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Exploring the Impacts of Educational Simulations on The Development of 21st Century Skills and Sense of Self-Efficacy

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ABSTRACT

The study of educational simulations at the secondary level has typically centered on programs that are competitive, shorter in duration, and characterized by their low fidelity, or a lack of realism. The resources required to hold longer, more immersive, and nuanced programs are often prohibitive for teachers of political science programs. As such, their effects on student learning outcomes have remained relatively unknown. In this paper, we explore the impact of a Model G20 (MG20) curriculum for high school and early college-aged students on students' sense of self-efficacy and 21st century skills. MG20 is a weeklong, immersive international conference modeled after the real G20 summit. In it, students learn about global governance and roleplay as heads of state and government ministers to negotiate for their collective interests. Using a mixed methods approach, we examine student learning outcomes from two MG20 summits, held in the United States and in the UK. Results show that internationally diverse, immersive, collaborative role-playing simulations significantly improve students' self-ascribed cross-cultural communication and public speaking skills, as well as students' sense self-efficacy. This research suggests future study into new and emerging formats of educational simulations may reveal greater potential for such programs to enhance student learning.

Organizers of simulations like Model UN (MUN), Model Arab League, and Model NATO face many challenges administering such events. These simulations, defined as "ongoing representations of real situations" (Ellington et al. 1998, 2), enable students to engage in active learning about global governance and international relations (Pettenger et al. 2014; Pass 2016). Such programs require an immense time investment by teachers and students (McIntosh 2001; Asal and Kratoville 2005; Pettenger et al. 2014; Raymond 2010; Wheeler 2006), yet studies reveal a demonstrative "reality gap" between simulated events and their real-world counterparts (Muldoon 1995; Zeff, 2003). Educators further lament that veteran

students leverage procedural knowledge from "playing the game" rather than a close, continuous study of the actual UN. Reflecting on 50 years of MUN, Muldoon (1995) further asserts that students' learning could be improved by expanding their geographic reach and integrating educational professional communities and technologies in their administration.

This research examines to what extent closing these gaps can improve student learning outcomes, specifically 21st century skills and a sense of self-efficacy, at the high school level. Much of the literature on political science simulations focuses on post-secondary simulations, which are either standalone programs or are integrated into advanced undergraduate- or graduate-level courses (Hatipoglu et al. 2014; Galatas 2006; Shellman and Turan 2006; Engel et al. 2017). Their assessments also tend to focus on the acquisition of content knowledge over skills (Raymond 2010; Jesuit and Endless 2018; Chasek 2005). We explore the impact of two Model G20 (MG20) simulations, one in Cambridge, United Kingdom and one in Boston, Massachusetts, on secondary students' acquisition of 21st century skills and sense of self-efficacy, revealing the value of investing in simulation learning programs at the high school level.

The MG20 model

MG20 is an immersive, weeklong simulation of the G20 Summit aimed at secondary students. It is not unlike many other conference-based simulations that have been examined over the last several decades, the most studied of which is MUN (McIntosh 2001; Hatipoglu et al. 2014; Engel et al. 2017; Jesuit and Endless, 2018). Both MUN and MG20 students role-play as representatives of member states and gain experience in international diplomacy and intergovernmental decision making. Because of the facilitation challenges stated above, high school simulations tend to be shorter, lower-fidelity events than their post-secondary counterparts, which often benefit from greater resources (Muldoon 1995; Dunn 2019).

By design, MG20 bridges the gap between most college and high school simulations. Administered by Knovva Academy, the official knowledge partner of the Y20, MG20 closes the "reality gap" through alignment with the actual G20. The MG20 is often held alongside G20 events, and its curriculum is designed to reflect current discussions and priorities. This curriculum is developed by a team of teachers who study each year's G20 agenda, giving students a recent—often real-time—model to guide their research. High-performing students are invited to participate in a smaller summit, called a Task Force, where they present their communiqués to the actual Y20. By comparison, the UN does not officially endorse or cooperate with MUN simulations, and few other programs integrate actual UN representatives (Hatipoglu et al. 2014). MG20 students complete pre-summit training online, which enables them to arrive with a baseline understanding of G20 history and vocabulary. At the event, they continue to train in public speaking and negotiation, and apply these skills at ministerial meetings, which they attend in business dress. Discussions are further guided by "classified files," which outline country-specific objectives and constraints, enhancing their veracity.

