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Transformative Experience in an Informal Science Learning Program about Climate Change

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Abstract

The Transformative Experience Questionnaire (TEQ) has previously been used only in formal science learning environments to examine how students' learning experiences extend beyond the classroom into their daily lives. In the present study, an example of how this tool can be useful to assess transformative experiences in an informal learning program is provided. The Lens On Climate Change (LOCC) program combined a place-based approach to learning with creative expression through storytelling, as middle and high school participants created short films about the impacts of climate change in their communities. Our findings suggest the LOCC participants had a transformative experience with regards to their learning about climate change as illustrated in greater post-program TEQ scores over a comparison group of research participants who did not engage in the LOCC program. The program was also transformative for both middle and high school students. Results are discussed within theoretical frameworks for designing informal transformative science learning experiences.

Keywords: transformative experience; informal science learning; climate change; filmmaking; place-based

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Introduction

Communities across the world are increasingly affected by a changing climate (IPCC, 2014; 2021; USGCRP, 2017), and engagement from community members is critical in mitigating impacts and in adapting to this changing climate. However, young people can feel daunted when faced with the need to address such a large-scale, global challenge. When youth learn about climate change and its impacts, they may become overwhelmed and disengaged, the opposite of what educational programs and resilience curricula intend (Ojala, 2012; Stevenson & Pearson, 2016). Thus, this calls for educational curricula and programs that consider youth perspectives and approaches to prepare them and their communities to be resilient and creative in joining efforts to alleviate climate change impacts in their communities and beyond. Providing educational experiences that open students' thinking to new ways of understanding their position in the world—seeing themselves as capable, active participants and collaborators in finding solutions to today's climate challenges—encourages a sense of agency and reduces the feelings of overwhelm that may preclude youth from further engagement (e.g., Li & Monroe, 2019; Hart & Nisbett, 2012; Trott, 2021; Trott & Weinberg, 2020). Research has shown that thoughtfully designed science education in formal, school-based settings can be transformative for students, inspiring them to apply their learning beyond school settings and encouraging them to seek out additional opportunities for learning, engagement, and careers in science (Pugh, 2002; 2011; Pugh et al., 2017; Pugh et al., 2010a; Pugh et al., 2010b; Pugh et al, 2021). For example, a recent study indicated that for women studying geoscience, these transformative educational experiences moderated the relationship between their interest and identity in science and their confidence in the geoscience major (Pugh et al., 2021). Thus, building on our understanding of how to design science learning experiences to be transformative may help instructors to reach more students underrepresented in science and broaden their participation in these fields. However, people spend the majority of their time outside of formal learning settings, making it important to consider how to engage learners in science outside of school settings (Falk & Dierking, 2010; National Research Council, 2009).

Informal Science Learning

Research on informal learning has shown that rich and valuable learning takes place outside of the classroom, particularly for science learning (Bevan et al., 2013; National Research Council, 2009). These informal science learning experiences are offered in a variety of contexts including, but not limited to, everyday experiences in which people learn about the natural world organically; designed spaces such as science or environmental centers and museums; science learning programs that take place in after-school settings and community-based organizations, and independent learning through reading books, news or scientific articles; or engaging with other media such as educational television programs or films (National Research Council, 2009). Learning in these settings also tends to be self-directed and often involves personal choice (e.g., choosing which parts of a museum exhibit to engage with or what topics to read about), which can be motivating and enjoyable for those engaging in the experience. Furthermore, the benefits to engaging in informal learning are vast, having positive impacts on learners' behavioral, emotional and cognitive engagement (National Research Council, 2009). These environments also provide opportunities to broaden participation in science, by sparking interest in science topics and helping learners to see the relevance of science in their own lives (National Research Council, 2009; NSTA, 2012). Informal science learning experiences can facilitate lasting learning and science achievement; positively affect learners' attitudes and identity around science; increase interest in science and motivation to learn about science topics; and support development of a sense of environmental science agency (Burke & Navas Iannini, 2021; Dabney et al., 2012; Gerber, et al., 2001; Goff et al., 2019; Harris & Ballard, 2021; Littrell et al., 2020a; Mulvey et al., 2020; Whitesell, 2016; Yildirim, 2020). However, research also suggests that informal science learning experiences can be strengthened by designing them to guide learners toward experiences that are transformative, inspiring further learning and engagement and shifting how the learner sees and understands the world through this new lens provided by their learning experience (Garner et al., 2016). Designing informal experiences in this way is especially important when considering science topics like climate change that have an urgent need to engage the participation of young people and inspire and empower them to take action.

The Lens On Climate Change Program

The Lens On Climate Change (LOCC) program was an informal science education program in which middle and high school students explored the local effects that climate change had on their lives and communities and shared their findings through a short film, as an artistic and engaging way to communicate about a topic. Four of the authors of this paper designed and implemented the LOCC program, participant surveys, and interviews. Two of the authors were involved as consultants conducting measurement and data analyses. The LOCC program aimed to give the program participants exposure to ideas and skills that would empower them to envision action and change around local climate topics, build important Science, Technology, Art, Engineering and Math (STEAM) skills, and consider possible related career paths. The program took place in two formats—as an after-school program during the school year and as an intensive, one-week summer program. Both settings provided participants the guidance, structure and equipment to complete these films in about 40 hours of engagement. Program participants were mentored by undergraduate film students and graduate students studying environmental science. They worked in small groups of four to five other students to create a short film together that communicated about the impacts of climate change and related environmental challenges in the region where they lived or went to school. The first phase of the project involved researching climate change topics affecting their communities, often including interviews with scientists or local professionals to learn more about the impacts and/or causes. Film groups then began to create a storyboard, to map out frame-by-frame the story they wanted to tell in their film. Next, the LOCC participants spent time scripting and filming scenes, and finally they edited the film to produce the final version. At the end of the LOCC program, the participants gathered at their school or a community space to share and discuss their films at a film screening event (see Gold et al., 2018; Littrell et al., 2020a; and Oonk et al., 2017 for additional details on the program design). The current study focused on whether or not the program was transformative for the LOCC participants, such that they left the program feeling inspired to continue learning and/or communicating with others about climate change or inspired to engage in actions to help mitigate climate change or other environmental challenges in their communities.

LOCC as a Place-Based Educational Program

The LOCC program was designed as a place-based educational program (PBE; Gold et al., 2015; Littrell et al., 2020b; Sobel, 2004). According to Sobel (2004) place-based education may be defined as:

> ...the process of using the local community and environment as a starting point to teach concepts in language arts, mathematics, social studies, science and other subjects across the curriculum. Emphasizing hands-on, real-world learning experiences, this approach to education increases academic achievement, helps students develop stronger ties to their

> community, enhances students' appreciation for the natural world, and creates a heightened commitment to serving as active, contributing citizens. (p. 6)

Such experiences, especially in geoscience education and communication about climate change, are known to foster students' learning and inspire them to engage in addressing environmental challenges by connecting these challenges to their personal experiences and to places that are meaningful to them (Deloria et al., 2001; Khadka et al., 2021; Semken et al., 2017). In the LOCC program, students were encouraged to choose topics that affected their home communities, and include imagery and content in their films that represented meaningful places in these communities. They were also asked to consider the factors and behaviors that exacerbate and mitigate climate effects. For example, one group of LOCC participants chose to discuss the effects of drought in their community. In their film, they highlighted their own personal stories visiting a local lake throughout their lives and noted how much the water level had dropped over time, reflecting on the impact this had on themselves and their community. The study suggested that the place-based nature of the program not only helped students to draw meaningful connections with the environmental challenge, but also inspired them to take action and continue their learning beyond the program—critical components of a transformative educational experience (e.g., Littrell et al., 2020b). For example, during follow-up interviews conducted a year after the program, students reported changing some of their day-to-day actions to conserve water as well as talking to family and friends about how to conserve water in the year following the program (Littrell et al., 2020b). In the current study, we further explored whether or not the program was a transformative educational experience using the Transformative Experience Questionnaire (TEQ, Pugh et al., 2010a; Koskey et al., 2018).

