Hacking Maslow: Assessment, Scale, and Survival of a Statewide Community College Makerspace Network in California

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Introduction

The California Community Colleges (CCCs) comprise 115 campuses (114 physical and 1 online) throughout the state. Serving over 2.1 million students every year, the CCCs are the largest higher education institution in the United States (REF). Students are enrolled full- and part-time to achieve various educational objectives: some aim to quickly upskill to be competitive in changing career paths, while others intend to transfer to 4-year institutions to earn their bachelor's degree (and beyond), while still others are continuing students—those have returned after earning a bachelor's degree and would like to transition to a different career track entirely. Not only do students in the CCCs represent a broad range of educational goals, but they also reflect the demographics and socioeconomic backgrounds of their respective communities and therefore California as a whole. In 2016, the California Community Colleges Chancellor's Office (CCCCO) invested $17M to engage the CCCs in the Maker movement as one strategy to fulfill its mission of providing quality, relevant education to a broad array of learners and to prepare students for jobs across California. These funds started the California Community Colleges Maker (CCC Maker) initiative, which led to the development of a statewide network of CCC-based STEM/STEAM-focused makerspaces over three years, 2016-2019. This paper is the fourth in a series describing the origins, startup, implementation, and now the conclusion of the CCC Maker initiative. It describes a framework—based on a popular theory of motivation—that can be used to discuss progress and relative success of makers and makerspaces, both in a community and in a broader context (e.g. a statewide network). Lessons learned from this innovative and large-scale program are applicable to anyone wishing to assess the growth of their maker-system along multiple dimensions.

Background

The CCC Maker initiative is a three-year effort to establish a statewide network of makerspaces throughout the CCC system, in order to meet the ultimate goal of enabling students to embrace the evolving innovation economy in California and beyond. This effort was informed initially by a white paper produced by the California Council on Science and Technology [1], and has the capacity to have very broad reach, with more than half of the 114 colleges participating in the initiative at some point, nearly a third receiving seed funding, and more than a fifth ultimately being awarded continued funding for the duration of the initiative.

At the outset, leadership [2] adopted key value statements and goals and an overall strategy of "Community First" to guide the program. One of the most important value statements driving the initiative is that the CCC Maker network is a way to encourage CCCs to lead the way in redefining what it means to be well-educated, especially in terms of a swiftly-changing economy demanding a resilient and adaptable workforce. Further discussion on the origins, initial investment, and early strategies for selecting colleges for inclusion were presented at ISAM 2016 [3].

The details and outcomes of the first phase of the initiative, a six-month-long "lean launch," were presented at ISAM 2017 [4]. During this phase, the leadership team directed participating college teams to consider four main areas of focused development for the duration of the project, the outcomes by which the project would be measured: **community of practice**, **work-based learning**, **curriculum**, and the **makerspace** itself.

The next phase, implementation, was described at ISAM 2018 [2]. The paper outlined implementation of each outcome area in terms of its primary network-defined problem statement, the overarching strategy to solve it, the value statements most closely associated with the chosen strategy, and a selection of tools, activities, habits of mind, and resources shared with the colleges to support their work. The full suite of components employed to help college teams through the startup and implementation phases to achieve the four project outcomes are provided in greater detail in a startup guide based on the CCC Maker experience [5].

The four program outcome areas established for the lean launch phase continue to be the dimensions by which college teams are tracked. Outcome-aligned metrics tracked by the college teams so far have shown an increase in engagement overall (Table 1), though it can still be difficult to gauge from these types of metrics alone what success *really* looks like in a makerspace environment [2]. After three years of deliberate development of a large-scale makerspace network, the CCC Maker initiative can build on lessons of how to gauge success, identify important moments, and assess where a makerspace, a maker, or a network is on a spectrum from foundation-level to advanced. Understanding the nature of these elements will be critical in launching the network into its next phase, when it will need to become self-sustaining.

