

Women in Entrepreneurship: Effective Strategies for Online Training and Development

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Abstract

From Lab to Fulfillment (FL2F) is a workshop that aims to support female academics entrance into the world of entrepreneurship. The program began as an in-person work- shop which has since transitioned into an online format supported by numerous custom applets to facilitate a variety of exercises. The workshop participants are professors coming from engineering and medical faculties who want to bring their research to market but are un- sure of how to start. Many previous workshop participants have since had successful startup launches in a di- verse industries ranging from Nano Technology to Medical Imaging. While previous work has characterized and optimized aspects of our teaching using machine learning, this work focuses on addressing feedback received from participants and examining our technology to refine and improve outcomes. As we are reflecting on the lessons learned from the past several years of course development we have identified and addressed key challenges regarding the scholarship of teaching and learning. Our iterative, technology-driven approach to course development continues to evolve with the goal of improving outcomes among participants.

Keywords: *Scholarship of Teaching and Learning, Women in Entrepreneurship, Evidence Based Teaching, University Startup Ecosystems*

1. Introduction

Female academics are substantially less likely to engage in entrepreneurial activity. While we hope this will one day no longer be true, recent statistics confirm this fact: only 4.5% of female PhD students, compared to 8.5% of their male counterparts engage in entrepreneurial activities of some form [13]. Society as a whole is increasingly recognizing this as an unacceptable state of affairs, and effort has been focused in recent years towards correcting this gendered discrepancy. For example, the Women Entrepreneurship Loan Fund was given a budget of \$55 Million in 2021 to provide microloans of up to \$50,000 to female led startups [4]. While financial support is a vital step forward, as educators we would argue that it is even more critical to equipping female

academics with the knowledge and confidence to succeed as entrepreneurs.

Date	Time	Activity	Duration	Topics
Monday, June 10, 2024	09:00AM - 10:00AM	Group Meeting #1	60 minutes	Introduction, Gender Bias, IP
Tuesday, June 11, 2024	09:00AM - 10:30AM	Group Meeting #2	90 minutes	IP, Real Pain, Skill Development
Wednesday, June 12, 2024	09:00AM - 10:30AM	Group Meeting #3	90 minutes	Real Pain, Vision and Mission Entrepreneurial Mindset, Skill Development
Thursday, June 13, 2024	09:00AM - 09:30AM	First Q&A Session	30 minutes	
Thursday, June 13, 2024	09:30AM - 12:30PM	First 1/1 Meeting with Coach(1)	25 minutes each	Individual Coaching
Monday, June 17, 2024	09:00AM - 12:00PM	First 1/1 Meeting with Coach(2)	25 minutes each	Individual Coaching
Tuesday, June 18, 2024	09:00AM - 10:30AM	Group Meeting #4	90 minutes	Lean Start-up, Team Buildup, Strategic Planning, Skill Development
Wednesday, June 19, 2024	09:00AM - 10:30AM	Group Meeting #5	90 minutes	Strategic Planning, Funding Support, Alliances
Wednesday, June 19, 2024	11:00AM - 11:30AM	Guest Talk (optional)	30 minutes	TBA
Thursday, June 20, 2024	09:00AM - 12:00PM	Second 1/1 Meeting with Coach (1)	25 minutes each	Individual Coaching
Monday, June 24, 2024	09:00AM - 12:00PM	Second 1/1 Meeting with Coach (2)	25 minutes each	Individual Coaching
Tuesday, June 25, 2024	09:00AM - 12:00PM	Group Meeting #6	180 minutes	Pitches, Efficacy, Summary
Wednesday, June 26, 2024	09:00AM - 09:30AM	Second Q&A Session	30 minutes	
Wednesday, June 26, 2024	11:00AM - 11:30AM	FL2F Completion - Certificate Handing Event	30 minutes	

Figure 1. FL2F Workshop Schedule

From Lab to Fulfillment (FL2F) aims to provide entrepreneurial education to bridge the gap in female

academic entrepreneurship. The generic workshop schedule (Figure 1), is tailored to the scheduling preferences of the hosting organization. Although the workshop began as a program specifically for professors at the University of Calgary, when it transitioned to an online format following the onset of COVID-19, it allowed us to host the workshop for a much broader range of audiences. The workshop has included the Edmonton Regional Innovation Network, Queen's University, Bar-Ilan University (BIU), and the Economic Development Workshop in Lethbridge. Across numerous sessions, the workshop has empowered many aspiring entrepreneurs with the practical tools and knowledge to proceed with their ventures.