Transformative Educational Experience

What does it mean to characterize an educational experience as transformative and why might we anticipate that participating in the LOCC program would be a transformative experience? Transformative experience includes characteristics similar to the concept of "school-prompted interest" in which learning in a formal context at school inspires students to engage in their own independent learning and communication about a topic outside of the original learning setting (e.g., Bergin, 1996; Ciani et al., 2010). With a focus specifically on science education, Pugh (2002) developed a construct for *transformative experience* (TE) that includes three ways in which students are prompted to continue their learning—through application in other contexts outside of school; through changes in their perceptions about the topic; and through gained value in new learning opportunities. Pugh and colleagues (Pugh, 2002; Pugh et al., 2020) developed the TE construct for science education by weaving together separate perspectives from the work and writings of Dewey on aesthetic experiences and concept formation (Dewey, 1933; 1958). Describing aesthetic experiences as transformational, Pugh (2002) highlighted Dewey's writings on how engagement with the arts often reshapes the way that people see the world. Pugh (2002) stated that, "in an [aesthetic] experience, a person comes to see some aspect of the world…in a new way, to find new meaning in this aspect of the world, and to value this new way of seeing" (p. 1102). Building on Dewey's work on concept formation, Pugh also suggested that science education could be transformative if students think about science concepts as *ideas*, framing them in a way that suggests that there are *possibilities* for those ideas to change and grow through testing and investigation. Although Dewey's writings did not convey these connections directly, Pugh (2002) made a connection between students' aesthetic experiences and their exploration of new concepts in science, saying that,

> …in Dewey's theory, a worthwhile idea fulfills the same function as art in that it transforms perception and value. It allows one to see and experience (rearrange and reconstruct) aspects of the world in a new, meaningful (more significant, more luminous, more fruitful) way. (p. 1103)

Out of these similarities, Pugh developed a construct for transformative experiences in science education, involving three interrelated aspects: Motivated Use; Expansion of Perception; and Experiential Value (Pugh, 2002; Pugh, 2020; Pugh et al., 2010a). The Motivated Use component of a transformative experience involves applying what was learned to a situation outside the learning context. Expansion of Perception refers to beginning to see the world differently through the lens of new knowledge. The Experiential Value component of a TE comes into play when a learner's change in perception leads to a greater appreciation or value placed on learning about a topic. This can also be expressed as a newfound interest in learning about a topic or finding value in similar learning experiences. Together, these components make up the various ways in which an educational experience in science can be transformative. The following vignette provides an example of how one young learner might experience all three of these components of a transformative experience in an informal learning setting:

> As part of a girl scout meeting, Stephanie and her troupe completed an activity in which they learned about what a carbon footprint is and how to reduce the impact they are having on the environment. This activity had a transformative impact on Stephanie related to her thinking and perception about the topic and her actions outside of the learning experience she had with her troupe. Over the following week, Stephanie began to notice many of the ways in which she and her family were contributing to their carbon footprint as a family. Previously, she really didn't like taking the bus to school and

wished her mom would just drive her there. However, after the girl scout activity she began to think about this differently, realizing that carpooling with other kids from school or riding the bus might actually be better for the environment than if every student was driven there in a separate vehicle. This new way of looking at her daily activities is an example of how a learning experience can contribute to Expansion of Perception. Furthermore, Stephanie decided that she would like to change some of her daily activities to reduce her carbon footprint. She talked to her family about taking public transportation more often together and riding their bikes to church on Sundays instead of taking the car. Stephanie also began turning off lights when she would leave a room in her house in order to save energy. These are examples of the Motivated Use component of a transformative experience. Now that Stephanie knew about the impacts of her daily activities, she was motivated to change some of these activities. Additionally, Stephanie signed up for an after-school environmental science club. She told her parents that she was excited about the club because she wanted to learn more about environmental science and how she and her friends could work together to protect the planet. Stephanie's newfound interest in learning more about these topics is an example of the Experiential Value component of a transformative experience.

Importantly, research on transformative experiences has shown that in formal learning settings these experiences impact learning deeply in many ways, including promoting lasting learning, transfer, and conceptual change, as well as positively impacting students' science identity, motivation, and interest in pursuing science topics (Alongi et al., 2016; Girod et al., 2010; Heddy & Sinatra, 2013; Heddy et al., 2017; Pugh, 2002; 2011; Pugh et al., 2017). Though informal science learning settings have also shown many positive impacts on learning, motivation, and interest, Garner et al. (2016) also suggest that scaffolding learning in these settings could strengthen and build upon these impacts by guiding learners toward a transformative experience. To measure transformative experiences, Pugh, Koskey, May, and colleagues developed and validated a measure, the Transformative Experience Questionnaire (TEQ), that captures each of the three components of transformative experiences, which together measure a single, unidimensional construct (Koskey et al., 2018; Pugh et al., 2010a). The TEQ has been used to measure transformative experiences for middle school, high school and undergraduate students in science classes (Koskey et al., 2018; Pugh et al., 2010a; Pugh et al., 2021). The current study used the TEQ to explore how transformative the Lens On Climate Change (LOCC) program was for students who participated. Thus far, the TEQ has been used to study transformative experiences in only formal science learning settings.

The Transformative Experience Continuum

Item difficulty within the Transformative Experience Questionnaire (TEQ) falls along a continuum. On one end are items that are easy for respondents to endorse, and on the other end are items that are more difficult to endorse. Past research on the TEQ has shown that in formal learning contexts, the items that refer to in-school or in-class experiences around a science topic are easier to endorse relative to items that refer to out-of-school or everyday experiences (e.g., Pugh et al., 2017). In the current study, conducted in an informal learning setting, we expected a similar pattern of responses. We also examined whether or not the informal learning program would demonstrate a transformative experience such that participants in the program showed a shift toward greater endorsement of more difficult items after taking part in the program, in contrast with a comparison group who did not participate in the program.

