A tool for measuring student skills in a successful entrepreneurship curriculum

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Abstract

This study describes a partnership to teach the Startup Generation entrepreneurship curriculum while measuring the growth of 21st century workforce skills. We use a framework that has proven useful in numerous studies (Hixson, Ravitz & Whisman, 2014) and provide a factor analysis with evidence supporting more recently developed student measures. Analysis of outcomes and processes suggests the curriculum provides meaningful learning opportunities, the measurement tools are helpful, and interactive dashboards can support more effective coaching.

Program Overview

Startup Generation employs a project-based and deliverables-based methodology that creates conditions for participants to learn entrepreneurial start-up skills. It is designed for middle school, high school, adult learners, or people outside of school to open doors to higher education and employability. Students learn advantageous skills for ideation, project/product development, research, team-building, collaboration, networking and presentation skills. These are skills valued by schools, universities and employers.

The curriculum transitions from simulations and games to real-world entrepreneurial tasks. Learners form teams to build early-stage businesses based on best practices and gain support from a network of seasoned entrepreneurs. The curriculum, completed in one semester, is facilitated by trained coaches and is available in both face-to-face and remote formats, currently in Google Classroom with a Canvas implementation under development.

Teams complete “deliverables” (e.g., a Founders Agreement, a Market Validation Report) and move through essential steps for launching a new product or service, such as market research, prototype development, product testing, marketing strategies, and financing. This culminates with a business proposal “pitch” to a panel of local entrepreneurs and business owners. Some prize money of ~$500 is available for winning teams and participants can decide to pursue their new venture or use what they’ve learned in their career development.

Program facilitators learn to deliver the curriculum using the same hands-on methods, led by Startup Generation leaders, in a sped-up version of the curriculum that includes forming teams, creating business ideas, conducting market research, designing prototypes, developing business models, and delivering an investor pitch. During program delivery, these facilitators (or coaches) participate in weekly online support meetings with Startup Generation leaders. Weekly meetings are informed by data-driven, participant self-reflections built around a validated framework of workforce skills and opportunities for peer check-ins, reflection and coaching.

Coaches and teams are working in creative ways to address learner needs and manage cases to promote workforce readiness in hard-to-serve, low-income populations in New Mexico. The program is currently running for its fourth cohort with early results presented to the Eastern New Mexico Workforce Board (Ravitz, 2020) and results shared with The Forum of the National Workforce Board (Serim & Elias, 2022).

A proven measurement framework for workforce skills

Measures used in Startup Generation use a pre-post student survey built on survey measures created by the lead author for the West Virginia Department of Education (Hixson, Ravitz & Whisman, 2012). The teacher skills survey, as self-published by Ravitz (2014), has become a #1 search result in Google and it has been widely replicated in Europe (Bray & Bauer, 2017), Canada (Sinay, Resendes & Graikinis, 2015); Philippines (Tindowen, Bassig, & Cagurangan, 2017) and many other locales.

> *"This teacher survey is available for re-use in studies of 21st century teaching and learning. It has demonstrated excellent reliability, improving on reliable measures from previous studies (std. alpha > .90, inter-item correlations > .58). Support for content validity is based on a review of existing frameworks and measures. Support for concurrent validity includes strong relationships to time spent using project-based learning" (Ravitz, 2014).*

The new student survey represents a long-awaited departure, with items revised based on earlier analyses, rewritten for easier reading level, and updated to represent more relevant practices. In order to use it with New Mexico educators, students and parents the survey was re-written for easier comprehension and translated into Spanish for use in piloting "datacasting" solutions to lack of broadband access (Ravitz, 2022).

As in the teacher study, the focus is on understanding and identifying "opportunities to learn" based on well-understood framework of 8 skills : critical thinking (CT), collaboration (CO), communication (CM), creativity & innovation (CR), self-direction (SD), global cultural connections (GC), local connections (LC), and using technology for learning (UT) – with increasing emphasis being paid to whether learners claim they have evidence of these skills.