Maslow's Hierarchy Hack

There is no universally-applicable standard for design of an ideal makerspace: one that is uniquely suited for/responsive to the community it serves. Because the lean launch intention-

Table 1. CCC Maker metrics from Q1-Q3, 2018 [19]

Community of Practice (CoP)	Q1	Q2	Q3	Total
Professional Development Activities	48	99	93	**240**
Blog Posts	31	68	90	**189**
Faculty Engaged - Cumulative	8	312	395	**395**
Elements in Ecosystem - Cumulative	1673	2509	3056	**3056**
Employer Matching Hours	426	36	798	**1260**
Volunteer Hours	0	2657	1385	**4042**
Matching Funds (in $)	-	-	-	**1.9M**
Makerspace (MS)				
Engagement Activities	191	249	521	**961**
Total Students in Makerspaces	2682	2300	4963	**9945**
Student Hours (Average)	-	-	-	**(3:49)**
Badges	81	71	258	**410**
Makers (MKR)				
Employers recruited - Cumulative	104	134	167	**405**
Students Recruited for Internships	70	144	274	**488**
Students in Pre-Placement Training	32	95	154	**281**
Students Completing Internship	0	2	38	**40**
Curriculum (Curr)				
Courses Accessing Makerspaces	181	114	167	**422**
Advisory Meetings	41	35	40	**116**

ally developed unique, individually appropriate makerspaces, finding a methodology to evaluate comparative progress and success beyond standard quantitative metrics was always going to be a challenge. With this ideal in mind, it should be no surprise that it is difficult to describe how well a makerspace is doing, when comparing across multiple and disparate communities with different needs, purposes, and resources. For example, is a makerspace that counts a high number of student hours "better" than another that reports fewer hours in the space, but features more focused workshops led by students? And in addition to its immediate community, which one is in a position to add more value to a network of makerspaces?

A. Maslow's Hierarchy of Needs

A model from psychology provides a relatively familiar and flexible way to frame the discussion surrounding assessment of makers, makerspaces, and maker networks: the Hierarchy of Needs, introduced by American humanist-psychologist Abraham Maslow in 1943 [6]. Maslow's Hierarchy of Needs (MHN) is a popular motivational theory concerning a person's ability to realize their full potential by satisfying a sequential series of needs.

MHN is frequently portrayed as a pyramid with multiple levels, each level representing a group of needs, starting with the most basic at the base of the pyramid. (Fig. 1) The fundamental idea behind MHN is that humans are generally motivated toward a pinnacle state of being—"Self-Actualization" at the top of the pyramid—by their satisfaction or dissatisfaction with their current unmet needs. The base tier (1) is satisfied when physiological needs are met—these include being sufficiently fed, rested, sheltered, etc. The next tier (2) is the need to be safe, followed by (3) the need to belong and be loved, (4) feel positive self-esteem, and finally (5) to be self-actualized, or to achieve one's potential (including creative pursuits).

An update to the hierarchy that Maslow added after its original introduction was a sixth level above Self-Actualization, or *Self-Transcendence*. To Maslow, this meant giving oneself to something beyond the self—for instance, acts of altruism. It is this version of MHN, with six levels (physiological, safety, belonging/love, esteem/self-respect, self-actualization, and transcendence) that has been adopted as the foundation for the remainder of this discussion.

The levels of needs making up the pyramid are commonly grouped into basic, psychological and self-fulfillment needs. Another way to group these needs is extrinsic versus intrinsic. This classification breaks the pyramid to two levels: the bottom three are needs that can be met by external factors and when met, the sensation of need is removed, while the top three are aspirational levels that are driven by intrinsic motivation—the sensation of need is ongoing.

The crux of the original hierarchy was that the needs at a lower level must be satisfied before a person is able to move to higher levels. However, this rigidity of the framework garnered some criticism (including from Maslow himself), and the theory has undergone significant revision (beyond the added level of Self-Transcendence mentioned above) in the decades since its introduction [7, 8, 9, 10, 11]. Scholars who use the framework generally accept that (a) passage from level to level is not linear, (b) satisfaction of a tier of needs may not be total before the next tier is addressed (degrees of satisfaction), and (c) there may be a fractal organization to the pyramid, where each level may contain all six levels within itself (e.g. a threat to freedom of expression is operating at the safety level within the self-actualization tier). These more flexible elements are kept in mind as the six-level MHN is applied to the CCC Maker initiative, facilitating the separation of signal and noise within a dynamic, evolving system.