Finally, unlike many high school MUN programs, MG20 is an inherently international experience, hosted in a new country each year with students from around the world. As such, MG20 fosters sustained, *un*-simulated cross-cultural collaboration. Delegations and ministerial groups are further diversified by gender, age, and origin.

Of note, MG20 includes both residential and nonresidential students, the impacts of which have not been thoroughly explored in the literature.

Learning outcomes

21st Century Skills are essential in today's knowledge-based economy. These skills include creativity and fluency in communication technologies (Levy and Murnane 2004), critical thinking (Bellanca and Brandt 2010; Trilling and Fadel 2010), collaboration, sociocultural skills, problem-solving, self-directed learning, and entrepreneurship (Voogt and Roblin 2012). In this research, we examine the following skills, as they most closely align with MG20 curriculum and events:

- **Creative problem-solving**: The process of redefining problems and opportunities and generating new and innovative solutions.
- **Cross-cultural communication**: Communication between people with differences in age, nationality, religion, race, and gender, through speaking and body language.
- **Teamwork**: The collaborative effort of a group of people to effectively and efficiently achieve a common goal.
- **Public speaking**: The act of performing a speech to a live audience.

While some studies reveal a positive relationship between simulation learning and skills acquisition, like the above, many of their findings are often anecdotal and evaluate students at the college level:

Sense of Self-Efficacy is defined as "beliefs in one's capabilities to organize and execute the courses of action required to manage prospective situations" (Bandura 1995, 2), and overall human attainment (Bandura 1992). Self-ascribed self-efficacy can be predictive of academic success, as well as students' ability to regulate their own learning (Coutinho and Neuman 2008). With respect to self-efficacy, we do not find any such analyses in the simulation literature. However, similar skills are explored, such as self-motivation (Galatas 2006) and awareness of one's learning (Pettenger et al. 2014).

Methods and results

In this research, we analyze the value of an MG20 curriculum for promoting skills-based learning in two high-fidelity, weeklong, immersive simulations in Cambridge, United Kingdom and Boston, Massachusetts. Through pre- and post-Summit surveys, participant observation, and student interviews and video journals, we test the following hypotheses as they relate to students' learning objectives:

H1: The MG20 simulation will positively impact students' self-assessment of 21st century skills, namely:

1. Creative problem-solving
2. Cross-cultural communication
3. Leadership
4. Teamwork
5. Public speaking

H2: The MG20 simulation will positively impact students' sense of self-efficacy.

Quantitative findings

We surveyed a combined 119 students enrolled at the two 2019 Knovva MG20 summits. After eliminating students who did not complete both the pre- and post-test and those for whom we did not obtain informed consent,[1] we arrived at our pooled sample of 88 students ($n = 42$ at the Boston Summit and $n = 46$ at the Cambridge Summit).

Demographics

The survey included demographic questions about student nationality, race/ethnicity, and language (including fluency) to establish the diversity of participating cultures and cross-cultural communication. These questions were followed with an open response about what students hoped to get out of MG20, placed early to increase answer length (Galesic and Bosnjak 2009), as well as a question about which target skills students hoped to improve. Our results showed students ranged in grade level from late middle school to early college, the majority of whom were grades 9–12. Of this group, 66 (75%) were native English speakers and 22 (25%) spoke English as a non-primary or secondary language.

These surveys were administered in Survey Monkey, with the pretest being completed upon students' arrival at the conference, and the post-test being completed on the final day of each summit. Pre- and post-summit surveys were compared using Wilcoxon's matched-pairs signed-ranks test (MacFarland and Yates 2016) on the pooled responses from the US and UK summits.