Transformative Experiences in Informal Learning Settings

Pugh and colleagues developed and tested the Teaching for Transformative Experiences in Science (TTES) model to provide guidance on how to design science education to be transformative (e.g., Pugh & Girod, 2007; Pugh et al. 2017). While prior studies on transformative experiences in science and the use of the TEQ measure have been conducted in these formal learning settings, the LOCC program was conducted in an informal learning setting. As such, the use of the measure in an informal science learning setting for this study fills an important gap in research. Although the TEQ has not been previously tested in this context, Garner et al. (2016) have developed a theoretical framework to apply the components of the TTES observed in classroom settings to informal science learning. They described how to design transformative experiences using the example of science-themed museum exhibits. The framework specifies three components important for designing transformative informal science learning experiences: *Reframing* the content as ideas that can be further explored, *Re-seeing* the topic and the ways in which it affects them personally, and *Re-enacting* or thinking about how their roles and actions around that topic may be different in the future. Though the LOCC program design was not directly guided by the framework, there is a strong alignment between these guiding design principles of the framework and the program design of LOCC.

The framework's goal of *Reframing* can be explained as a way to prepare the learner "...for the possibility that, through trying out new ideas or new ways of thinking, acting or labeling oneself, he or she might be changed as a result of the [learning experience]" (Garner et al., 2016, p. 346). In the LOCC program, the participants engaged in storyboarding and storytelling exercises about the topic considering their role in communicating with the audience and what messages, images or scenes could be used to communicate with their audience. For example, what information and emotions does a specific image evoke for the audience? Why are these choices important in telling the story behind the impacts of climate change and doing so in their home community? How can their own personal experiences with the topic in their community (e.g., experiencing periods of drought) help them share the message? These activities may have similarly engaged the LOCC participants in a *Reframing* of ideas around climate change and communication about the topic and prepared them for thinking about ideas and possibilities for communication in new and different ways.

Re-seeing aims “to trigger identity exploration through experiences of discrepancies between the visitors’ current identities and their experience with the exhibit, promoting re-seeing of one’s past, present or future, or considering a new role for oneself” (Garner et al., 2016, p. 347). During the LOCC program, the participants were asked to think about and research the effects of climate change on their local communities and interview local experts. They then built a storyline for how they would communicate about the topic with their communities through film and how to incorporate different voices. In this process, we have found that the LOCC participants often think about their actions and roles that they had not previously considered (e.g., Littrell et al., 2020a).

Garner et al. (2016) stated that *Re-enactment* “…aims to promote new thinking, perceiving or acting that the visitor [learner] may do in other areas of the museum [or other informal learning settings], or at other time points after their first attempts at re-seeing” (p. 347). Our prior research suggests that through the LOCC film-making process and its focus on local climate change impacts, the LOCC participants’ thinking changed so that they placed greater importance on climate change and began to see it as a serious issue. In turn, they reported that they began to consider what they could do to help address climate change in the future (e.g., Littrell et al., 2020a). For example, the LOCC participants reported rethinking how they approached environmental challenges, considering what choices they make on a daily basis (e.g., recycling vs. throwing items in the trash; riding a bike vs. driving a car); how they can help their community with these challenges; and what roles they have personally or collectively to make an impact on these challenges (Littrell et al., 2020a; 2020b; Tayne et al., 2020).

The Lens On Climate Change Program and Transformative Experience

Situating the Lens On Climate Change (LOCC) program within the frameworks for transformative experience in formal and informal learning settings (Garner et al. 2016; Pugh, 2002; Pugh & Girod, 2007; Pugh et al., 2020), shows that the experience touched on the same elements that Pugh derived from Dewey's work, and it also aligns well with Garner et al.'s (2016) guidance for developing informal learning to create a transformative experience. The LOCC participants were asked to think about environmental challenges from a new perspective: a) how does [*participant-selected climate change topic (e.g. drought)*] affect my community? and b) what is the best way to share a story about the topic with my community? The program was designed to inspire LOCC participants to think about the science content through an artistic and storytelling lens, thus engaging them in an aesthetic experience and reflection on a climate science topic (for greater detail about the program, see Gold et al., 2018; Littrell et al., 2020a; Oonk et al., 2017).

Method

Research Design and Procedure

The study employed a pre/post quasi-experimental design to explore the level to which the LOCC program was transformative for the participants, using the Transformative Experience Questionnaire. The study included participants from two summer LOCC programs and two academic year LOCC programs conducted after school, as well as a comparison group described below. Students participated in the study from 2016 - 2019, prior to the COVID-19 pandemic in the United States.

LOCC Intervention Group

During the academic school year, comparison group participants were recruited from middle and high schools in the region to take part in an after-school version of the LOCC program so that each cohort of students in both groups would have similar experiences academically while in school (e.g., science education based on the state standards for their grade level) and temporally (e.g., current events during the time of the study). During the summer, LOCC partnered with existing summer programs in the region such as Upward Bound Math Science (UBMS) and the I Have a Dream Foundation (IHAD). We invited students from these programs to take a week of their time in these programs to participate in the LOCC project before returning to the regularly scheduled activities of their home summer program.

Comparison Group

The comparison group participants were recruited from groups of LOCC participants' peers with similar demographics based on gender, race or ethnicity, and grade level. These comparison group participants were peers of the LOCC students, recruited from the same schools during the academic year and from the same home communities and summer programs (e.g., UBMS and IHAD) as the LOCC participants. The comparison group students took part in their academic work as usual either during the school year or in the summer program they were attending and thus had similar experiences as those students who participated in LOCC, with the exception of the LOCC filmmaking project. The summer programs did not offer additional climate change educational units beyond what the LOCC program offered. Some summer comparison group participants also took part in the LOCC program in a subsequent year after participating in the comparison group. However, comparison group participants in our analyses included only those students who had never engaged in the LOCC program.

Participants in both the LOCC intervention group and comparison group were given the Transformative Experience Questionnaire (TEQ) before and after the study period. The comparison group participants were surveyed at the time of the LOCC intervention so that summer and academic year comparison groups completed the surveys at about the same time as the intervention groups and with approximately the same duration between pretest and posttest. However, the comparison group members did not participate in the LOCC program during that year.

Research Questions

In the current study, we examined responses on the TEQ from intervention and comparison group members to show whether or not an informal science learning program was transformative. Specifically, we addressed the following research questions:

1. Did condition (intervention/comparison) statistically significantly predict the participants' scores on the TEQ at posttest, above and beyond grade level (middle school/high school), and timing of program (summer/academic year), controlling for pretest TEQ scores?
2. Where did the participants' measures fall along the TE continuum from before to after the LOCC program?

Participants

Middle and high school students ranging from sixth to twelfth grade participated in this study through the Lens On Climate Change (LOCC) program implementations at 10 different sites across Colorado. A total of 233 students participated in the study, 134 in the intervention group and 99 in the comparison group. There was a 71.6% (n = 96) response rate in the intervention group and a 61.6% (n = 61) response rate in the comparison group for participants who completed surveys at both time points. Only those participants who completed both the pre- and posttest were included in the analysis. The final pre-post analysis sample included 61% of students from the intervention group and 39% from the comparison group. For comparison groups, it was more difficult to collect pre- and posttests because participating students were sometimes absent on the day the test (either pre or post) took place and failed to make up this optional assignment. It was easier for the intervention group to collect both pretest and posttest data or to make up a missed pre- or posttest given that the LOCC participants met regularly with the program team. Even still, some participants in the intervention group did not complete both surveys. Other cases of missing data in the intervention group included a few participating students who did not finish the program.