B. MHN, adapted to CCC Maker

Multiple disciplines beyond psychology have made use of MHN. For instance, the general schema have been applied to nursing, to inform decisions on patient care priorities [12]; architecture, to inform human-centered design of, for example, hospitals [13]; management and workplace design, to ensure the productivity of employees [14]; social work, to inform relationship-building with people in crisis [15]; and of course, education, to guide in both instructional [16] and classroom design [17].

Model. Adapting the MHN to assess progress in CCC Maker can provide a framework that allows for the lessons learned
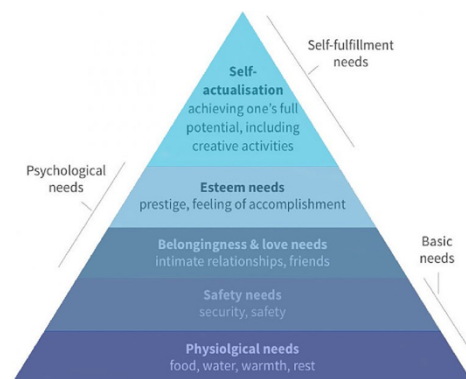

Fig.1 Maslow's Hierarchy of Needs (MHN).

through the initiative to come through, while also helping to identify where interventions might be needed for the progress of the individual college or the network. Translated to the CCC Maker network, these levels become:

1. Physiological → Functional Space
2. Safety → Personal Physical Security
3. Belonging/Love → Membership in a Community
4. Esteem, Self-Respect → Mutual Respect, Intellectual, and Aesthetic Appreciation
5. Self-Actualization → Achieving Personal Goals, Exercising Creativity
6. Self-Transcendence → Transcending to Community

Advantages of using this model include it being well-known and readily understandable by a broad array of people; it is flexible enough that it can be universal to communities with different needs or focused makerspaces serving different purposes; and it can be used to describe transitions and scale. Translated for the CCC Maker initiative, the MHN becomes the Maslow's Hierarchy Hack (MHH, Fig 2).

Transition. Recall the groupings of extrinsic and intrinsic needs suggested by Maslow and mentioned above. In the MHH then, levels one through three (Physiological, Safety, and Belonging/Love) describe needs to be satisfied extrinsically, while levels four through six (Esteem & Self-Respect, Self-Actualization, and Self-Transcendence) describe needs that are intrinsically driven. Previous presentations of lessons learned [2] pointed to emergent conditions as a signal of success at various scales within CCC Maker, preceded by a "tipping point" that was at the time evident but challenging to measure. Defining the threshold between extrinsic MHH levels and intrinsic MHH levels as the tipping point helps to clarify what it may look like and can also signal to a team that real progress is being made. In such a case, emergent conditions may be recognized (as success!) sooner, reinforcing the efforts of the team experiencing the shift.

Scale. Using the model with Self-Transcendence as the top tier opens the model up to include needs beyond the individual, including expansive/inclusive societal identification, cultural transmission, sustainability, and legacy. These needs link scales, an important consideration when operating as any makerspace community (individuals scale up to the makerspace community), but especially important when the goal is to create and sustain a thriving network of makerspaces. Individuals scale up to the immediate makerspace community, which further scales to the network as a whole, and beyond. The model as it is adapted here is flexible enough that scales could be further resolved, if practical, to include intermediate communities, such as student cohorts or college departments.

Score. As shown in Figure 2, overlaying examples of demonstrated achievement within each of the four outcome areas on this translated, multi-level framework creates a rubric by which teams can be scored and compared to each other, or progress made visible. A note: for this purpose, one of the outcome areas—originally "**work-based learning"—**has been replaced with "**Maker,"** a more transferrable descriptor; the Maker, as an individual economic agent, is therefore related to—but not limited by—an original CCC Maker initiative goal of filling an internship quota.