With regard to 21st century skills, the most significant changes were observed for skills directly related to the summit activities (Table 1):

21st century skill	Source	Findings
Creative problem-solving (or critical thinking)	Engel et al. 2017; Shellman and Turan 2006; Dougherty 2003	Findings appear to correlate with students' preparation and commitment.
Cross-cultural communication	Shannon 2020; Shellman and Turan 2006	Few studies examine cross-cultural communication, but some do explore students' attitudes toward the cultures they simulate.
Teamwork	Engel et al. 2017; Dougherty 2003	Based on facilitators' observations and students' written reflections.
Public speaking	Dougherty 2003; Crossley-Frolick 2010; Lantis 1996	Based on facilitators' observations of students' performance rather than students' comfort.

Creative problem-solving

On the whole, there was a positive and statistically significant change between students' pre- and post-summit confidence in solving problems creatively. However significance varied by subgroup; only alumni and primary English speakers showed significant, positive change. This may suggest that confidence in one's creative problem-solving may be partly dependent upon one's comfort or familiarity with the language and procedure of the summit.

Cross-cultural communication

These summits placed students in settings in which they communicated with people from different cultures and different parts of the world. Therefore, unsurprisingly,

Table 1. Results for variables relating to 21st Century Skills.

21st Century Skills	Total Sample		Primary English Speakers		Non-Primary English Speakers		First time participants		Alumni	
	Means Pre/Post	Significance	Means Pre/Post	Significance	Means Pre/Post	Significance	Means Pre/Post	Significance	Means Pre/Post	Significance
Public speaking	**3.2262**	**−4.2090*****	**3.4390**	**−2.9600****	**3.0750**	**−2.8640*****	**3.0984**	**−3.8560*****	3.5652	−1.7920*
	3.7412	**(0.0000)**	**3.9024**	**(0.0031)**	**3.6500**	**(0.0042)**	**3.7097**	**(0.0001)**	3.8261	(0.0732)
Problem solving	**3.6548**	**−1.6840***	**3.8537**	**−1.8300***	3.5000	−0.1910	3.6721	−0.8970	**3.6087**	**−1.7320***
	3.8118	**(0.0921)**	**4.0976**	**(0.0672)**	3.5500	(0.8487)	3.7581	(0.3699)	**3.9565**	**(0.0832)**
Teamwork	4.0596	0.6720	4.3659	0.8390	3.7750	0.3010	3.9672	0.0350	4.3043	1.2170
	3.8588	(0.5014)	4.0488	(0.4015)	3.6250	(0.7632)	3.8710	(0.9717)	3.8261	(0.2236)
Cross-cultural Comm.	**3.7024**	**−3.6780*****	**3.8293**	**−2.5610****	**3.6250**	**−2.3500****	**3.7541**	**−2.8850****	**3.5652**	**−2.2990****
	4.0471	**(0.0002)**	**4.1951**	**(0.0104)**	**3.8750**	**(0.0188)**	**4.0645**	**(0.0039)**	**4.0000**	**(0.0215)**
Leadership	**3.5596**	**−2.5370****	3.9512	−1.1940	**3.2000**	**−2.1800****	**3.4426**	**−2.8680****	3.8696	−0.1920
	3.8	**(0.0112)**	4.0244	(0.2324)	**3.6250**	**(0.0292)**	**3.7742**	**(0.0041)**	3.8696	(0.8478)

Note: Table presents z-values obtained from Wilcoxon's matched-pairs signed-ranks test. Prob > z values are provided below the z-values in parenthesis. Results are generated using the signrank command on Stata. *** indicates significance at $p < 0.01$. ** indicates significance at $p < 0.05$. * indicates significance at $p < 0.10$.

students' perceived ability to engage in cross-cultural communication improved significantly for both the pooled sample and for subgroups, across the board.

Leadership

Taking on leadership roles was found to be significant among the combined student population, but more so among non-primary English speakers and first-time students. This may be due to cultural differences, as many of the alumni and primary English speakers were American, and had high pre-summit confidence levels in their leadership skills. It's also possible that non-primary English speakers and first-time students simply had lower expectations for their performance before the summits, because of their language or inexperience in such programs.

Teamwork

Surprisingly, a comparison of students' pre- and post-summit surveys revealed a negative, albeit not significant, change in their confidence collaborating in teams. This was true for the pooled sample and all student groups, except for alumni, who reported an overall positive, albeit not significant, change. Students' qualitative assessments offer some insight into this finding.