Methods

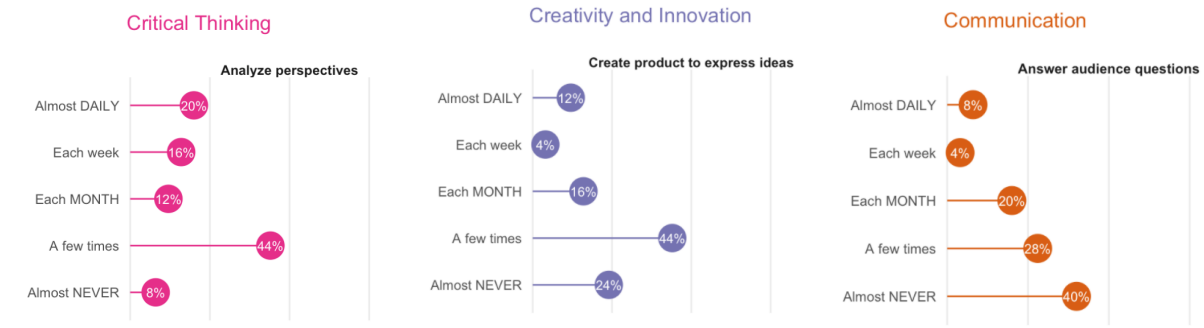
The student start of program self-reflection (pre-survey) marks each learner's official entry into the program, effectively guaranteeing a 100% response rate. This was completed by 26 students in the Fall 2021 cohort (Aug - Dec 2021), with a course completion rate of 77% (N=20). The post-survey response rate was 70% (N=14).

For the factor analysis, below, we increased the number of cases by utilizing data from two earlier cohorts and coaches courses, both pre- and post-surveys. This produced a total of N=81 responses representing pre (N=63) and post (N=18) surveys. These data were used to produce principal component (PCA) scores via a regression strategy, varimax rotation, and pairwise replacement of missing values (defaults for "principal" in R-psych package, 11/30/21).

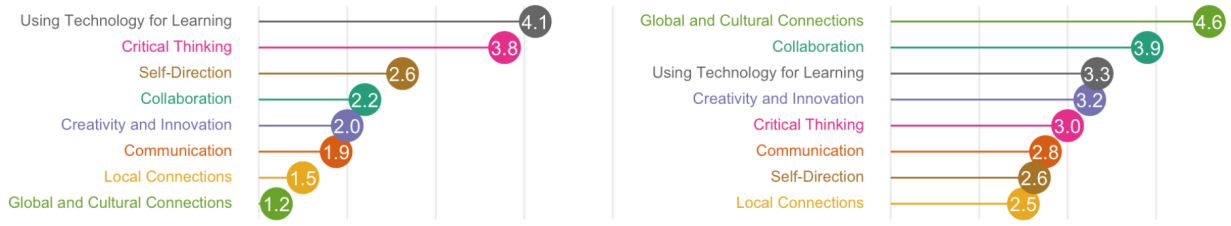
Results

The pre-survey has proven useful to Startup Generation and coaches, because it provides information on group responses and individual profiles. The following are screenshots of the pre-survey dashboard output that each coach sees. Guidance to coaches include several specific suggestions – such as giving those with less experience explicit encouragement or providing low-risk opportunities to exercise skills.

Group Responses



Individual Profiles



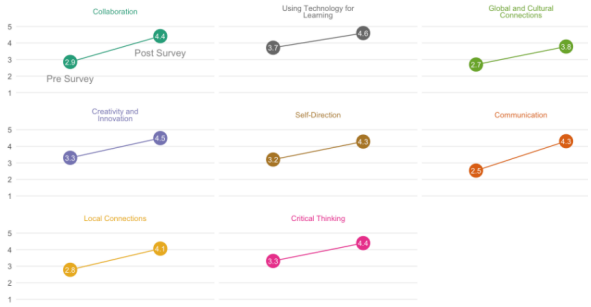
The spreading out of students (individual profiles, above) for different skills suggests that there is not just a positive response bias and, in fact, the measures are effectively allowing students to reflect on differences in experiences, opportunities to learn, and their likelihood of having evidence of their skills.

Pre-Post Scores

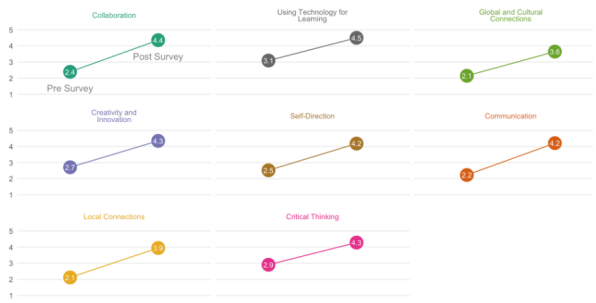
The post-survey as an indicator of change over time has been particularly useful for funders and the program, because it highlights growth in skills overall. To help interpret average score gains, the tool for accessing these data includes pre-post "diverging lollipop" charts that allows easy calculation of differences. Pre-post changes for individual items and learners are

available in the coach and program dashboards (as shown in Ravitz, Bakhshaei, Hardy & Seylar, 2020), while overall gains are provided to funders, as highlighted seen for two recent cohorts below.

