organized by self were school and activities organized by others (sports, clubs, and after-school activities). Both adult responsibilities and arts had means below average, demonstrating low influence for these youth. Note that these highest-rated influences also were rated highest at T_4.

Paired t-tests between T_0 and T_1 data (immediate post-program) showed no significant differences between time periods indicating a stable scale. Also, at T_1a expected, the items *Having to support myself* and *Living on my own* were very low for T_1 as most of the students were still in high school and most, if not all, lived at home. Mean scores for the arts influence were also low.

For purposes of describing and quantifying the relative effect of Project TRUE over time, as described in the instrumentation section above, a true influence score was calculated from students' responses to the outside influences scale. At the immediate post measure, the Project TRUE influences of general program; Mentor; and Field Research, revealed just over half of the participants rated the influence as high; a third as medium, and the remainder (approx. 15%), low. The youth rating Project TRUE as highly influential explained their ratings most frequently with comments on career preparedness (positive), authentic science beyond school learning, and skill building (teamwork and critical thinking). At T_1, the overall Project TRUE mean influence score was 5.79 (sd=0.182) with a mean of 5.6 for both the mentor subscale (sd=0.182) and the Field Work subscale (sd=0.138). The Project TRUE influence score remained higher over time than did the other influences.

At that time, at the height of enthusiasm for the completion of a summer program, program influence scored highest among all the influences with "being in nature/being outside coming second.

Across the four years of measurement, there was movement on the influences scale. The subscale of Organized by Others had a downward trend while Family/Religion mostly trended positively. Not surprisingly, Adult Responsibilities did go up. For the testing of the instrument against the expected finding, we did not see decay occur as rapidly as anticipated. The overall Project TRUE influence score stayed mostly stable until we saw a visible decay in Time 4. The influence of the mentor did have the rapid and continual decay while Field Work remained fairly stable in its influence as shown in Table 3.

When using the PICS to measure change over time, between T_1 (immediate post) and T_2 (one year follow-up), the influences varied only slightly, with only Arts having any statistical significance and the largest mean difference (−0.32). For T_1, responses were paired with T_2 and therefore we used paired t-tests. Recognizing that beyond T_2, the respondents were not completely independent samples and we realized we would lose too much data to use paired t-tests, therefore using a regular t-test across all cohorts. Only School had a positive mean difference.

Overall, influences remained relatively stable over the four-year period (T_1 to T_4). School, Activities organized by self and Activities organized by others all became more influential (at least among the 24 responders) at T_4. Proportionally, the relative influence of mentors rose both from T_1 to T_2 and T_1 to T_3 as can be seen in Table 3 above.

The differences between Time 4 and Time 1 had several statistically significant subscales: Activities organized by self (gain score of −0.80), School (gain score of −0.70) and Activities organized by others (gain score of −1.00). Table 4 shows the comparison data for T_1 and T_2 as well as T_1 and T_4.

5. Lessons learned and conclusions

Understanding the influence of an intensive summer research experience on an individual is a challenge. Comparing the influence of the program experience against other influences in the lives of a youth is important for being able to make claims of impact. Adding specific program elements to the list of influences provides further detail for mechanisms by which the program contributes.

This study produced The Perceived Influence Contribution Scale, an

Table 3
Influence scores across all post measures by time.

Subscale	Item	T_0 n = 143 M	Sd	T_1 n = 188 M	Sd	T_2 n = 188 M	Sd	T_3 n = 51 M	Sd	T_4 n = 24 M	Sd
Organized by self		**5.14**	**1.09**	**5.17**	**1.05**	**5.11**	**1.10**	**5.20**	**1.13**	**4.64**	**1.33**
	Friends	4.74	1.57	4.66	1.66	4.66	1.66	5.02	1.64	5.17	1.40
	Being in nature/ being outside	5.58	1.35	5.63	1.47	5.63	1.47	5.49	1.54	4.63	1.81
	Volunteering	5.15	1.70	5.16	1.74	5.16	1.74	5.04	1.71	4.13	2.07
School		**4.91**	**1.15**	**5.00**	**1.23**	**5.17**	**1.07**	**5.18**	**1.14**	**5.04**	**1.32**
	School classes	5.09	1.46	5.17	1.48	5.17	1.48	5.45	1.38	5.33	1.37
	School teachers	4.80	1.50	4.82	1.56	4.82	1.59	5.06	1.43	4.92	1.41
	Other adults in my life	4.83	1.61	4.95	1.59	4.95	1.68	5.04	1.50	4.88	1.85
Organized by others		**4.84**	**1.15**	**4.84**	**1.30**	**4.69**	**1.14**	**4.55**	**1.26**	**4.31**	**1.25**
	After-school programs	4.99	1.68	4.80	1.98	4.80	1.98	4.29	20.2	4.08	1.82
	Organized sports (including school)	3.72	2.19	3.63	2.12	3.63	2.12	3.47	2.02	3.75	1.94
	Hobbies	5.66	1.31	5.94	1.21	5.94	1.21	5.57	1.53	5.21	1.72
	Extra-curricular activities	5.11	1.63	4.95	1.85	4.95	1.85	4.86	1.69	4.21	2.27
Arts		**3.68**	**1.76**	**3.58**	**1.74**	**3.36**	**1.73**	**3.49**	**1.78**	**3.46**	**1.69**
	Visual arts	3.85	2.00	3.67	1.81	3.67	1.81	3.65	1.82	3.88	1.94
	Performing arts	3.48	2.03	4.80	1.98	3.50	1.98	3.33	2.07	3.04	1.88
Family/Religion		**4.47**	**1.12**	**4.60**	**1.45**	**4.74**	**1.51**	**4.69**	**1.45**	**4.98**	**1.36**
	Parents/guardians	5.63	1.56	5.59	1.67	5.59	1.66	5.90	1.56	6.21	1.10
	Religious groups/ religious education	2.73	1.95	2.87	1.93	2.87	1.94	3.18	2.10	3.25	2.17
	Family expectations for school	5.06	1.82	5.23	1.90	5.23	1.90	5.06	1.88	5.33	1.86
	Family expectations for career	4.52	1.97	4.72	1.96	4.72	1.96	4.57	2.01	5.13	2.15
Adult responsibilities		**3.8**	**1.59**	**4.18**	**1.56**	**4.24**	**1.60**	**4.55**	**1.62**	**4.65**	**1.67**
	Work/my job	4.44	1.87	5.08	1.79	5.08	1.79	4.75	1.99	4.71	1.71
	Having to support myself	4.38	2.15	4.36	2.24	4.36	2.24	4.98	1.93	5.04	2.12
	Living on my own	2.72	2.13	3.11	2.26	3.11	2.26	3.92	2.31	4.21	2.41
General Project TRUE				5.79	1.23	5.61	1.30	5.65	1.21	5.17	1.40
Mentor				5.55	1.51	4.77	1.53	4.65	1.82	4.25	1.85
Field Work				5.58	1.41	5.08	1.69	5.45	1.33	4.96	1.65