FL2F differs from other entrepreneurial bootcamp courses most notably in terms of target demographic. Much of the literature on entrepreneurship education focusses on improving undergraduate entrepreneurial thinking and general entrepreneurial confidence. FL2F is designed specifically to cater to professors, an audience rarely addressed in the relevant literature. Our program also strongly emphasizes the long term outcomes of the course, we use our six month follow up to assess the long-term outcomes of our teaching. This has allowed us greater insight into how our teaching has impacted participants' outcomes which we capture and present here.

Our previous work in this area looked at characterizing our pedagogy quality solely through machine learning methods [9]. This work builds on that base to address some of the deficiencies and elaborate on our teaching strategies with relation to synchronous online learning. We have completed significant software development and video production efforts to support student development and have hosted our internal applications in various formats both locally and in public cloud infrastructure. Our development efforts have been based on our personal experience learning with online platforms; however, our approach has in retrospect lined up well with existing literature. Past work suggests that for online platforms ease of use and quality of content play a significant role in perceived usefulness and intention to use of the platform [18]. In our case this has taken the form of significant video production efforts as well as web applet design for a custom learning management system and custom exercise utilities.

The video development exercises began with our undergraduate course content with great success optimizing the course material for delivery during COVID [1]. Once the base lectures for the course were translated into video form this work was then expanded to include not only pre-recorded lectures, but also group activities supported by small applets for the FL2F workshops, and associated discussions. The applets themselves were started by Lachlan Vanegmond and Maxim Vasic as a volunteer effort

while they were in high school doing work for the lab, and while the initial applet they prepared has since been fully rewritten to accommodate the growth of the project, the positive feedback from early workshop participants during the pandemic was a large part of motivating the greater development exercise.

We will discuss the course content that has been developed, the associated infrastructure hosting hurdles, and finally discuss the outcomes and impact the workshop has had on students based on feedback we have received.

2. FL2F Workshop Overview

The FL2F workshop has before, after, and 6-month follow-up surveys as shown in Table 1 and Table 2 respectively. Participants are also asked afterwards to provide testimonials and written feedback about their experience with the workshop. Although early iterations of this questionnaire used a yes or no response for the 6 month follow up, more recent versions have used a Likert-like scale to try and capture more nuance in terms of the discrepancies in levels of understanding. The survey respondents are also asked to provide commentary on their entrepreneurial progress since leaving the workshop.

Table 1. Example of pre- and post-workshop questionnaire: self-assessment survey for participants regarding their entrepreneurial skills

Measuring Item	Poor	Fair	Good	Very Good	Excellent
Q1: Able to Assess market needs	1	2	3	4	5
Q2: Bias Aware and Adaptive	1	2	3	4	5
Q3: Fosters Creative thinking	1	2	3	4	5
Q4: IP Knowledgeable	1	2	3	4	5
Q5: Good Communicator	1	2	3	4	5
Q6: Presenter/Self promoter	1	2	3	4	5
Q7: Good Negotiator	1	2	3	4	5
Q8: Resilient	1	2	3	4	5
Q9: Strategic Planner	1	2	3	4	5
Q10: Alliance Builder	1	2	3	4	5

Table 2. Follow-up Questionnaire.

Question	Poor	Fair	Good	Very Good	Excellent
Q1f: Did you pursue any IP?	1	2	3	4	5
Q2f: Did you apply for government grant?	1	2	3	4	5
Q3f: Did you have success in securing funding?	1	2	3	4	5
Q4f: Did you work with other FL2F participants?	1	2	3	4	5
Q5f: Did you start new initiatives?	1	2	3	4	5
Q6f: Did you open a new company?	1	2	3	4	5

Of note with our early workshop efforts is an issue with clerical errors handling the data which had to be addressed. While these were all cleared up and caught, in the early workshops we used google forms for sending out the surveys to participants. Each workshop had its own form, which then needed to be collated for analysis, at some point in this work there was an unacceptable risk of copy errors. After catching one such error we moved to our own custom solution for the surveys, this allowed us to efficiently automate moving the data into our final database. This also allowed us greater creative freedom with the

surveys as they can use the same aesthetics as the rest of our website and be fully customized in terms of user interface required. This change had additional benefits allowing us to customize onboarding of workshop participants by giving a starting point for moving them into our software ecosystem. It also allows us to effectively associate related surveys where a user can see their entry responses while filling in their after-workshop survey by auto selecting their old results as the default response.