Public speaking

Students' confidence in public speaking seems to have significantly improved between the pre- and post-summit survey. This improvement holds true for both native English speakers and those who spoke English as a second or third language. One exception was alumni, which might indicate that the impact of the simulation on students' confidence in public speaking is likely to decline with experience. This might be driven by the potential for returning students to have already achieved significant improvement in their self-assessments of public speaking.

Sense of Self-Efficacy

To measure overall baseline self-efficacy, the "Self-Efficacy Formative Questionnaire" (Gaumer Erickson et al. 2018) was implemented. The pre- and post-summit tests evaluated changes in students' perceived ability to achieve certain goals and milestones by asking them to evaluate whether 13 statements accurately described them (see Appendix).

Surprisingly, we found little to no significant change for most items. Among those exhibiting significant change, the change was, however, mostly positive. For the total pooled sample, only two items showed significant, positive overall change. These were for the statement, "I will succeed in whatever career path I choose" and "I think that no matter who you are, you can significantly change your level of talent." Among primary English speakers, the former was also significant and positive, while students' belief that their "ability grows with effort" was significant, albeit *negative*. Among non-primary English speakers, we found that only the item, "I think that no matter who you are, you can significantly change your level of talent," showed a positive and significant change.

First-time participants' self-assessments of their ability to improve, with effort, was also significantly negative. Among alumni, their belief that talent improves with effort and that "the brain can be developed like a muscle" were both found to be both positive and highly significant. This latter finding appears to make sense, given that this group benefited from applying their learning at more than one summit and could take stock of their change over time.

It was surprising to learn that many of the other survey items showed a negative, albeit mostly not significant change. There could be many reasons for this. One possible reason relates to the size of our sample, which was limited to two MG20 simulations. Further, this sample was composed of extraordinarily high-performing students from around the world. Despite MG20's affordability and the availability of scholarships for many students, MG20 participants tend to derive from elite private schools, and alumni often go on to attend competitive universities. There is clear selection bias there, which seems to be confirmed by high baseline self-efficacy scores (4+ out of 5) in the pre-summit surveys. We believe these high baselines reduced the usefulness of the reported self-efficacy instrument (Gaumer Erickson et al. 2018), because significant improvements were quantitatively unlikely. Relatedly, we found one negative, significant change among primary English speakers. This may have been because these students were mostly American and entered into a challenging simulation very confidently. Finally, we also consider Raymond's (2010) assertion that student self-assessments may be inherently flawed. However, because we are measuring a change in students' confidence in their own skills, we feel that a self-assessment approach is warranted. We interrogate this assumption further, in our qualitative analysis, which follows.

***

Overall, these findings provide evidence that simulations like MG20 are likely to enhance students' self-assessments of certain 21st century skills. The quantitative survey revealed significant improvement to students' public speaking, cross-cultural communication, and collaboration skills, which related directly to the facilitated simulation activities. On the other hand, the simulations' effects on students' sense of self-efficacy are quantitatively inconclusive.

Qualitative findings

While Baranowski and Weir (Baranowski and Weir 2015) argue that administering pre- and post-tests is the most suitable design for evaluating simulations, Wright-Maley (2015a, 2015b) asserts that because simulations are characterized by their fluidity and dynamism, methods which capture additional facets of the simulation are ideal. Therefore, we elaborate on these findings through observations and interviews. This approach connects and builds on findings from other simulation studies, which tend to take a more singular or qualitative approach (Duchatelet et al. 2018; Jefferson 1999; Raymond 2010).

In this section, we report on the main themes and patterns that emerged during the simulation. While there is no single coherent theory that explains how and why simulation learning works, several have been proposed. Kolb, Rubin, and McIntyre (1984) model of experiential learning is perhaps the most cited. He divides the simulation into

a fluid series of phases during which participants build upon past experiences and assumptions with active learning and reflection (Bryan, Kreuter, and Brownson 2009; Okuda et al. 2009). Through each phase, students' newfound knowledge is integrated into their existing body of knowledge, which either matches or departs from their expectations. Along the way, new knowledge and understanding are either produced or reinforced (Perkins 2007). In the next sections, we trace this process through three stages: role-play and experimentation, reflection and debriefing, and abstract conceptualization. In each, we highlight the most prominent 21st century skills and the development of a sense of self-efficacy through the authors' observations and students' interviews and video journals.