Specific participant characteristics by condition, program timing, and grade level are reported in Table 1. A majority of the LOCC intervention participants (65.6%) experienced the program during the summer. Across the intervention and comparison groups, over 70% of the participants were in middle school. The gender makeup was similar across the intervention and comparison groups with about 50% boys and girls in each group for those who reported their gender. Both groups were also similarly matched in terms of racial and ethnic identities, with 43.8% of the intervention and 34.4% of comparison group identifying as white; 35.4% of the intervention and 32.8% of the comparison group identifying as Hispanic, Latino, or Spanish origin; and 14.6% of the intervention and 14.8% of the comparison groups identifying as American Indian or Alaska Native (see Table 1). To test whether to control for differences in demographics across conditions, ethnicity/racial group was collapsed into two groups meeting the minimum cell count of ⩾ 5: Not underrepresented in STEM (White, Asian or Asian American) / underrepresented in STEM (all other groups). Chi-square tests of association showed no statistically significant difference in demographic variables by condition (X^2_{gender} = .218., p = .641; $X^2_{\text{underrepresented in STEM}}$ = .379, p = .538).

[Table 1 about here]

Instrumentation

The participants in both the intervention group (the LOCC participants) and the comparison group were given the same modified version of the Transformative Experience Questionnaire (TEQ; Koskey et al., 2018; Pugh, 2011; Pugh et al., 2010a) before and after the LOCC program. The original TEQ was shortened from 29 to 15 items (five from each of the three components of the transformative experience construct—Motivated Use, Expansion of Perception, Experiential Value) to avoid survey fatigue among participants in this informal learning environment. To adapt the instrument to the LOCC program, we replaced the topic that was being measured (i.e., "adaptation and natural selection" on the original TEQ with "climate change") but kept other wording of the prompt the same as in the original instrument. Prior mixed methods research has demonstrated that the TEQ may be modified to focus on different topics, as long as core language within the statement is maintained (Koskey et al., 2018). For instance, we reworded "I'm interested when I hear things about *adaptation and/or natural selection* outside of school" into "I am interested when I hear things about *climate change* outside of school." Items were excluded if it was not clear how to adapt them to focus on climate change or if they repeated ideas that were very similar to those represented in other included items. For example, we included three items on applying knowledge in different ways: "thinking about how to apply;" "looking for chances to apply;" and "applying the knowledge." Two other items about applying knowledge were excluded to make room to represent other aspects of transformative experience. For each survey item, the participants were asked to rate on a 6-point scale how strongly they agreed or disagreed with questions that assessed how they think about the topic of climate change and act on their knowledge, (e.g., "Knowledge about climate change in my community is useful in my current, everyday life." See Figure 1 for the full list of statements).

Evaluating Instrument Modifications

Prior to assessing the participants' TE growth, pretest scores were equated to posttest scores through common item equating (Wright & Stone, 1979). Common item equating is conducted with the purpose of putting measures from pre- and posttest assessments on the same scale (or frame-of-reference) to allow for greater measurement fidelity between assessments. Although the same items are generally used on a pre- and posttest assessment, item difficulties may vary from pre- to posttest with the items appearing more challenging at pre- and easier at post- due to learning.

The process of common item equating began with the development of pretest TE item measures through Rasch rating scale analysis (Andrich, 1978) from Winsteps© version 4.4.5 (Linacre, 2019). All pretest TE item measures were evaluated to determine their suitability as anchors to link pre- and posttest TE measures within an appropriate level of *displacement* (change in item difficulty between measures). Of the 15 items, 12 (80%) were able to be used as anchor items since their displacement measure from pre- to posttest fell within an acceptable range of –0.40 to +0.40 logits (Kenyon et al., 2006). It is not unusual to equate with only three or four common items on small assessments (Pibal & Cesnik, 2011). Thus, having the ability to use 12 items as anchors allows for a higher degree of measurement fidelity between pre- and posttest TE measures.

Each participant's TE measure was also plotted on a Rasch item-person map to visually inspect his or her growth from pre- to posttest. Equating the TEQ at the two time points allowed for this direct comparison where each person was plotted against the items as if placing each participant on a TE ruler.

TE Measure Fit. A polytomous Rasch rating scale analysis (Andrich, 1978; Rasch, 1960; 1980) was conducted to determine the fit of the data to the specifications of the Rasch model to demonstrate evidence of acceptable psychometric quality. This analysis also allowed for the LOCC intervention and comparison groups to be plotted on the TE continuum.

Sufficient item (3.43) and person (3.39) separation were observed on the pre-TE indicating that more than 4 strata or significantly distinct groups of items and the participants were distinguished along the TE measure. Reliability for items (.92) and persons (.92) indicated the ordering of items and participants along the TE continuum is strong and stable (Bond & Fox, 2007). Items spread across the continuum ranged from –1.05 to 1.27 logits. The person mean of 0.15 (*SE* = .47) was statistically similar (within error bands) to the item mean of 0 (*SE* = .15), indicating the items were appropriately targeted for the participants. However, the range of items indicated additional items from the TEQ were needed at the lower and higher ends of the continuum (i.e., easier or harder to agree with). Item point-biserial correlations were acceptable as there were no negatives and they ranged from .67 to .80.

According to Wright and Linacre (1994), acceptable item infit and outfit ranges for rating scales (surveys) are 0.6 – 1.4 MNSQ (mean-square). Infit MNSQ item values ranged from 0.77 to 1.34 and thus were all within the acceptable range. Similarly, outfit MNSQ values were appropriate and ranged from 0.79 to 1.29 across items. Thus, all items fit the Rasch model and were retained to compute the participants' TE scores. The pre- and posttest calibrated measures were used in statistical analyses to address the research questions in this study.

Data Analyses

Once pre- and posttest TE measures were on a similar scale, the research questions were addressed using traditional statistical methods using the equated and calibrated person measures (logits) rather than raw scores. The item difficulty mean is set at 0 in Rasch with higher person measures indicating higher levels of TE and lower person measures indicating lower levels of TE.

One-way ANOVAs showed no statistically significant difference on pre-TE scores by gender ($F_{(1,145)} = .021$, $p = .886$), ethnicity/race ($F_{(7,120)} = 1.27$, $p = .270$), or underrepresented in STEM ($F_{(1,125)} = 2.82$, $p = .095$). The participants' scores on the TEQ on the pretest assessment statistically significantly differed between the LOCC intervention ($M = 0.25$, $SD = 2.02$) and comparison ($M = – 0.81$, $SD = 2.32$), $t_{155} = 3.02$, $p < .01$) groups (See Table 2). As a result of this finding, the baseline differences in pretest were controlled for in the hierarchical regression. Pretest TE measures in the first block, grade level in the second block, program type in the third block, and condition in the fourth block to examine the overall model and unique contribution of each predictor variable on the criterion (posttest TE scores). Dummy coding was used to indicate a target and reference group since the predictor variables were categorical, dichotomous. A G*Power analysis showed that the study sample size exceeded the minimum sample size (N =

68) needed to identify a medium effect (*f* = 0.15) for hierarchical regression with two tested predictors and four total predictors assuming 80% power (1-ß) and a .05 alpha level.