Fig.2 Maslow's Hierarchy Hack (MHH): Maslow's Hierarchy of Needs (MHN) modified for making. *Examples are given that align with each of the four program outcomes: Maker (Internships), Community (Community of Practice), Makerspace, Curriculum. Each of these can be used as an indicator of MHN level along each program outcome.*

Methods

Dimensions Scoring. Colleges were scored by the Technical Assistance Provider (TAP) for each dimension (outcome area) based on the MHH as a rubric, with up to 10 points for each MHH level attained. Scoring was based on conversations, observations, and formal data reports filed quarterly (see [4] for details of what data are collected on a quarterly basis from the CCC Maker colleges, and Table 1, this paper, for a subset). For instance, a college with an exemplary, well-resourced makerspace with a sound safety culture and clear branding/messaging to potential users, that supports the professional development of its users with (e.g.) digital badging, that regularly features community events and consistently documents and shares its philosophy and process—especially with the aim to help other makerspaces serve their respective communities better—would score a 60 for the makerspace (MS) dimension, whereas if Makers in an established space were only encouraged to take safety workshops, it would score a 20 for the curriculum (Curr) dimension. These scores were plotted on four-point radar diagrams to give a sense of how colleges would compare at a glance. (Fig 3)

College Tiers. In addition to scores along the four dimensions of the CCC Maker initiative, colleges were given an engagement score (up to 60) based on scalar engagement: how frequently and significantly they contributed to activity at different scales—CCC Maker network events, communication, sharing, problem solving, and connecting communities (including regional collaborations between members of the network); makerspace-level engagement; and maker-level engagement. Each of these five scores (four dimensions + engagement) was summed to give an overall score for each college. Next, colleges were sorted into three tiers based on these overall scores: Advanced ($240 \leq$ overall ≤ 300), Tipping Point ($150 <$ overall < 240), and Foundation-Level (overall ≤ 150). The thresholds between tiers were determined before scoring and sorting colleges and were based on a range of hypothetical makerspaces that portrayed the characteristics of each tier. The Foundation-Level tier was intended to describe colleges laboring at the lower levels of the MHH on all or most fronts; the Advanced tier was intended to describe colleges that had passed the tipping point in the majority of dimensions and were engaging the whole community; the Tipping Point tier by default describes the colleges between these levels, and is intended to capture colleges possibly experiencing a transition along one or more dimensions. Note that in Figure 3 colleges are plotted together with others in the same tiers, and some may overlap entirely; while no colleges are missing from the figure, not all are visible. (Legends with college names have been omitted from this publication intentionally.)

Other scales. While the primary focus of this paper is application of the MHH to college teams within the CCC Maker network, the framework can be used with slight modifications to the rubric to score elements at different scales. For instance, while not evaluated here, this same framework could be developed to include descriptions appropriate for an individual maker at each level. An individual maker-based MHH rubric could be generic or based on widely-accepted criteria with some specifically tailored to a makerspace's goals, if it is specialized in some way (e.g. toward a specific skillset or discipline). At the other end of the scale spectrum, a rubric could

be developed within this framework to score and assess needs of different networks of makerspaces/communities of practice.

As a simple metric for discussion at the network scale in this paper, the scores along each of the four dimensions of all colleges were summed to give the full network a collective score. Scalar engagement was not included in this combined scoring simply because the original metric for scalar engagement for college teams extended to the CCC Maker network and not necessarily beyond; broader scalar engagement scoring may be revisited in the future.