Role-play and experimentation

Following a series of in-person, skills-based workshops, which provided students with the scaffolding necessary to begin working within and between their country groups, students began negotiations, or "deal-making." It is here that we witnessed the most salient shifts in **leadership** and **teamwork** style. While engaging in and between groups, the need for students to adjust their leadership and problem-solving approaches to be more collaborative and less adversarial was apparent. This was especially true for many students who had participated in MUN in the past. These students found that to succeed in making a deal, they had to engage the other group's interests both individually and as a whole, which required generating multiple solutions and having "open, complicated discussions about complex solutions," according to one student.

Another student pointed out that in their MUN experience, only one person represented a country, whereas in MG20, multiple people represent a country, which required more collaboration than they had experienced at MUN. While these students emphasized how the structure and number in each group changed the way they were used to negotiating, another student emphasized the differences in the programs' culture. According to the former MUN delegate, MG20 felt more informal and intimate than MUN, which required him to be more prepared. Another student supported this assertion:

> "[MG20] is more [about] the collaboration part of things. I learned how to collaborate more efficiently … It's not just about debating, it's about finding solutions."

Perhaps the most salient observations of positive change in students' self-perceptions came when students reflected upon their experiences in **cross-cultural communication** and the friendships that emerged from them. Consistent with the literature on MUN and longer simulations, these observations also focused on events that took place alongside and in between the program-facilitated role-play, rather than during the simulation itself. These students spoke at length about the interactions that took place in their hotel or dorm rooms and during evening extracurricular activities, such as the student talent show.

Although the authors observed that students largely remained in character and continued their negotiations during meals, breaks, and evening events, students noted that there was a difference in the quality of relationships they built between formal settings.

This difference emerged when residential and nonresidential cohorts reflected on their experiences in interviews and video journals. As one nonresidential student from the Boston summit pointed out, "We don't have that residential piece that forces us to build those strong relationships." Another related, "I think it's more fun and beneficial to be in the residential program because I get to actually work with my team [more] physically." Overall, students were observed engaging extensively with others from different countries and cultures at both summits, and students' reflections and interviews from each (apart from this residential difference) focused on the novelty of these experiences rather than the challenges they introduced.

One final prevalent subject of students' reflections was their perceived improvement in **public speaking**. In this respect, students' reflections supported the findings of our quantitative analysis, which found that students' confidence in public speaking improved across the pooled sample and all subgroups, with the exception of alumni. As one non-native English-speaking student noted,

> I have probably done more public speaking today than I've done in the past year, because I've done the opening conference, as well as two ministerial working group speeches, as well as improvised speeches to communicate with fellow members.

Reflection and debriefing

Role-playing activities are often concluded with a debriefing session, where participants reflect on their experiences and receive feedback from an instructor, who possesses expert knowledge and didactic skills (Rall, Manser, and Howard 2000; Morgan et al. 2009; Savoldelli et al. 2006; Butcher 2012; Crossley-Frolick 2010; Elias 2014; Raymond and Usherwood 2013; Sands and Shelton 2010). As a parallel to the self-assessments found in the survey, we drew heavily on students' reflections in the MG20 debriefing to learn about changes in their perceptions of self-efficacy and skills development. In alignment with the literature, we listened for these changes as teacher facilitators guided students along the following de-briefing objectives (Kolb, Rubin, and McIntyre 1984):

- Helping students process and synergize the information they encountered;
- Identifying a common set of observed perceptions and attitudes;
- Receiving feedback on their involvement, behavior, and decisions;
- Considering alternative courses of action; and
- Re-asserting trust and comfort in the educational environment.