Results

Predicting Post TE Measures

Descriptive statistics for participants' pre- and posttest TE scores are reported in Table 2 in logits where higher scores indicate a higher level of TE. As reported in Table 2, the intervention group's average TE score increased by 0.85 logits, increasing the average score from at to above the item mean set at 0 logits. The comparison group's average TE score increased by 0.18 and remained below the item mean.

[Table 2 about here]

Variance inflation values (VIF) ranged from 1.12 to 1.27 across the predictor variables and thus were acceptable falling below the conservative criterion of 2.5 (Allison, 1999; Everitt, 1996; Miles & Shelvin, 2001), indicating lack of multicollinearity. Multiple linear hierarchical regression results indicated that the overall model was statistically significant, $R^2 = .341$, R^2adj = .323, $F(4, 155) = 19.52$, $p < .001$. Regression results are reported in Table 3.

[Table 3 about here]

The coefficients statistics showed that pretest TE scores were the strongest predictor of posttest TE scores ($\beta = .441$), followed by condition (intervention vs. comparison groups, $\beta = .238$), and program timing (summer vs. academic year, $\beta = .166$). After controlling for pretest TE scores, grade level, and timing of the program, condition statistically significantly predicted the participants' posttest TE scores, $t = 3.41$, $p = .001$. Pretest TE scores explained 27.5% of the variability in posttest TE scores. Condition explained an additional 5.1% of the variability in posttest TE scores. When controlling for pretest TE scores, the intervention group members had a higher score on the posttest TE compared to those in the comparison group.

Program timing statistically significantly predicted the participants' posttest TE scores when controlling for the other variables in the model, $t = 2.23$, $p < .05$. As shown in Table 4, the intervention group, academic year participants ($n = 33$) had a higher average posttest TE score than the participants ($n = 63$) who completed the program during summer. A similar pattern was observed for the intervention group's average growth scores; academic year participants had 0.12 higher growth scores compared to those participating during the summer program.

[Table 4 about here]

As reported in Table 3, grade level did not statistically significantly contribute to the overall regression model. Descriptively, high school students in the intervention group had higher average posttest TE growth scores ($M = 1.34$, $SD = 2.04$) as compared to the middle school students ($M = 0.66$, $SD = 1.98$). The high school students in the comparison group had slightly lower average posttest TE growth scores ($M = -0.15$, $SD = 2.41$) as compared to the middle school students ($M = 0.26$, $SD = 2.91$).

Participants' Scores Along the TE Continuum

The distribution of participants' pre- and posttest TE scores and difference in growth by condition is further illustrated in Figure 1. Overall, a greater shift was observed in TE scores along the continuum for the intervention group than the comparison group. The intervention group's range shifted from –6.83 to 5.72 logits on the pretest to –6.57 to 7.23 logits on the posttest. In contrast, the comparison group's shift in range was more narrow from –6.83 to 4.05 logits on the pretest to –6.57 to 4.66 on the posttest. Additionally, 79% ($n = 76$) of the intervention group's TE scores increased, whereas 50.8% ($n = 31$) of the comparison group's TE scores increased.

[Figure 1 about here]

Posttest TE item measures are reported in Figure 1 and ranged from –0.52 to 1.27. After controlling for pretest TE scores, on average, the intervention group was more likely than the comparison group to endorse statements above the item mean. In general, these statements related to active out-of-school engagement with climate change (e.g., “talk with others,” “think about climate change,” “apply the knowledge I’ve learned”) and unprompted thinking about climate change (e.g., “find myself thinking about climate change in everyday situations,” “look for examples of climate change”). The intervention group’s average measure of 1.10 logits was within 0.17 logits of the most difficult item along the TE continuum (“Outside of school, I talk with others about climate change.”). In contrast, the comparison group’s average measure of –0.63 was below the easiest item along the TE continuum relating to interest in climate science.

Discussion

Transformative Informal Science Education

Over a third of the variability in posttest TE scores were explained by the overall model. This finding is consistent with research in behavioral sciences in that 50% or less of the dependent variable is typically explained (Frost, 2019). Results from this study suggest that participation in this informal science learning program was transformative with regards to the participants’ perceptions, motivations to apply their learning, and value placed on learning about climate change. As the LOCC participants researched topics, interviewed experts and developed films around a locally relevant topic, their posttest TEQ scores shifted towards higher engagement around the topic from before to after the program. This growth was statistically significantly greater for the LOCC participants than the comparison group. Although condition reliably increased the overall adjusted percentage of variance explained in posttest TE scores by 5%, this increase was a small effect size. Further, the average standard error of estimate of posttest TE scores was 2.15 logits for the overall model. Considering posttest TE scores ranged within ±7 logits for this study sample, an *SE* over 2.0 logits is wide. Prior research conducted by Heddy and Sinatra (2013) yielded a large effect size ($\eta 2$ = .39) for differences in TEQ between a comparison group and intervention group applying the Teaching for Transformative Experience in Science (TTES) model (Pugh et al., 2017). However, this prior research did not test or control for any pre-existing differences on the TEQ and utilized a college sample.

A prior qualitative case study (Littrell et al., 2020b) supports the current findings of TE as an important variable to continue to research. We interviewed a small group of four LOCC participants one year after they participated in one of two summer LOCC programs. The case study focused on a deeper look at how the place-based and storytelling components of the LOCC program impacted the students who participated, and thus only students from the LOCC intervention group were interviewed. Though the findings are limited given the small sample, the case study provides support for the findings of the current TEQ study and context on how the project impacted students beyond the program. The LOCC case study students' interview responses suggested that the program was transformative for them, influencing changes in their day-to-day behavior and how they thought about and communicated about climate change differently after the program (Littrell et al., 2020b).

Program Timing Considerations

Our findings revealed that while the dosage of our program was the same for both interventions (~40 hrs.), the time period over which the LOCC participants worked on their films appears to affect their TEQ scores. Changes in the post TEQ scores were higher for those who participated in the academic year programs when compared to summer programs. The results may be due to differences in the format of the programs. The academic year program was conducted after school, over the course of five months, whereas the summer program was condensed into one week with an intensive, all day schedule. It appears that the more spread-out academic year program had a greater impact on the LOCC participants' transformative experiences than the condensed summer program. Further investigation is warranted to suggest why this difference was observed. It is possible that participating in the informal program in a context closer to the formal learning context, after school during the academic year, helped the LOCC participants to more carefully consider the impacts their afterschool experience had on day-to-day life, in- and outside of the classroom. It is also possible that spreading out the LOCC program over a longer period of time facilitated the participants' thinking about the topics they were investigating in a variety of contexts. With more time for reflection or possibly conversations in between the program sessions, the intervention appears to have a stronger transformative effect than the same intervention compressed into a short time period. Similar considerations have fueled a long-standing debate among school administrators on whether teaching on a compressed block schedule or a traditional longer school schedule is more impactful; results show that while the block schedule may have various benefits like improving school climate, student achievements results are inconclusive and vary mostly with teacher preparation for the different format (Zepeda & Mayers, 2006). Although the academic year program showed a stronger transformative experience effect, the LOCC participants also showed growth from the shorter, intensive summer program suggesting that the program was transformative even in the condensed format. While studies have established that the duration of an educational program shows a strong positive correlation with outcomes (e.g., DeLoach et al, 2019; Fredricks & Eccles, 2006), our study adds to this body of literature as we explore exposure to the same program in a condensed or a long-format program.