Results

There is a clear coherence among colleges scoring high on the MHH rubric + scalar engagement spectrum: their diagrams are open, as they typically exhibit Self-Transcendence in multiple dimensions. At the other end of the spectrum, the foundation-level colleges mostly have diagrams that are much tighter, skewed slightly toward MS, indicating that for the most part, those that scored low on the scale are universally
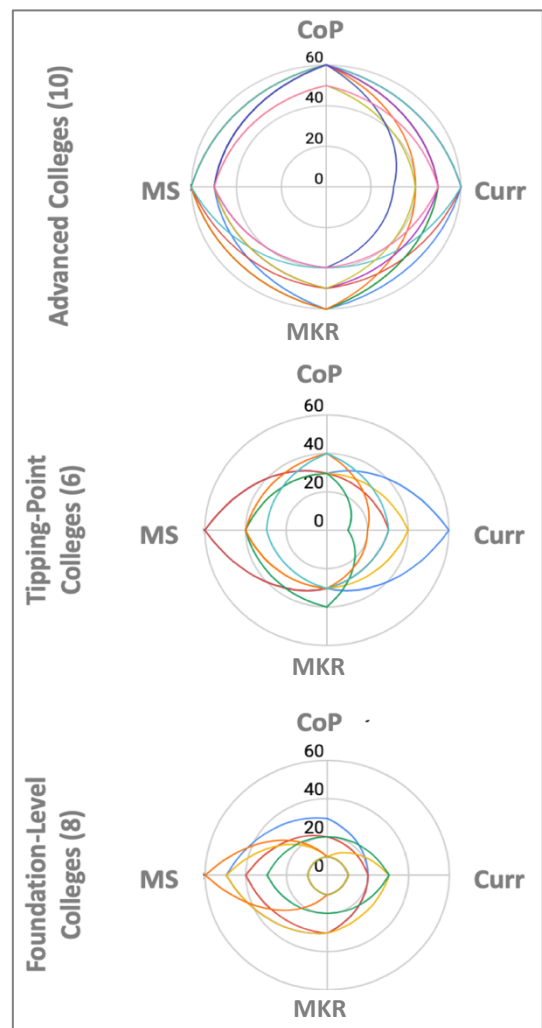

Fig.3 Four-point radar diagrams of sorted CCC Maker colleges. *All 24 CCC Maker colleges are sorted by overall score and plotted along MHH-level for each of four dimensions (program outcomes): Community of Practice (CoP), Curriculum (Curr), Maker (MKR), and Makerspace (MS). Colleges are sorted according to overall score: sums of these dimensions plus scalar engagement scores.*

underperforming, rather than excelling in one area at the expense of others. (There are, of course, exceptions. For instance, one college has a high MS score but virtually no other positive marks. Another college has "levelled up" on multiple fronts but has a very low scalar engagement score.)

In the middle are the tipping point colleges. From their plots, it is evident that there is success (sometimes excellence) along multiple dimensions. In some cases, the plots are skewed along one dimension, whereas in others the plot is evenly open but not as wide as the colleges in the advanced category. This distribution is a visual indication of where the team's efforts have paid off. (And in turn can indicate (a) where resources are allocated, (b) where obstacles prevent progress, or (c) a combination of the two.)

There are also noteworthy features along dimensions. For instance, the MS dimension frequently has the highest scores across the network. In contrast, MKR and especially Curr scores vary widely—even some colleges in the Advanced tier have room to improve.

Summing each of the dimensional scores for a combined score for the CCC Maker network as a whole showed that, collectively, the network scores 63% of the possible score for all four dimensions. See Table 2 for cumulative scores.

Discussion

Outcome areas. MHH levels are described for each CCC Maker outcome area. At the same time, it should be recognized that these outcome areas have their own hierarchy. To wit, the MS outcome is foundational; progress in MS is fundamental to progress in other outcome areas—one must have a makerspace to have a fully-functioning makerspace community, for instance. (Note, however, the makerspace needn't be narrowly defined as a dedicated facility—there must simply be a place/time for (collaborative, connected, communal) making to occur for there to be development along other dimensions in the MHH.)