Spring 2021 (N=12)



Fall 2021 (N=14)



To illustrate these results, the findings for Fall 2021 Startup Generation reveal that the proportion reporting they had learned collaboration skills to "a very great extent" jumped from 5% to 55%, while those reporting having evidence of collaboration skills "to a great extent" increased from 10% to 82%. Similarly, the proportion who said they had learned creativity and innovation skills "to a very great extent" increased substantially from 7% to 67%. For opportunities to learn communication skills, those who said they conveyed ideas in forms other than writing "almost daily" increased from 4% to 58%.

In addition to these pre-post survey results, coaches in Startup Generation utilize four (4) check-in surveys that allow reflection on team functioning, challenges, accomplishments, and use of the skills at key points in the curriculum for each skill (e.g., collaboration after team formation). Based on informal conversations with coaches in weekly meetings, learner responses in these team check-ins have closely reflected what they were seeing in their class interactions. Having these data has prompted rich discussions of ways to support teams and learners better and are used by coaches to support assessments of students (and badging) on course completion.

Factor Analysis

A key result of this work is a student survey for identifying skills. The ability to spread students out and respond to treatment indicates that the measures are serving their purpose. The factor analysis more specifically addresses the measurement qualities of the new instrument and the relative independence of each skill as an aggregate measure or construct. These analyses suggest the student version may effectively measure distinct skills, even more cleanly than the widely-used teacher version which showed areas of overlap in the first "4C" skills (Hixson, Ravitz & Whisman, 2012, p. 63).

For the new student survey, scree plot and principal components loadings seemed to confirm measures of up to 7 distinct skills, very nearly as expected. The largely as-predicted factor loadings had only a few exceptions. Specifically, the Self-Direction items were most closely associated with the set of Critical Thinking items, and two Creativity and Innovation items loaded more strongly with Using Technology for Learning. These results are summarized here, and shown in detail in the Appendix below.

All Items Loaded Together on the same Factor

- Critical Thinking
- Collaboration
- Communication
- Global Connections
- Local Connections
- Using Technology for Learning

All Items Loaded Together, except 2

- Creativity and Innovation (except 2 loaded with Using Technology for Learning)

Not Loading Together

- Self-Direction (5 with Critical Thinking, 1 with Collaboration, 1 alone)

Limitations

There are some limitations to these analyses that future research might address. As with the teacher survey, there may be potential bias in how the survey presents each set of skills. These are listed as a distinct set of learning opportunities. However, failures to predict how a few items perform (like self-direction or items in the teacher study) suggest this pattern of presenting questions is not overly deterministic.

A more serious concern is that the number of cases is small for such a complex model, and using responses from people who answered both pre-and post-surveys could inflate reliability. Despite these issues, confidence in use is building as results are appearing to be valid and useful across several cohorts and replications including Ravitz (2022) and through the combining of data from several Startup Generation cohorts here.

The factor analyses did not include items about perceptions of skills (tried to learn, learned, or have evidence). The analyses focused on the frequency of learning opportunities, but our attention is turning more and more to where evidence of learning is being claimed (by learners, teachers or even parents) as a result. This gives visibility not just to who has engaged in learning, but what evidence of skills can be investigated, assessed, and shared for learning purposes.

Discussion

The results strongly support continued use of these measures. Even the individual items that are less well-aligned with others (including for self-direction), can still carry qualitative meaning and prove worthwhile if they provide a key part of the picture (as the potential value of a single item is discussed by Ravitz, 2002). The combination of items and how they correlate to each other (reflected in the varied factor loadings) can also promote new understandings and conversations. Certainly there is potential for streamlining further and having fewer measures drawing from these items.

What is especially useful for research and measurement purposes, however, is the overall confirmation that the items, by and large, correlate as expected with each other. Based on these results, with past performance never being a guarantee, these measures are very likely to provide reliable and robust measures, in fact for all 8 skills. Even though as not distinct from critical

thinking as we would like, the self-direction items still loaded together with each other and are all reasonably strongly correlated. In short, the student measures have shown themselves to be at least as reliable and valid as the teacher measures, which have been used to generate findings in many dozens of studies.

Another strength shared with the teacher survey is that technology is not a requirement for exercising any of the skills, except the last – Using Technology for Learning. This is different from technology-focused studies that have effectively used the same framework as a starting point, but set these in the context of technology applications only (Bakhshaei, Hardy, Ravitz & Seylar, 2020; Ravitz, Bakhshaei, Hardy & Seylar, 2020). Particularly in the New Mexico setting, where limited access to technology is often a substantial barrier to learning already (Ravitz, 2022), requiring technology use to demonstrate these skills would not honor what students actually know as called for by anti-racist assessment scholars (e.g., Sul, 2019).