Achieving each of these objectives in the simulation requires a well-designed simulation and well-trained teacher facilitators, ensuring an atmosphere of trust and respect, to reduce participants' fear of making mistakes or being judged by other group members (Rudolph et al. 2006). This trust and respect took center stage in the MG20 debriefings, which were framed as "Open Mic" sessions. These sessions were made up of teacher-facilitated discussion about student learning and progress, followed by an awards ceremony. In them, students were given a platform to describe and reflect on their experience and express appreciation for their teams and their accomplishments. At both summits, students described a welcoming atmosphere of family and

community. They talked about new lifelong friends from around the world, and how they found inspiration to overcome their personal challenges. One student noted:

> "The connections that I made with people here have really changed me. I have always been a really shy person. I have always had a hard time making friends … but I'm now proud to say that I've made … friends who will last a lifetime from Russia and from China and from Massachusetts … What's a program without the people in it?"

Like some MUN programs, the MG20 awarded individual students and student groups with awards and scholarships to future MG20 simulations based on their performance. These awards were based, in part, on students' level of cooperation and creative problem-solving—two valuable 21st century skills.

Abstract conceptualization

It was mainly in the debriefing and during students' interviews that students began to make more solid connections between their experiences and their overall feelings of **self-efficacy**. This is especially true of veteran MG20 delegates. For example:

> "The reason that I keep coming back … whenever I come here … it's getting to meet people like you and getting to meet people from all around the world and hearing their stories … I guess it's a source of inspiration being able to come here and being like wow these kids are doing such amazing things, and that all of these kids in this room are going to be at the policymaking table one day and they're going to change the world and it's kind of truly inspiring."

Most students' reflections relating to their sense of self-efficacy were tied to the development of specific skills or individual aspects of the program. For example, one student reflected on how the travel component of the program enabled them to develop greater independence from their teachers and family. Another student facilitator emphasized how their role in the summit enhanced their sense of self-efficacy in their interview, stating:

> "Quite inspiring, I really get to look at this experience not only from the lens of a delegate, but also a teacher. That helps me a lot in my own learning process at school, where I can look at classes and see it from the teacher's perspective."

Another student connected the experience to their future career prospects, relating:

> I was nervous, I don't know how to negotiate with people or formally be diplomatic … so when we started negotiating, I was like: "This is interesting, I enjoy this." So, I actually learned about myself that maybe this was a career path or educational path that I could consider in the future.

Interestingly, where the self-efficacy instrument used in the quantitative analysis referenced students' future career paths, we found little to no significance. Overall, students' reflections in the qualitative analysis appear to better support the notion that educational simulations like the MG20 may positively impact student self-efficacy, even though the results of the quantitative analysis did not.

Conclusions

The hypotheses of this article were:

> H1: The MG20 simulation will positively impact students' self-assessment of 21st century skills.

H2: The MG20 simulation will positively impact students' sense of self-efficacy.

The qualitative analysis appears to offer more supportive evidence of the simulations' effects, with students reporting improved confidence across many areas in interviews and video journals. Despite many calls for more rigorous quantitative assessment (Raymond 2010), this suggests that future research could carefully consider how such an approach is taken . With respect to students' sense of self-efficacy, we found that the qualitative approach was most effective, as students who attended the summits reported high baseline levels. In this respect, future quantitative studies might benefit from using a larger sample of students with wider-ranging academic abilities or taking a mixed-methods approach, as we do here, to better interpret findings.

With regard to students' development of 21st century skills, we found that the quantitative and qualitative analyses revealed an overall positive and significant effect on students' learning. Overall, the most salient change, as evidenced by the survey, observational, and interview data, was students' confidence in their public speaking skills. This is consistent with much of the literature on post-secondary simulation studies (Engel et al. 2017; Lantis 1996).

Students' reflections in their debriefings and interviews together revealed how informal interactions, socioemotional learning, and building relationships mediated their success in the program and positively contributed to their sense of self-efficacy and 21st century skills. In this respect, longitudinal studies focusing on longer and less structured simulation programs may yield important findings as to the use of educational simulations in different contexts.

Finally, this research demonstrates a need to invest more widely in extracurricular and active learning programs at the secondary level. According to the Afterschool Alliance (2014), approximately 10.2 million school-aged children across the United States (18%) participated in afterschool programs. While 19.4 million not enrolled in such programs *would be* enrolled in such programs, if they were available to them. Federal investment, however, has remained flat over the last several years, despite a growing demand. Our findings suggest investment in simulation learning approaches may enhance students' development of important 21st century skills and a sense of self-efficacy, beyond mere knowledge acquisition.