Figure 2. Screenshot of the custom survey applet used for FL2F workshop data collection

As seen in Figure 2 the survey app is also now used for bringing potentially interested participants into the workshop proper when they fill out an inquiry survey. This creates a smoother onramp with fewer needed interactions between the participant and a workshop coordinator.

Table 3 goes over the 6 primary sessions that compose a running of the FL2F workshop. In addition to the 6 group sessions there is also one-on-one coaching sessions to help students directly with structuring their entrepreneurial ambitions and addressing individual blind spots.

Table 3. Course Lessons and Descriptions

Lesson Number	Topic	Description
1	Introduction, Gender Bias, IP	Overview of course objectives, an introduction to gender bias, and the basics of intellectual property.
2	IP, Real Pain, Skill Development	In-depth discussion on intellectual property, identifying customer pain points, and foundational skill development.
3	Real Pain, Vision and Mission, Entrepreneurial Mindset, Skill Development	Understanding customer pain, crafting vision and mission statements, fostering an entrepreneurial mindset, and enhancing relevant skills.
4	Lean Start-up, Team Buildup, Strategic Planning, Skill Development	Applying lean start-up methodologies, building effective teams, creating strategic plans, and refining skills through case studies.
5	Strategic Planning, Funding Support, Alliances	Detailed exploration of strategic planning, securing funding, and forming strategic alliances, along with project requirements.
6	Pitches, Efficacy Summary	Developing and delivering effective elevator pitches and summarizing key takeaways from the course.

The topics covered in the six sessions have been chosen based on their relevancy to the personal experiences of Dr. Orly Yadid-Pecht; they are intended to help others avoid pitfalls that she encountered during the early days of her own entrepreneurial journey. Figure 1 shows the general format of the workshop; however, this is customized to suit the preferences of the hosting organization. Overall, the workshops consist of 20+ hours of program material, 6 collaborative group meetings, 2 individual coaching meetings, 2 QA sessions, and depending on the instance up to 2 guest talks from other established entrepreneurs.

2.1. FL2F Web Applets

We have developed several web-based tools to help facilitate workshop activities in an engaging manner. The workshop apps were written by various graduate students and other programmers volunteering or employed with the workshop to create engaging app designs. Due to constraints with staffing the apps were developed separately with a limited number of interactions between different apps beyond using a common underlying database. The goal of this was to maximize portability and minimize onboarding as additional developers would not need to be familiar with the full application stack to begin being productive.



Figure 3. Peer Assessment Tool Graphic

The Peer Assessment Exercise takes place during the workshop’s Lesson 4 on team buildup. The webpage hosted at <https://peer-assessment.fl2f.ca/> and runs an exercise based on the Johari Window [10]. As seen in Figure 3, the exercise divides personal traits into four quadrants: Open (behaviors where motivation is known to others as well as ourselves), Blind (traits others can see in us, but that we are unaware of), Hidden (traits where we know their motivations but keep that hidden from others), and Unknown (traits where neither ourselves nor others know the motivation) [10]. The purpose behind the exercise is to make the participants more aware of the parts of themselves which they keep hidden, thereby facilitating healthy communication. Workshop participants evaluate each other’s personality traits and provide them each with charts based on the responses they give for themselves and for others.

Elevator pitching is covered in Lesson 6 of the workshop and it is one of the most challenging skills for new entrepreneurs to develop. The act of asking a potential investor for a substantial sum of money with the promise of even larger future returns can be intimidating for even experienced business people. The concept of the elevator pitch is demonstrated through a custom web application that allows users to "bid" fake investment funds towards each other’s pitches based on the ideas they find most compelling. The investment panel for the workshop administrator is shown in Figure 4, this allows them to reset the funds as well as declare a "Winner" based on whomever garnered the most investment during a round of pitches. Alternate formats for the pitching exercise may be considered if the setup is moved to

local again, such as those proposed in [12], where an alternate pitch format is suggested and explored that encourages more group level participation. The exercise is generally well received in the workshop as a good successor to our earlier in-person workshop pitches where students used monopoly money to simulate investment decisions.