Framework: Colleges. The MHN framework is most often applied to the individual. Here, the modified model is used primarily to assess a collection of college teams. Radar plots, along with ranked sorting of scores facilitated by the MHH, allow for high-level comparison of the 24 different colleges within the network. The radar plot is a helpful tool to quickly gauge the distribution of needs and potential energy in a group of very different college teams and their makerspaces. The shape of the radar diagram allows one to quickly ascertain where a team is struggling, and also identify a potential mentor match from elsewhere in the network. At a glance, one can see who the emergent champions should be, and who needs additional supports (and in what areas) in order to get out of foundation-level status (i.e. "survival mode").

Foundation-level colleges are those still struggling in one or more dimensions, meaning that much of their energy is being spent on the lower levels of the MHH in multiple outcome areas. These colleges are preoccupied with getting their basic needs met and expending their resources to that end. Therefore, they tend not to have capacity to make significant contributions at a sustained level to the larger community and will need support from the network to grow. This is not to say, of course, that colleges working at the foundational level do not have important contributions to make or lessons to share with

Table 2. Cumulative score across network over the four dimensions. The network overall is scored for each of four dimensions (as shown for each college team in Fig 3) and given as percentage of highest possible score.

Dimension	Cumulative Score	Percent of Possible Score
Community of Practice	900	63%
Makerspace	1080	75%
Maker	850	59%
Curriculum	820	57%
OVERALL	**3650**	**63%**

the broader community. Their resources are simply focused on ensuring their survival rather than on growing and connecting, beyond what satisfies their immediate needs. Therefore, the scales at which these colleges engage tend to be on the individual maker and makerspace.

A tipping point occurs when a college reaches the threshold between extrinsic and intrinsic needs—they are transitioning to a point where further development is not dependent on external forces; they are poised to start applying some of their energy and resources to the next scale up. Their focus ranges from the individual maker, to the makerspace, and in some cases to the network as a whole. This tipping point could be considered the true beginning of transformation, as the community college makerspace is embedded in an environment where the lower three MHH levels are already expected to be satisfied to some degree (perhaps just not at the site of the actual makerspace): an environment which aims to be available, safe, and connected to the greater community.

A transition will happen in varying degrees depending on the level the college has achieved, but as soon as tipping point has been reached, the college may be seen as a potential resource/contributor to the next scale (network) and be tapped to share their growing expertise with colleges who have not yet reached a tipping point. While the advanced colleges are most likely the ones to have both the expertise and capacity to provide ongoing guidance and sharing across the network, the tipping point colleges will be important reinforcers of the network, as they are simultaneously striving to attain higher MHH levels for themselves but are also secure enough—and have enough success—to assist foundation-level colleges.

Advanced colleges have attained high levels of satisfaction in multiple dimensions, and have been able to operate well at multiple scales simultaneously (maker, makerspace, network). Transcending the individual maker and their own makerspace communities as they invest energy back into the CCC Maker network, these colleges often contribute spontaneously and significantly to discussions and skills-building activities, offer guidance, and share throughout the broader community. This level of engagement is emergent; it is not driven by a central leadership—motivation is intrinsic and colleges feel secure enough to spend energy in an out-facing manner. Through these actions, Advanced colleges can help push the network as a whole up a network-scale MHH from basic needs (sustaining and connecting to the greater network of academic makers) to higher-order needs (broadly demonstrating an evolved definition of being well-educated).

Reaching self-transcendence to engage at the network scale will be important in driving the future success of the network. Looking ahead, the colleges identified here as Advanced are the ones most likely to drive the progress—and ultimately, maintain the survival—of the network when the grant and full-time support from leadership ends in 2019. A nuance of the framework helped leadership to understand why colleges in the Advanced tier are also the ones that have been most likely to address sustainability challenges before the end of the grant. Recall the fractal notion of pyramids within pyramids from above—a fear of losing the high-level gains of their efforts has led many of these colleges to secure institutional funding, make support positions permanent, align curriculum to earn apportionment, and continue to grow their ecosystems. This realization has prompted leadership to urge colleges to align with higher-order goals from the outset.