Program Impact by Grade Level

Results indicated a similar effect for middle school and for high school students. Although post TEQ scores were higher for high school students compared to middle school students in the LOCC program, grade level was not a statistically significant predictor of post TEQ scores overall, suggesting that the level of transformative experience depended more on participation in the LOCC program and program timing than grade level. In other words, the LOCC process of thinking about climate changes in the context of the local communities and discovering creative ways to communicate through film seems to be transformative regardless of whether the participants were in middle or high school. Literature around place-based education shows that place has an important meaning to learners of different ages (e.g., Semken et al., 2017). Our study supports that engaging with locally relevant topics and challenges is similarly impactful for youth learners independent of their age.

While differences exist between the two intervention types, the LOCC participants' TEQ responses support that this film-making project was transformative. In exploring further which component of the program was important for its transformative nature, we draw on Pugh's work as we explore the question. The program design combining science and art in the LOCC program ties in well with Pugh's prior work on how to design transformative science education interventions (Pugh, 2002; Pugh, 2020). Pugh (2002) had indicated the parallels between science and aesthetic experiences, suggesting that when students (or scientists) frame science concepts in a new and dynamic way they may have an experience that is similar to engagement with art and sparks further interest in similar ways. In the LOCC program, participants focused on investigating and learning about science around how climate change affects their home communities. While this process alone may be transformative, we have found that the process of participants exploring their self-selected topics further by thinking about different ways to communicate with their audience through artistic means (i.e., film and storytelling) was also impactful (Littrell et al., 2020b). In this way, participants combined the art of storytelling and film with science learning. Many other studies have shown that this combination of art and science increases learning, interest and engagement with science (Gold et al., 2015; Littrell et al., 2020a, 2020b; Otto, 2017; Rooney-Varga et al., 2014; Trott & Weinberg, 2020; Walsh & Cordero, 2019). While the artistic lens is only one facet of transformative educational experiences, it is likely an important contributor to the success of the LOCC program.

Item Difficulty Along the TE Continuum

Items in the Transformative Experience Questionnaire (TEQ) fall along a continuum of item difficulty from items that are easy to endorse to items that are difficult to endorse. Typically, when the TEQ has been used in formal learning settings, the items that refer to in-school or in-class experiences are easier for learners to endorse, whereas the TEQ items that focus application of learning outside of school tend to be more difficult for learners to endorse (e.g., Pugh et al., 2017). Results for the LOCC program showed that in general, the hierarchy of item difficulty was similar to what is usually observed, even in an informal science learning setting. The intervention group was more likely than the comparison group to endorse statements that fell above the item mean and these items were mostly statements related to out-of-school experiences or spontaneously thinking about climate change without being prompted. However, two of the “during class time” items (items 2 and 7) had item difficulties above the item mean, indicating that they did not fit the typical pattern of item difficulty. One possible explanation for this observation might be that the students in the intervention group were considering their traditional class time when responding to items targeting “during class,” which was really outside of the after-school or summer program context. Future studies implementing the TEQ measure in informal settings should consider if it is appropriate to decipher between *during the program sessions/classes* as compared to *in class during school* to meaningfully capture engagement moving from beyond the context in which the topic was learned.

Limitations to the Study

The findings of this study are limited by characteristics of the sample. There were baseline differences in TE scores at pretest in the intervention and comparison groups. This was addressed in the analyses conducted, but remains a limitation in that the participants who chose to attend the LOCC program may have been different than those who joined the comparison group. Recruitment of the comparison group participants aimed to include approximately the same number of students as in the intervention group. However, it was difficult to collect data from students in an informal setting outside of the LOCC program. If students were absent on the day of the pre- or posttest, it was much easier to meet with them on a different day to participate in the survey if they were in the intervention group than the comparison group, given that program staff met with the intervention students on a regular basis. However, even still, some of the LOCC participants took only the pre- or the posttest survey and could not be included in the current analysis. As a consequence of these conditions, the final design was unbalanced in that the intervention and comparison groups had different numbers of participants. Additionally, we were not able to follow-up with students longitudinally to determine the long-term impact of the transformative experience on their engagement in science and sustainability efforts around climate change in their communities and beyond. However, students in a case study published prior to this study, indicated that within a small group of students interviewed one year after the LOCC program, there was a continued desire to communicate with and educate their families and communities about local environmental challenges and suggest potential solutions (Littrell et al., 2020b). Despite these limitations, we believe the results provide a strong case for transformative experiences in informal science learning settings and support use of the TEQ as a measurement tool that can be adapted for use in informal learning to better understand the immediate impacts on youth's thinking and intentions to continue to engage in learning and engagement.

Theoretical and Practical Implications

Pugh and colleagues' prior work around transformative experiences in science has mostly taken place in formal educational settings. The current study explored transformative experience for the first time in an informal science learning setting, using the Transformative Experience Questionnaire. We believe that the Garner et al. (2016) framework may help to further explain why the LOCC program was a transformative experience for the participants. This framework includes three mechanisms that should be included in informal learning experiences to design them to be transformative. These include Reframing the content to encourage exploration and generation of new ideas around the topic; Re-seeing the topic through the lens of this reframing; and Re-enacting or thinking about the topic in new ways such as how they might change their roles and actions around that topic in the future.

The LOCC program participants were encouraged to *Reframe* their ideas around climate change and environmental challenges with a focus on how it impacted their community and the places that held value for them. The process of researching the effects of climate change on their communities and building a storyline for their films likely engaged them in *Re-seeing*—thinking differently or building new interpretations of these challenges as important issues that affect them personally. Further, our prior research suggests that the LOCC participants also engaged in

Re-enactment by shaping their thinking around how they could help their communities either through direct action or continued communication with family or community members about climate change and other environmental challenges after the program (Littrell et al., 2020a, 2020b; Tayne et al., 2020). This is further supported by the outcomes of the current study, showing greater change in the LOCC participants' TEQ scores in contrast with the comparison group and overall demonstrating that informal science learning programs that align well with the Garner et al. (2016) framework have the potential to be transformative.

Prior research makes a strong case for the deep educational benefits for learning science in informal settings, including impacts on learners' science identity, attitudes and interest in science, and motivation to continue their learning (Dabney et al., 2012; Gerber et al., 2001; Goff et al., 2019; Littrell et al., 2020a; Mulvey et al., 2020; Whitesell, 2016; Yildirim, 2020). So, one might ask why is it important or necessary to focus on designing these experiences to be transformative in the specific ways outlined in this study and the Garner et al. (2016) framework? When it comes to climate change, we are no longer in a position to "wait and see" what will happen in the future. There is an urgent need for immediate action, and this requires new thinking from youth and adults alike (Hodson, 2003; Trott & Weinberg 2020). In a recent study, Trott and Weinberg (2020) suggested that while many sustainability-focused science education programs in the United States emphasize increasing or strengthening the STEM pipeline, this alone is not an adequate solution to address the major environmental challenges our planet currently faces. They indicate that "…the modes of transformation required to adequately address sustainability challenges are those that force us to rethink, reinvent, and restructure our institutions…" (p. 2). And they suggest that in order to do this, youth science education needs to focus on empowering youth toward continued interest in taking action for a sustainable future.