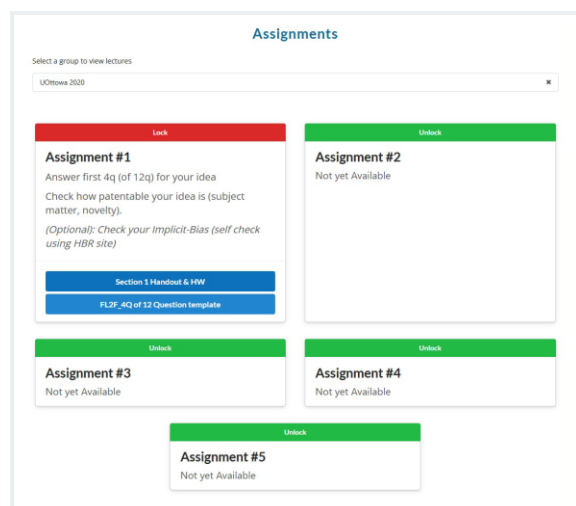


Figure 4. Investment Panel Application Admin Dashboard

The Dan and Dana Roleplay is a negotiation exercise that improves individual student negotiation and communication skills in a safe environment. Participants are assigned to the roles of Dan and Dana through the course website, each student is only provided their version of the character descriptions. The Dan character runs an established company and is looking to potentially acquire the new technology developed by the Dana character to enhance their business. There is an information asymmetry worked into the provided documents where each character and their actors have only part of the relevant information on their counterpart to model the asymmetry that exists in a real negotiation. This scenario is adapted from a real experience of Dr. Yadid-Pecht and is used instead of a direct representation of the individual student startups. This is done deliberately to ensure the exercise works for everyone while avoiding situations where an idea is not far enough along to effectively construct this sort of negotiation exercise. Roleplay exercises like these are recognized for helping students to improve their communication skills [8].

As a central maypole that the workshop around which all the workshop and applets revolve, a custom learning management system (LMS) was developed to coordinate access to assignments and course content at the correct times and intervals. The administrator panel for an earlier workshop is shown in Figure 5. We chose to build our own system instead of adopting existing software such as Moodle or

Desire2Learn due to both cost considerations and the level of customization allowed by developing the platform ourselves. For example, with the Dan and Dana exercise, most major LMS do not simply

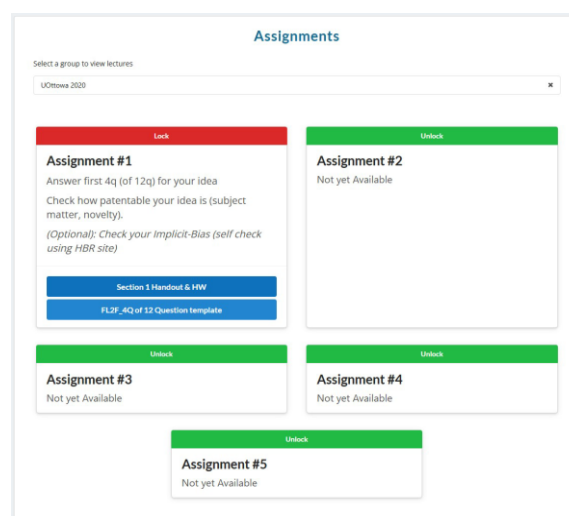


Figure 5. FL2F Workshop Custom Learning Management System

support per student assignment of documents, but we deemed this fundamental to ensure the targeted learning outcomes. Additionally, while most LMS will allow some level of setting availability periods for documents and other restrictions, it is not trivial to set the timing for these restrictions through the system API calls or through the graphical interface. An earlier version of our LMS system was implemented on an open-source course site generator based on Jekyll [7]; however, this offered limited course customization options for controlling material access over time or password-protecting content. Finally, the off the shelf LMS systems would require substantial work to appropriately white label for the FL2F workshop, this would create substantial additional overhead.