Conclusion

Due to the heavy engagement exhibited by those who complete Startup Generation, there is no guarantee results like those we see in Startup Generation will apply in other contexts. However, the measurement qualities of the instrument are likely to remain strong and the value of the dashboards – for understanding the experiences of individual learners and groups, and making their learning of skills more visible – is only beginning to be explored. Overall, the results are very encouraging for the continued use of the student measures by teachers, programs and funders. Coupled with real-time access for teachers, coaches and staff, having a dashboard of learning experiences and perceptions of learning outcomes for each skill offers a useful tool for further development and study.

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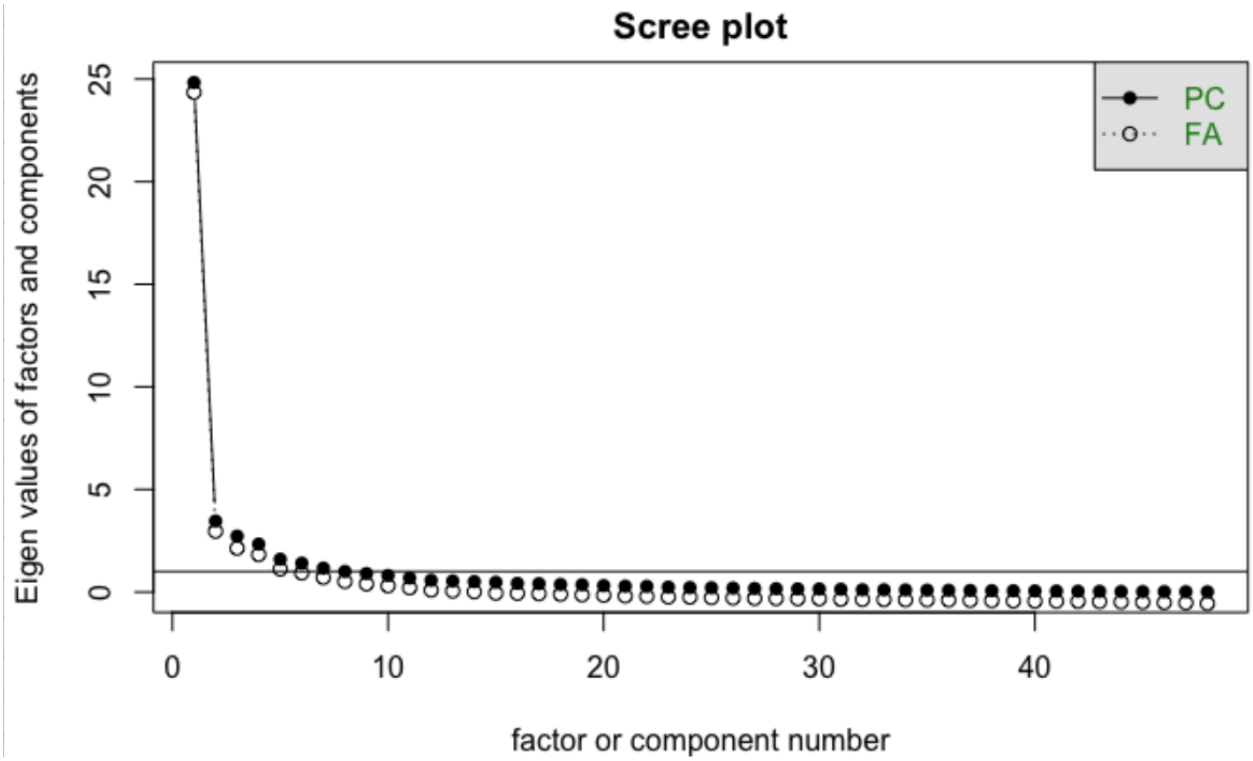
Appendices

Appendix A. Scree Plot for Practices Items (Student Version, Opportunity to Learn)