Framework: Network. The MHH framework applied to colleges also gives insight into the network as a whole. While simply summing scores does not capture all nuances that a network-scale modification of the MHH would, it does provide a quick-and-dirty way to assess overall progress in the network. Collectively, the MS dimension has received the highest combination of effort and success, followed by CoP. The MS score is not surprising, given that establishing and outfitting a space is a concrete goal and early support within the initiative focused on purpose, design, and implementation of spaces. The CoP score reflects the primary strategy of the initiative, to begin with a "Community First" approach.

The lower cumulative scores for Curr and Mkr, on the other hand, likely reflect delayed support for these dimensions as leadership focused on getting most of the network started with spaces and connections, as discussed previously [2]. Noting the tipping point may occur between the third and fourth levels or the MHH (50 and 67% of the way up the pyramid), it looks like the network as a whole may itself be at a tipping point, poised to activate toward higher-level work.

Examples, Observations, and Lessons Learned

Interventions. One of the biggest impacts of using the MHH was a shift in the way leadership interacted with colleges. Understanding better where the college was on the MHH allowed leadership to tailor messaging—more toward inspiration, or more toward filling basic needs. In some of these cases, support structures were created to help carry colleges through the lower levels so they could engage in higher work. For example, noting that many colleges were struggling with onboarding maker interns (low MKR scores) prompted an investigation which uncovered a system-wide legal obstacle related to payroll. A solution was to address this by supporting colleges through basic needs—the result was the design and distribution of a team internship process that bypassed this obstacle and helped propel colleges over the tipping point, toward offering successful maker internship experiences. [18]

Noting large differences across the network in scores along a particular dimension also led to productive interventions that helped leveraged the successes of some teams to aid struggling teams. An example of this was a system-wide symposium that highlighted the systems and philosophies that led to the development of impactful curriculum for teams with high Curr scores. These events serve to celebrate successes within the network. They are especially powerful for teams who can see that their own colleagues are operating at a high level; these interactions can be formalized as mentor matches for different regions and needs within the network. In the case of the curriculum symposium, several teams learned from their colleagues and immediately began implementing some of the ideas presented.

The Big Picture. **Foundational needs are extremely important as they represent an early stumbling block for colleges**. Establishing early whether this challenge arises as the result of a lack of institutional support—or insufficient capacity or effort on the team's part—is crucial for early correction.

Foundational needs are more difficult for an individual to achieve independently at any scale (individual, makerspace, or network). Foundational-level colleges often had very low scalar engagement scores, indicating they did not place connection and ecosystem feedback and interaction very high. Their challenges may be the result of seeking too little support from the network, or the network not being aware of their challenges due to lack of connection.

Foundation-level tools should be shared widely and early to mitigate plateauing below the tipping point. This ability is part of the advantage of the network. CCC Maker developed a startup guide to support colleges through lower MHH levels to help colleges reach higher-order goals and increase capacity to support the network.

"Community first" has repeatedly shown to be an important strategy. Without integrating belonging and group identity into the goals of the makerspace, these needs cannot be sufficiently met, and it is harder for Makers and the makerspace to allow transition through tipping point and toward higher-level work.

Aligning college goals to reach the top levels of the MHH from the outset, some of the stress of achieving foundational levels was relatively less limiting. Additionally, focusing on higher-level needs early often led to easier institutional support, making the foundation-level needs easier to satisfy.

At a minimum, colleges starting out should target "tipping point" as the crucial, intermediate goal toward being an asset to the network and achieving sustainability. This allows for some momentum to be established while not being too daunting.

Conclusion

As the initiative winds down, we bring to the ISAM community the fourth in our series of papers: lessons we have learned and a lens through which to discuss them. In this paper, we review Maslow's original hierarchy of needs, adapt it to makerspaces, and apply it to the case of the California Community Colleges Maker initiative (CCC Maker), to provide a framework to assess growth and engagement on scales ranging from individual to statewide, as well as identify important tipping points and interventions when teams are plateauing unproductively. With this information, the CCC Maker network has a clearer idea of which colleges are ready to take the network into its next iteration, a self-sustaining and intra-correcting collection of community (and other) college makerspaces that span the state and share resources, insights, and an evolving vision of truly well-educated students.

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