2.2. Hosting Concerns

To develop the FL2F workshop we evaluated a wide range of hosting options, from major hosting providers (Google Cloud, Amazon Web Services, Digital Ocean, IBM Cloud, Oracle Cloud, Scaleway, Hetzner, Azure, Fly.io, and Alibaba Cloud) to self-hosted infrastructure and co-location services. We also evaluated a variety of different email hosting services such as Google Workspace, Office 365, and Amazon Work Mail, as the workshop is not formally tied to the University of Calgary and using our institutional addresses would be inappropriate. Each vendor has a differing degree of lock-in to their ecosystem, with different advantages and pricing structures. While we used Google Cloud Platform (GCP) and Google Workspace for a substantial period of time, we eventually brought our infrastructure local

as a method of cost control. This is now supported by both a home server hosted, and an email server hosted from an AWS virtual machine.

In architecting an online course consisting of numerous small applets, an immediate decision that needs to be made is to prioritize either the convenience of cloud infrastructure for instant scalability or prioritize predictability with the upfront cost structure of self-hosting along with the greater maintenance demands. For instance, while a Google Cloud Virtual Machine can cost as little as \$10 per month; practically speaking, cloud costs are going to generally be substantially more. We transitioned to self-hosting our infrastructure after cost overruns using Google Cloud, in January 2025 our GCP bill included \$14.56 for transferring a grand total of only 96.21 gigabytes of data ("Artifact Registry Network Internet Egress North America to North America"). This is a modest amount of data considering a project being actively developed by multiple developers. For reference Figure 6 shows our 2024 billing across various google services prior to us making efforts to bring the software to local infrastructure.

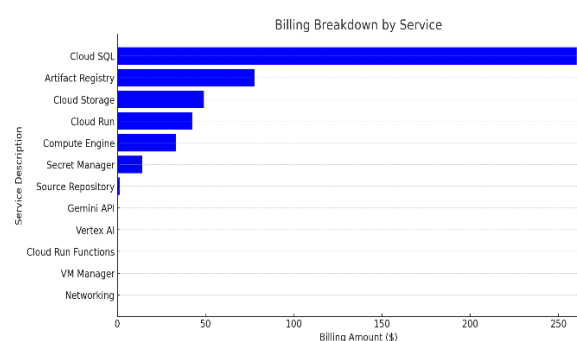


Figure 6. 2024 Google Cloud Billing

Our overruns were quite substantial for the year with totals coming in at almost \$500 for one year of hosting, not including our emails and non-google hosted products. This contrasts with alternate hosting providers such as Digital Ocean which provides a more integrated solution where you lose the level of customization and tool selection in favor of substantially more predictable monthly costs. Digital Ocean droplets offer substantial network traffic with their instantiation before any additional costs are levied for net-work egress.

Our system is heavily built on a microservices-oriented architecture with each of our applets being deployed within a separate Docker container. This architecture means that a team of disparate developers, such as ours, can work on the course elements independently and combine them together without issues of compatibility between different codebases and programming languages. Crucially this also means that vendor lock-in is kept to a minimum, as when the services change and develop, the

underlying structure can be redeployed on an as-needed basis to most cloud platforms. We were therefore able to redeploy this infrastructure to local servers using open source software stacks to eliminate our earlier reliance on GCP and create a predictable monthly cost without rewriting any portion of the code.

3. Feedback and Lessons Learned

"...This workshop was really kind of an enlightenment. . . It really helped me understand what it takes to transform the research ideas into successful companies! I know the recipe now, and I have to start using it... It was really a great learning experience for me... It hasn't really been available for me before, thank you so much!"

— Dr. Gouri Ginde, University of Calgary

Quote 3 from Dr. Ginde, who attended the workshop during one of the running's at the University of Calgary, helps start a qualitative assessment of the workshop's entrepreneurial efficacy. We are interested in finding what students experiences have been post workshop and how the workshop content has helped them achieve their entrepreneurial goals; there are generally positive sentiments reflected on our testimonials page that emphasize elements of the importance of community [3]. We can examine the various comments we have received in our follow-up surveys and try and draw a conclusion about how the workshop is affecting people.

Table 4 has a subset of the comments that we received in our follow-up surveys, examining if there are some definite trends in the comments received. Some people made moderate progress on their journey, even a simple step like starting a website can be significant. Others were too busy with teaching and research responsibilities to make significant progress on their journey; however, the goal is still present in their mind after returning from the workshop. We intend to at some point follow up with these former participants farther into the future, and hope to see further progress, both with those who have already started their business ventures and those who have been delayed.