Furthermore, we note that there are similarities to the LOCC program in both the approach this recent study took to connecting with students and the goals for the program's intended impacts on students. Trott and Weinberg (2020) engaged youth in grades four through seven in learning about climate change through an after-school program called Science, Camera, Action! (SCA). In this program, youth participated in learning activities on climate change and then used a method called Photovoice, in which they took digital photos in their communities and reflected on how those photos connected with the topics they had learned. Similar to the LOCC program's use of film to engage students in deeper learning, SCA combined learning about climate change with artistic and creative expression and reflection through photography. Trott and Weinberg's (2020) focus on getting youth to "rethink, reinvent, and restructure" parallels Garner et al.'s (2016) framework goals to encourage "re-framing, re-seeing, and re-enacting," suggesting that although described differently, these programs center around the same goals and share a common perspective on how to transform youth's perspectives and empower them toward deeper engagement. Furthermore, in another recent paper on the SCA program Trott (2021) cited Transformative Learning Theory (TLT) as a framework guiding the SCA program. TLT is discussed in the literature as a separate paradigm with different explanations for the occurrence of transformation than the frameworks for transformative learning in science we have discussed heretofore, yet the outcomes are quite similar in our understanding of what transformative learning means. TLT posits that some learning experiences create cognitive dissonance—a sense of discomfort or disorientation created when a new perspective does not match their prior perspectives or views of the world. This cognitive dissonance can lead learners through a series of emotional and cognitive states as they begin to reflect on their learning and move toward perspective changes and sometimes toward taking actions that address the discrepancy between their prior and new ways of thinking (Mezirow, 2008; Trott, 2021). A goal for future research should include a deeper, and perhaps broader, understanding of how and why these types of programs with similar design elements and goals are effective at transforming students' perspectives by bringing together the aspects of these programs that tap into cognitive, affective, and behavioral changes. Future research should also seek to understand whether or not these transformative experiences continue to inspire students to be engaged well beyond the initial learning experience.

One way in which informal learning experiences could be examined more broadly is through the lens of the Sociocultural Learning Theory, which recognizes the importance of social connections and cultural contexts as embedded aspects of the learning experience and what is learned (Deloria et al., 2001; Semken et al. 2017; Vygotsky & Cole, 1978). The LOCC program was designed originally with a focus on Place-based Education (PBE) to suggest how place connects learners to science topics through the contexts in which they live and learn (Gold et al., 2015; 2018; Littrell et al., 2020a; 2020b). Many of the LOCC design aspects also align with another STEM learning theoretical perspective for informal settings, the Connected Learning Framework (Ito et al., 2013). This framework also draws on concepts from Sociocultural Learning Theory and emphasizes the use of new media to connect students' learning about science within relevant social and cultural contexts. Connected learning occurs when youth pursue learning about topics that they have personal interest in with the support of their community (e.g., parents, friends, teachers, etc.) and they are able to connect that learning with opportunities to further engage with their community or pursue related paths in civic engagement, academics, or careers (Ito et al., 2013). The LOCC program aligns with several of the design elements proposed within this framework. For example, students worked with peers and adults toward a shared, production-centered goal—in this case they worked together to build a story to communicate with their community through film for the purposes of educating or calling others to action around climate change or other environmental challenges. Film projects in the LOCC program were driven by the youth participants' personal interests as they investigated local environmental concerns with the use of digital media, through researching science topics online and searching for community members to interview, and through engaging with community members and family with interviews on their film topic. This connected learning approach has been described as a way to bridge the gap between in-school and out-of-school learning, especially for youth who may not typically have access to such opportunities (Ito et al., 2013). The parallels in the design of Trott and Weinberg's (2020) Science, Camera, Action! (SCA) program and Ito et al.'s (2013) Connected Learning Framework are also apparent. Similar to LOCC, the SCA program engaged youth in personally relevant, goal-oriented learning and expression of their perspectives on family-based and community-based solutions to climate change through the use of digital media (digital photography). These similar design frameworks for learning settings illustrate a roadmap for designing effective learning experiences that strengthen youth agency and personal engagement with science topics.

Future Directions

Future research should seek to understand how existing frameworks that focus on transformative experience and sociocultural connections with science topics in informal learning settings (e.g., Garner et al., 2016; Ito et al., 2013) can come together to empower youth to become active participants in science and sustainability efforts. Of particular importance is honing in on how elements of programs like the Lens on Climate Change can be better designed to inspire and empower youth in a powerful and lasting way. As demonstrated here, the

Transformative Experience Questionnaire provides an additional method for measuring youth's changing perceptions, motivations, and inspiration to take action, and it aligns well with other existing theoretical approaches and a call for transformative change.

Environmental education programs often focus on individual actions youth can take in their everyday lives toward sustainability. However, in order to realize change that will have a significant impact on the health of the planet, we need youth to also think in new ways to affect collective change across communities and more broadly within existing institutions, nearby regions, and around the world (Kenis & Mathijs, 2012; Tayne et al., 2020; Trott & Weinberg, 2020). Thus, future research should also take a longitudinal approach to understanding how transformed attitudes, perceptions, and motivations affect both individual and collective behavioral change long term, and how likely it is that young people will continue along the path of learning and engagement beyond their informal learning experiences.

Conclusions

This study illustrated a first "real-world" application of the transformative experience framework for informal science settings outlined by Garner et al. (2016). This study also demonstrated that the Transformative Experience Questionnaire (TEQ) provides an effective measure of transformative experience in informal learning settings, building on past research that has utilized the TEQ in only formal learning settings. The LOCC program also had an effect on multiple age groups, with similar TEQ results for middle and high school-aged participants. Another important finding was that having a longer program duration had a greater impact on transformative experience, even though the participants in the condensed program engaged in approximately the same amount of time on the project and in working with their mentors. This has potential implications for the design of similar programs. Our findings highlight the need to further examine the degree to which different informal learning settings (e.g., libraries, museums, after-school and other short-term programs) provide transformative experiences for participants. More research could be done to explore ways to engage participants in a transformative experience given the unique opportunities and challenges of informal, non-guided educational settings. For example, how do we best engage intergenerational audiences in the scaffolding of reframing, re-seeing, and re-enacting of experiences? Are there ways in which a learning opportunity (e.g., educational program; workshop; exhibit) may be designed to engage participants in an educational experience with limited time constraints (e.g., visiting a library or museum exhibit on one occasion)? Our study suggests that the TEQ can be successfully applied for informal science settings; however, more research could be done on how to shorten the measure to be more appropriate for informal science contexts and whether or not the references to formal science education settings (e.g., school) are an effective comparison for participants. The findings of the present study around the impacts of informal learning programs are important for science learning broadly, but they are also important in a time when concerns about the immediate and long-term effects of climate change are growing. Transformative experiences have the potential to not only increase young people's interest in science, but also to encourage them to continue their learning, communicate about the science with others, and contribute to actions to mitigate environmental challenges and lead to a more sustainable future.