Further study of the effects of high school political science programs, especially more diverse groups of students will deepen this understanding. This study was a modest attempt to do so. As Muldoon (1995) states, the integration of different professional communities—including private educational simulations, like MG20 or other entities partnered with the organization being simulated—may offer new insights and ways to overcome the immense time investment such programs require of high school teachers and administrators. We found the MG20 simulations in Boston and Cambridge to yield significant benefits for students' skill-building beyond the classroom.

Note

1. Institutional Review Board approval was granted for the proposed research design with minors. Approval date: June 21, 2019; Protocol Number:19-025-F-E-6/21. Informed consent and parental consent were obtained by all participants prior to beginning the survey.

Acknowledgments

Disclosure statement

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Notes on contributors

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Sean Peacock is a PhD researcher based at Open Lab, Newcastle University, United Kingdom. He is researching how digital technologies can support young people self-organizing in educational and youth work settings to realize better futures for their cities. His professional background is as an urban planner, working in London and North East England before returning to university. Through his research, he has developed expertise in designing digital methods to amplify youth voice in civic and environmental issues. While completing his studies, Sean has interned at Engagement Lab in Boston and in the UK Government's Department for Digital, Culture, Media and Sport.

Jedd Cohen is an independent researcher. He specializes in learning design and instruction for high school and early college students. Jedd helped to develop the original MG20 curriculum at

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Ross Weissman specializes in childhood wellness in cross-cultural and religious contexts. Ross helped to develop the original MG20 curriculum at Knovva Academy, in Boston, Massachusetts. He holds a Master's degree from the Harvard Graduate School of Education. Prior to studying at Harvard, he worked on a behavioral health research team at the Johns Hopkins University School of Medicine and for an educational startup in Israel.

Eric Gordon is a professor of civic design and the director of the Engagement Lab at Emerson College in Boston. His research focuses on the transformation of public life and governance in digital culture, and the incorporation of play into collaborative design processes. He has served as an expert advisor for local and national governments, as well as NGOs around the world, designing responsive processes that help organizations transform to meet their stated values. He has created over a dozen games for public sector use and advised organizations on how to build their own inclusive and meaningful processes. He is the author of two books about media and cities: The Urban Spectator (2010) and Net Locality: Why Location Matters in a Networked World (2011). He is the editor of Civic Media: Technology, Design, Practice (MIT Press, 2016). And his new book, Meaningful Inefficiencies: Civic Design in an Age of Digital Expediency is out now from Oxford University Press.

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Data availability statement

The authors confirm that the data supporting the findings of this study are available within the article and its supplementary materials.

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Appendix. Survey instruments

Table A1. Results for variables relating to efficacy.