To avoid biasing the interpretation of the feedback received the text was run through a twitter-based model sentiment analysis model to evaluate if each comment was positive, negative, or neutral. The model itself is freely available [2]. As can be seen in Figure 7 the majority of the sentiment was determined to be neutral; and gratifyingly no participants expressed a negative sentiment in their comments. We'd like to assert that this is a pure expression of quality; however, being realistic it may also be due to the small number of comments as we are smaller

organization with only a moderate number of participants.

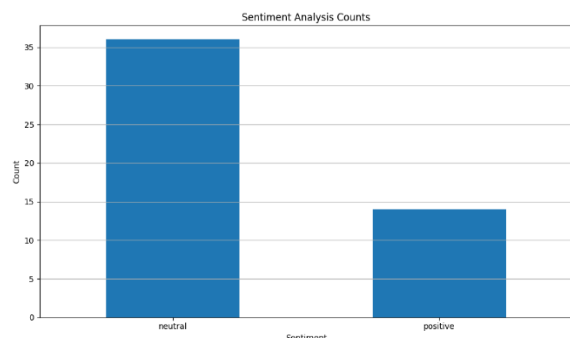


Figure 7. Sentiment Analysis of Survey Results

If we take a look at one of the neutral evaluated sentiments from the survey, we see "We are still in the early stages of building the platform." This would seem to indicate that a neutral sentiment is mostly just a lack of sufficient progress so far to have a generally positive outlook. Some of the outcome text can be seen in Table 4.

We attempted to perform embeddings of the comments received from participants to try and get an idea of the relationship between the different comments. Text embedding takes the text and converts it into a high dimension vector representing the ideas behind the text, this is one of the underlying technologies behind the current LLM technology. Figure 8 shows those dimensions reduced to 2 in order to visualize any clustering in the results.

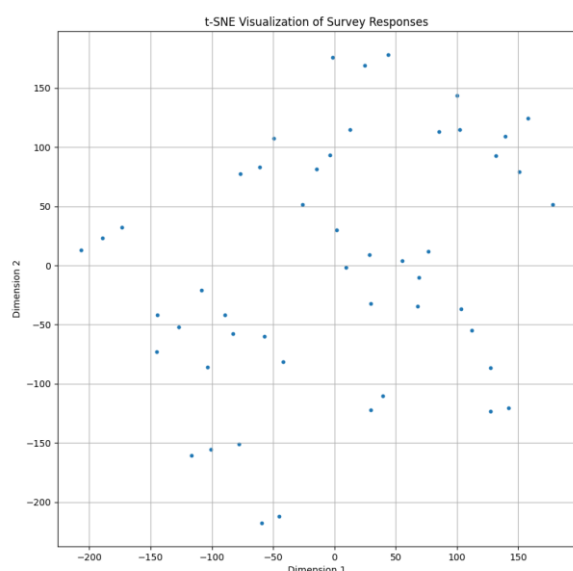


Figure 8. Text Embeddings of Survey Results

Visually here we see some clustering starting to occur; however, there is still too little data to draw significant conclusions. This method of analysis will

hopefully deliver more significant results in the future once we have sufficient data to create strong clusters between feedback ideas.

Table 4. Positive Results: Survey Feedback

Comment

I think one thing is the courage to navigate the business side of the world and to come out of my comfort zone Better as a leader for my team. How to empower others.

I think so, I feel I have become more open to collaboration with industry companies and willing to know more about how their business operates and seek potential opportunities for myself.

Yes. I made progress with our company, Get a Site Going. Not much. Too busy with the teaching and research.

It gave me the tools and motivation to initiate a start-up, which I thought was out of my abilities before the workshop

yes- the workshop really broadens my entrepreneurial thoughts. I was able to come up with great ideas after the workshop, though still working on them, but I have started building a team which is a great step for me

*For every grant that I am applying I am thinking in terms of a complete solution which can be productised, Networking
Yes there is positivity*

I gained confidence that I could have my own business based on my knowledge

It provided me with knowledge of entrepreneurial activities and allowed me to decide whether I am ready to undertake it

4. Outcome and Impact

Dr. Elise Fear, a former FL2F participant founded WaveView Imaging [15]. Kairos Cognitive Care was founded by Leah Kazmerik another FL2F Participant [3]. Dr. Kamala D. Patel was yet another FL2F participant who has been part of the founding of Luxidea [11] Measuring the true outcomes from the workshop will require time and larger numbers of participants; however, we are drawing initial conclusions based on our survey results and the received feedback that appears to show that we are having positive impact in terms of understanding across various topics. The before and after results are shown in Figure 9 where we can see how people feel

they have improved average out across all the previous workshops in the various topics.