nT_0 = 143; nT_1 = 188; nT_2 = 188; nT_3 = 51; and n$T_{4=}$48.

Table 4
Time$_1$ and Time$_2$; Time$_1$ and Time $_4$ comparison statistics by subscales.

	T_1 and T_2 Mean diff	Sd	S Err Mean	t	df	Sig (2tail)	T_1 and T_4 Mean diff	Sd	S Err Mean	t	df	Sig (2 tail)
Organized by self	-0.08	1.02	0.12	-0.32	73	0.49	-0.80	1.0	0.2	-1.3	23	**0.00**
School	0.05	1.21	0.14	-0.23	73	0.75	-0.70	1.0	0.2	-1.1	23	**0.00**
Organized by others	-0.13	1.36	0.16	-0.44	73	0.42	-1.00	1.3	0.3	-1.6	23	**0.00**
Arts	-0.32	1.42	0.16	-0.65	73	0.05	-0.60	1.7	0.3	-1.3	23	0.11
Family/Religion	-0.15	1.11	0.13	-0.41	73	0.25	-0.28	1.2	0.24	-0.8	23	0.26
Adult responsibilities	-0.08	1.95	0.23	-0.53	73	0.73	-0.50	1.7	0.3	-1.2	23	0.14

Bonforroni correction applied.

instrument that provided an opportunity to examine how a particular urban ecology research mentoring experience influenced the youth involved as they transitioned from high school and into college, and for the full project study, how the program influenced academic and career intentions or not. The longitudinal study of these youth in this summer intensive program provided a unique opportunity to examine how, over time, the experience contributed to their life choices. Moreover, use of the PICS provided an opportunity to examine the potential decay of program influence, which, in this case, did not occur at the level or rate anticipated.

The PICS created for this component of the project was meant to contextualize the program in the larger lives of the youth and to provide a comparison measure across the mid-term. The PICS itself showed stability in the influence of the intensive experience, and the findings on the scale tests suggest this measure has transferability for other projects.

School remained one of the strongest categories of influence, which makes sense given that the youth entered while in high school and moved into college. Moreover, program selection criteria included academic success. The capture of decay of OST activities organized by self, and activities organized by others also makes sense as the youth move toward leaving college and assuming more adult responsibilities, which began to grow in terms of influence. The findings also suggest that this type of intensive experience for youth *does* have a lasting impact, and that measures of outcomes from these programs need to be future focused, with the impact of the program contextualized in both current and future contexts. Additionally, the ability to explore the influences along with qualitative insights as to directionality of the influences is extremely important, and we believe especially for youth in underserved communities.

The influence of a program on youth's academic and career interests is the goal for many intensive youth programs and experiences. Having a means of reliably examining the impact both immediately and over time is a valuable resource for these types of informal science education experiences.

We also feel an important contribution of this work is to bring contribution analysis into informal science program theory. Because the project had the requisite requirements for using contribution analysis, we were able to move through the steps of setting out the cause-effect issue to be addressed, use the postulated theory of change and risks to the causal links which was the purpose of this particular scale and associated measures, gather evidence on the theory of change, assemble and assess the contribution claim and challenges to it, gathered additional evidence from the implementation of the intervention, and finally revise and strengthen the contribution story, presented here in the conclusions (Befani and Mayne, 2014).

Limitations of this study were that respondents were inconsistent over time. Also, despite our testing, selection bias may have occurred. Future use of these tools to understand post-high school program experience of teens should correct for these limitations. But continued validation and refinement of this tool and approach will provide a means for researchers to understand the true influence of an intensive experience or program on the youth involved.

CRediT authorship contribution statement

Joe E. Heimlich: Concept, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Deborah Wasserman**: Data curation, Formal analysis, Investigation, Methodology, Validation, Writing – original draft, Writing – review & editing. **Karen Tingley**: Funding acquisition, Project administration, Resources, Supervision, Writing – review & editing. **Su-Jen Roberts**: Formal analysis, Investigation, Supervision, Writing – review & editing. **Jason Aloisio**: Data curation, Formal analysis, Project administration, Writing – review & editing.

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