Appendix B. Factor Analysis of Student Skills Survey

How often did you...	1:Using Tech (UT + 2 CR)	2:Collaboration (CO + 1 SD)	3:Global/ Cultura Connect GC)	4:Critical Thinking (CT + SD)	5:Local Connect (LC)	6:Communication (CM)	7:Creativity and Innovation (CR)	8:Self-Direction (1 SD)
UT2.select.tech	**.83**	.17	.16	.29	.17	.09	.21	-.02
UT1.self.instructional	**.78**	.08	-.03	.20	.03	.25	.11	.11
UT5.share.multimedia	**.78**	.00	.23	.23	.26	.18	.13	.06
UT8.tech.for.tracking	**.77**	.38	.14	.17	.14	.01	.08	.10
UT4.use.tech.to.analyze	**.73**	.07	.20	.31	.31	.13	.15	.17
UT6.online.team.tools	**.72**	.31	.18	.12	.32	.19	.00	.06
UT3.evaluate.tech	**.68**	.15	.31	.26	.19	.08	.35	.06
UT7.tech.interactions	**.51**	.36	.23	.08	**.42**	**.46**	.00	-.01
CR2.generate.solutions	**.51**	.04	.26	.25	.15	.34	**.42**	.01
CR1.idea.creation	**.49**	.11	.31	.38	.26	.15	**.41**	.34
CR4.invent.new.ways	.37	.34	.20	.25	.19	.17	**.67**	.13
CR3.test.ideas	**.42**	.27	.30	.19	.16	.21	**.65**	.05
CR5.create.something	.28	.33	.24	.19	.19	.26	**.55**	.11
CO1.pair.work	.25	**.85**	.12	.17	.14	.16	.10	-.02
CO2.make.team.work	.22	**.78**	.09	.20	.26	.14	.16	-.02
CO6.give.feedback	.06	**.74**	.35	.21	.24	.20	.03	.21
CO5.use.feedback.team	.20	**.73**	.28	.06	.27	.27	.16	.10
CO3.create	.05	**.70**	.06	.12	.37	.34	.12	.07
CO4.present.group.work	.02	**.66**	.12	.11	.26	**.45**	.18	-.01
SD7.use.feedback.self *	.30	**.62**	.21	.17	.04	.13	.06	**.53**
GC5.study.geography	.07	.19	**.83**	.05	.20	.19	.06	.09
GC6.connect.issues	.16	.11	**.83**	.13	.23	.16	.02	.04
GC4.understand	.20	.16	**.80**	.16	.12	.06	.20	.18
GC2.use.info	.17	.18	**.78**	.23	.12	.11	.22	.09
GC1.study.countries	.14	.19	**.76**	.18	.08	.20	.04	-.03
GC3.discuss.topics	.13	.04	**.76**	.19	.19	.09	.13	.02

Continued on the next page…

Appendix B. Factor Analysis of Student Skills Survey (continued…)

How often did you...	1:Using Tech (UT + 2 CR)	2:Collaboration (CO + 1 SD)	3:Global/ Cultural Connect (GC)	4:Critical Thinking (CT + SD)	5:Local Connect (LC)	6:Communication (CM)	7:Creativity and Innovation (CR)	8:Self-Direction (1 SD)
CT4.analyze	.26	.26	.26	**.78**	.16	.03	.18	-.01
CT2.draw.conclusions	.23	-.02	.11	**.78**	.07	.25	.12	.23
CT3.summarize	.35	.21	.30	**.75**	.10	.11	-.06	-.09
CT5.develop	.30	.27	.18	**.72**	.19	.09	.29	-.11
CT1.compare	.10	.14	.08	**.70**	.10	.30	-.01	.33
CT6.solve	.36	.21	.18	**.58**	-.02	**.41**	.21	-.14
SD6.assess.own.work	.21	.30	.18	**.50**	.36	.21	.20	.41
SD1.take.initiative	.28	.14	.32	**.49**	.24	.25	.38	.17
SD2.choose.topic	.21	.01	.36	**.46**	.11	.30	.31	.39
SD4.choose.examples	**.41**	.16	.26	**.46**	.39	.17	.09	.33
SD5.monitor.self	.31	.17	.25	**.45**	**.41**	.34	.13	.30
SD3.plan.for.self	.31	.12	.25	**.40**	**.40**	.08	.29	**.49**
LC2.apply.learning	.23	.19	.20	.23	**.74**	.11	.11	.04
LC3.talk.to	.20	.39	.20	.15	**.73**	.27	.02	.09
LC4.analyze	.24	**.45**	.26	.09	**.70**	.14	.12	.03
LC5.weigh	.26	.32	.22	.05	**.70**	.23	.17	.06
LC1.investigate	.27	.25	.32	.13	**.61**	.04	.15	.08
CM3.prepare	.14	.29	.16	.25	.19	**.72**	.24	-.06
CM4.answer	.28	.27	.24	.22	.19	**.71**	.10	-.04
CM5.decide	.25	.24	.31	.17	.16	**.71**	.03	.08
CM1.structure	.16	.34	.12	.21	.12	**.69**	.18	.30
CM2.convey	.11	.31	.17	.28	.14	**.62**	**.40**	.09

Note. Loadings of .40 or higher are bolded to assist with interpretation.