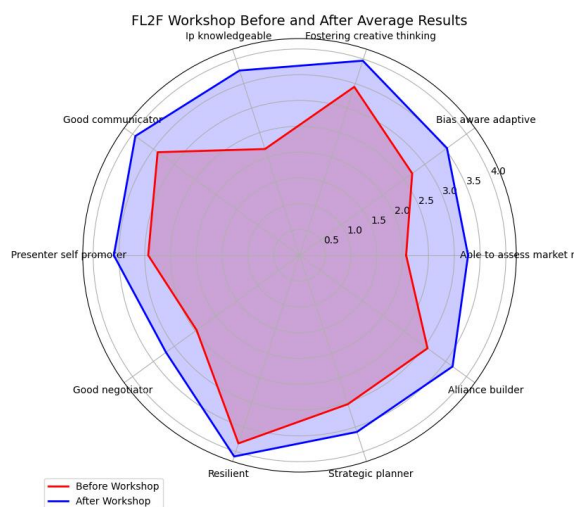


Figure 9. Before and After Workshop Results

- *IP knowledgeable*: This is the area where our workshop shines the brightest with the greatest average improvement across all previous participants. Hopefully this is indicative that when participants do choose to file patents, they are filing effective patents that can be actively defended and commercialized. To those familiar with this topic this may seem too obvious to be covered with an audience of professors; however, surprisingly only roughly 22% of teachers gave a correct definition for a patent [14]. The misconceptions as to what patents can cover include many things that could sink into an otherwise successful business like thinking that it protects ideas, or thoughts [14]. Knowing what is protectable and how it may be protected is the difference between being able to operate without revealing too much or being unnecessarily guarded.
- *Able to Assess Market Needs*: We are a fan of the hilarious case of market misalignment seen in the case of the chicken eye glasses [6]. Presumably this improvement will help our alumni to avoid failures of a similar kind.
- *Bias Aware Adaptive*: This area is our point of pride in terms of our content. Biases are typically looked at in a negative light; however, emotion and bias play a role in the process of entrepreneurship. Optimism Bias increases the intention of individuals to undertake entrepreneurial ventures [17]. Female Entrepreneurs are more likely to garner funding in a crowdfunding context; funders' implicit gender biases serve to actually strengthen perceptions of

women as trustworthy valuable actors in a crowd-based funding setup over a formal market [5]. These facts suggest that funding is available for women who are aware of and willing to exploit others' implicit biases to achieve better results themselves, keeping an optimistic but realistic view of the situation.

- *Good Negotiator, Presenter Self-Promoter, Alliance Builder, Strategic Planner, Good Communicator, Fostering creative thinking, Resilient*: These areas had on average less than a full point of improvement. This suggests that these are areas where we have the greatest possibility for optimizing the course content. To this end we are considering developing additional online tools to better teach the relevant topics through interactive online exercises.

5. Conclusion

We hope to further improve our educational offering in the coming years; we typically host a handful of workshops each year depending on individual availability. Through reflecting upon the feedback and conclusions of our surveys we have drawn initial conclusions which will be drawn to improve future interventions of our course. We seek to improve the workshop further through curriculum refinement as well as the addition of new tools and exercises to help students realize their entrepreneurial goals. This will likely include further applet development to focus on improving areas where students are showing the weakest improvements.

Our target audience of professors presents a unique challenge in terms of the scholarship of teaching. Most of the same principles of teaching apply; however, with the overtone of entrepreneurship and the lack of a clear seniority relationship between student and instructor this makes teaching more effectively collaborative. This is in many ways ideal for minimizing the sage on the stage dynamic that comes with typical classroom structure. Ultimately, we have held meetings where alumni of the workshop have provided their own feedback to students about the current iteration of the workshop.

Ultimately there is still much work to do as estimates to reach gender parity in various fields place the date much too far into the future. A more equitable world will require work to help address biases and systemic advantages. This is beneficial for everyone and will strengthen the economies and overall societies of anywhere that embraces equitable entrepreneurship.

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