Measure	Total sample		Primary English Speakers		Non-Primary English Speakers		First time participants		Alumni	
	Pre/Post Means	Significance	Pre/Post Means	Significance	Pre/Post Means	Significance	Pre/Post Means	Significance	Pre/Post Means	Significance
I can learn what is being taught in class this year.	4.3571 / 4.3059	−0.2270 (0.8207)	4.5122 / 4.4634	−0.4100 (0.6821)	4.2750 / 4.1500	0.4520 (0.6514)	4.3279 / 4.1935	0.4820 (0.6298)	4.4348 / 4.6087	−1.6330 (0.1025)
I can figure out anything if I try hard enough.	4.2024 / 4.2353	−0.7260 (0.4676)	4.2683 / 4.2927	−0.2630 (0.7928)	4.2250 / 4.1750	−0.1270 (0.8993)	4.3115 / 4.2097	0.1550 (0.8768)	**3.9130 / 4.3043**	**−1.7280*** (0.0839)
If I practiced every day, I could develop just about any skill.	4.1667 / 4.1412	−0.5390 (0.5901)	4.1463 / 4.0732	−0.2340 (0.8148)	4.2500 / 4.2250	−0.0650 (0.9480)	4.1967 / 4.1290	0.0330 (0.9738)	4.0870 / 4.1739	−1.0640 (0.2876)
Once I've decided to accomplish something that's important to me, I keep trying to accomplish it, even if it is harder than I thought.	4.3133 / 4.2353	0.3110 (0.7559)	4.3902 / 4.3171	0.1840 (0.8537)	4.3077 / 4.1750	0.5000 (0.6174)	4.3500 / 4.1613	0.7950 (0.4265)	4.2174 / 4.4348	−0.8130 (0.4164)
I am confident that I will achieve the goals that I set for myself.	3.9286 / 4.0120	−1.6090 (0.1076)	4.0732 / 4.0244	−0.0950 (0.9243)	3.9000 / 4.0256	−1.6160 (0.1062)	3.9344 / 3.9836	−1.0180 (0.3087)	3.9130 / 4.0870	−1.2920 (0.1963)
When I'm struggling to accomplish something difficult, I focus on my progress instead of feeling discouraged.	3.6310 / 3.8929	−1.5810 (0.1139)	3.6585 / 3.8250	−0.5820 (0.5604)	3.6000 / 4.0000	−1.7300 (0.0836)	3.6885 / 3.9180	−1.2410 (0.2147)	3.4782 / 3.8261	−1.0100 (0.3124)
I will succeed in whatever career path I choose.	**3.7108 / 3.9765**	**2.2210**** (0.0264)	**3.8780 / 4.1707**	**−2.3120**** (0.0208)	3.6154 / 3.8250	−0.8410 (0.4005)	3.7667 / 3.9355	−1.4920 (0.1358)	**3.5652 / 4.0870**	**−1.7060*** (0.0879)
I will succeed in whatever college major I choose.	3.8434 / 3.9530	−0.9830 (0.3256)	4.0244 / 4.1951	−1.0360 (0.3001)	3.6923 / 3.7250	−0.3380 (0.7351)	3.8833 / 3.8710	−0.1710 (0.8642)	3.7391 / 4.1739	−1.4720 (0.1411)
I believe hard work pays off.	4.3810 / 4.3176	0.0630 (0.9494)	4.5854 / 4.4390	0.1130 (0.9097)	4.1500 / 4.1750	−0.2820 (0.7780)	4.4098 / 4.2258	1.0890 (0.2763)	4.3043 / 4.5652	−1.6040 (0.1087)
My ability grows with effort.	4.5119 / 4.2824	1.3090 (0.1905)	**4.6341 / 4.2927**	**1.7590*** (0.0786)	4.4250 / 4.2750	0.3070 (0.7592)	**4.5410 / 4.1935**	**1.7480*** (0.0805)	4.4348 / 4.5217	−0.4020 (0.6874)
I believe that the brain can be developed like a muscle.	4.2530 / 4.2236	−1.3260 (0.1847)	4.4750 / 4.3902	−0.4370 (0.6620)	4.0750 / 4.0750	−1.1570 (0.2472)	4.2951 / 4.1129	0.0380 (0.9696)	**4.1364 / 4.5217**	**−2.8210***** (0.0048)
I think that no matter who you are, you can significantly change your level of talent.	**3.9405 / 4.1059**	**−1.6580*** (0.0972)	4.0488 / 3.9756	0.3320 (0.7401)	**3.8250 / 4.2000**	**−2.5210**** (0.0117)	3.9836 / 4.0484	−0.5360 (0.5921)	**3.8261 / 4.2609**	**−2.3560**** (0.0185)
I can change my basic level of ability considerably.	4.1071 / 4.1765	−0.9550 (0.3394)	4.1220 / 4.2927	−1.1360 (0.2560)	4.1250 / 4.0500	0.0810 (0.9352)	4.1475 / 4.0645	−0.1960 (0.8443)	4.0000 / 4.4783	−1.4630 (0.1435)

Note: Table presents z-values obtained from Wilcoxon's matched-pairs signed-ranks test. Prob > z values are provided below the z-values in parenthesis. Results are generated using the signrank command on Stata. ***Indicates significance at $p < 0.01$. **Indicates significance at $p < 0.05$. *Indicates significance at $p < 0.10$.