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Conflict of Interest Statement

The authors agree that there are no conflicts of interest to report, related to the contents of this manuscript.

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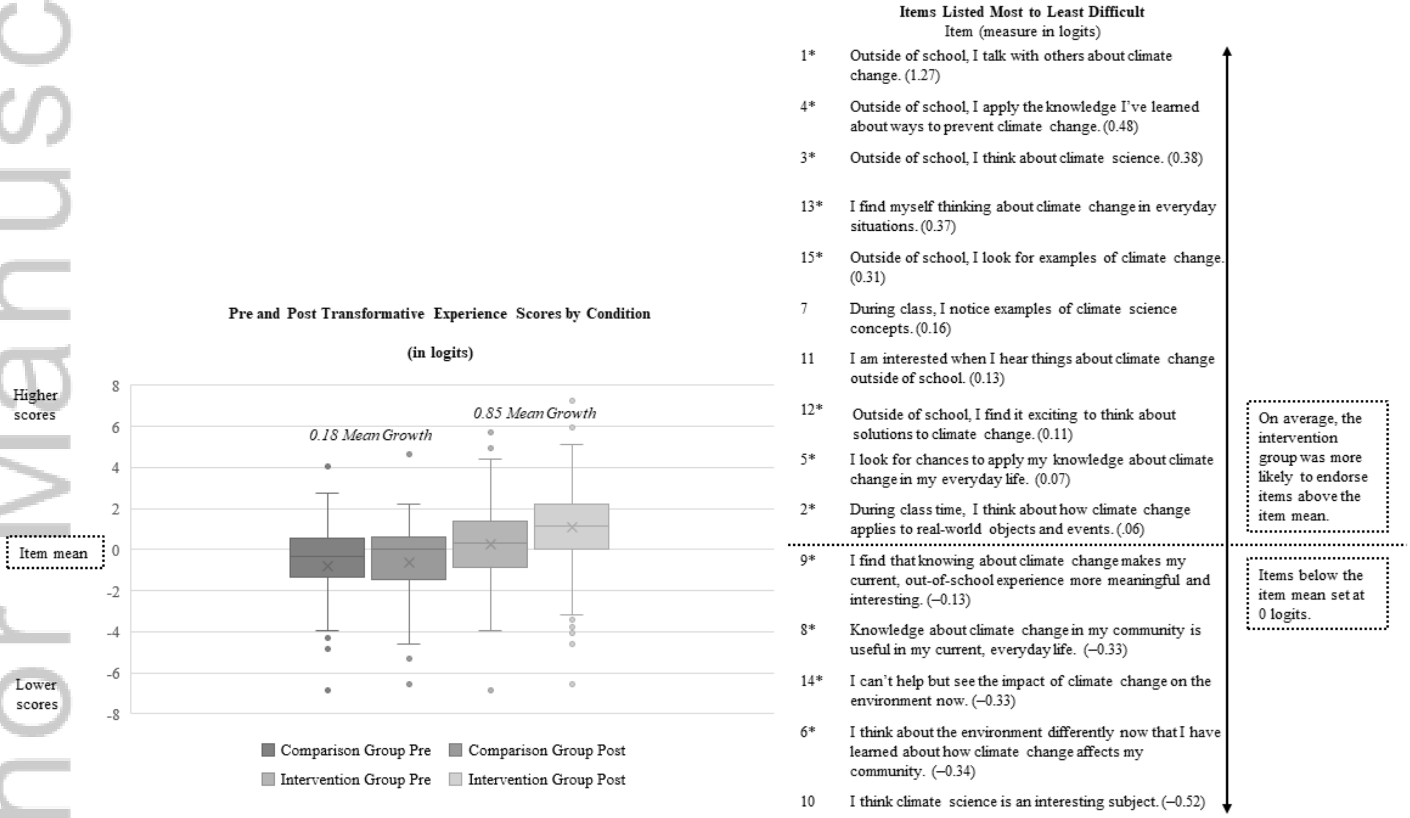

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Table 1

Descriptive Statistics by Group for Participants Completing the Pre and Post TEQ

Group	Condition					
	Intervention Group (*n* = 96)		Comparison Group (*n* = 61)		Overall (*N* = 157)	
	f	%	*f*	%	*f*	%
Program Timing						
Summer	63	65.6	29	47.5	92	58.6
Academic Year	33	34.4	32	52.5	65	41.4
Grade Level						
Middle School	68	71.6	50	82.0	118	75.6
High School	27	28.4	11	18.0	38	24.4
Gender[1]						
Boy	48	53.9	29	50.0	77	52.4
Girl	41	46.1	29	50.0	70	47.6
Not reported	7	7.3	3	4.9	10	6.4
Race or Ethnicity[1]						
White	42	44.7	21	34.4	63	40.6
Hispanic, Latino, or Spanish origin	34	36.2	20	32.8	54	34.8
American Indian or Alaska Native	14	14.9	9	14.8	23	14.8
Asian or Asian American	5	5.3	1	1.6	6	3.9
Black or African American	3	3.2	8	13.1	11	7.1
Native Hawaiian or Pacific Islander	1	1.1	2	3.3	3	1.9
Other	7	7.4	5	8.2	12	7.7
Not reported	6	6.3	6	9.8	12	7.3

Note. [1]Percentages computed out of those who responded to this survey item.

Table 2

Descriptive Statistics for Participants' Transformative Experience Scores by Condition (N = 157)

	Intervention Group (n = 96)		Comparison Group (n = 61)	
Scores (logits)	*M*	*SD*	*M*	*SD*
Pretest TE Scores	0.25	2.02	– 0.81	2.32
Posttest TE Scores	1.10	2.50	– 0.63	2.42
Growth	0.85	2.00	0.18	2.81

Table 3

Change Statistics and Coefficients for Posttest TE Scores

Predictor Variable[1]	F_{Change}	R	R^2	Adjusted R^2	SE	R^2 Change	t	Unstandardized Coefficient	Standardized Coefficient β
Pre-TE	58.54***	.525	.275	.271	2.23	.275	6.30***	.524	.441
Grade	0.76	.528	.279	.270	2.23	.004	1.31	.570	.094
Program Timing	2.38	.539	.290	.276	2.22	.011	2.23*	.878	.166
Condition	11.61***	.584	.341	.323	2.15	.051	3.41***	1.27	.238

Note. [1]Middle school coded as 1, academic year program coded as 1, intervention group coded as 1.
*p < .05. ***$p \leq .001$.

Table 4

Descriptive Statistics for LOCC Participants' Transformative Experience Scores by Program Timing

	Summer (n = 63)		Academic Year (n = 33)	
Scores (logits)	*M*	*SD*	*M*	*SD*
Pretest TE Scores	– 0.17	1.96	1.05	1.90
Posttest TE Scores	0.64	2.39	1.99	2.51
Growth	0.81	2.04	0.94	1.96