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The Effects of Hackathons on the Entrepreneurial Skillset and Perceived Self-Efficacy as Factors Shaping Entrepreneurial Intentions

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Abstract: Purpose: While traditional university programs primarily use regularly scheduled classes as the primary means for developing students, this program evaluation explores the direct effects of intensive entrepreneurial learning activity in the format of a hackathon. This is one of the first papers to explore the learning outcomes of hackathons as an intensive entrepreneurial pedagogy. Design/methodology/approach: The researchers implemented a pre-test/post-test model with students participating in an entrepreneurship hackathon and tested the changes in their confidence levels in the ability to craft a successful entrepreneurial venture. Findings: The results support a hackathon model of entrepreneurial learning. As the result of a one-day workshop, significant results were achieved for self-reported ability in identifying a viable entrepreneurial concept, and for having the ability to successfully launch a new venture. Further, class standing and prior entrepreneurial courses, as well as gender did not influence the learning outcomes. Importantly, while hackathon-generated increases in entrepreneurial self-efficacy proved to be statistically significant, same gains proved not to be significant in a traditional entrepreneurship class setting. Authors conclude that short, intensive entrepreneurship learning methods like hackathons may be more effective in developing entrepreneurial self-efficacy than semester long courses. Originality/value: A hackathon is likely an effective entrepreneurial learning methodology suitable for a general student population which includes students with limited knowledge of and interest in entrepreneurship. The usefulness of a hackathon for entrepreneurial learning has potential implications for educators, scholars and policy makers. For educators, a hackathon approach may outperform a number of traditional entrepreneurship pedagogies in the form of lectures, case studies, class discussions or even a business plan development over a semester-long course. A hackathon may also allow students to gain entrepreneurial skills and self-confidence much quicker and using less resources than in a traditional entrepreneurial course. The potential reasons for these findings as well as their implications are discussed along with future research areas.

Keywords: entrepreneurial learning; hackathons; entrepreneurial self-efficacy; problem-based learning

1. Introduction

Prior research has established links between entrepreneurship and economic freedom, regulatory environments, access to entrepreneurial finance, barriers to entrepreneurial entry and national culture among others (Puia and Minnis 2007). Entrepreneurship research including the Global Entrepreneurship

Monitor (GEM) system has systematically tracked attitudes toward careers in entrepreneurship for more than two decades (Wong et al. 2005). There has also been significant research devoted to understanding how to change and develop an individual's attitude toward entrepreneurship as a career (Kuratko et al. 2015). The importance of entrepreneurial education is illustrated by prominent special issues, for example by the Journal of Small Business Management in 2018 and Entrepreneurship and Regional Development in 2012. Nevertheless, the findings on whether, and to what extent, teaching interventions are effective for boosting interest and developing skillset needed for entrepreneurial activity remain inconclusive and fragmented (Mwasalwiba 2010). The existing body of literature on best practices in entrepreneurial education is also limited by the fact that most entrepreneurial teaching interventions studied had a type of traditional classroom curriculum in the form of classroom discussions, case studies or lectures over semester-long courses (Bennett 2006).

The topic of best interventions in entrepreneurial education constitutes a significant research and public policy question; if public policies are designed to increase entrepreneurial activity, it will be valuable to learn the extent to which individuals can be influenced to value and seek entrepreneurial careers. Moreover, entrepreneurial skills have been identified as part of a general skill set that is needed to succeed in dynamic modern job markets (Savickas et al. 2009), that are marked by uncertain economic environments, but also potential opportunities created by technological change. It is therefore valuable to understand which types of interventions may be the most effective in boosting feelings of entrepreneurial self-efficacy and skillset needed to launch new ventures.

Despite the wide popularity of hackathons in entrepreneurial contexts, their effectiveness for entrepreneurial learning and changing attitudes toward entrepreneurship are under-investigated. This research aims at addressing the question of their potential usefulness for entrepreneurial education, and therefore, remedying this gap in entrepreneurial research and practice. Our research questions seek to determine whether an entrepreneurial learning experience in the form of a hackathon will lead to two major outcomes: Increased confidence in one's ability to identify an entrepreneurial idea and increased confidence in one's ability to craft a successful entrepreneurial venture.

Entrepreneurship is known to involve risk-taking, uncertainty, creativity, leadership and proactivity, but it also entails several motivational characteristics like passion and persistence (Newman et al. 2019). The authors posit that educational experiences that emulate a high-pressure, real-world business environment and force participants to rapidly apply newly acquired knowledge and receive feedback on these ideas may be more effective for increasing entrepreneurial self-efficacy than developing and refining entrepreneurial ideas over a longer periods of time (like for example several days, weeks or even months) in a less pressurized classroom setting. The authors theorize that these types of intensive experiences better emulate a high degree of motivation and energy that is typical for embarking on new entrepreneurial ventures, as well as have the potential to create a strong and lasting positive feedback loop that alters individuals' beliefs related to their own ability to apply and utilize entrepreneurial concepts and best practices. The authors hypothesize that applying entrepreneurial concepts quickly to the development of an idea, and presenting these ideas as fully developed (if not yet fully tested) entrepreneurial opportunities increases individuals' self-belief in their entrepreneurial acumen more than developing ideas over a longer period of time. Therefore, this research study focuses on the educational effects of a pressurized teaching intervention in a form of an entrepreneurial hackathon on the development of entrepreneurial self-efficacy and entrepreneurial skillset.

Hackathons are intensive, timed events during which participants immerse deeply in team activity focused on solving a specific problem, or, in entrepreneurial contexts, creating a viable business idea market delivery through an appropriate business model. These events create a concentrated, competitive, and strictly scheduled working and learning environment. Hackathons have been determined to produce valuable outcomes for solving complex challenges in the fields of science (Olson et al. 2017; Briscoe and Mulligan 2014; Trainer and Herbsleb 2014), social policy (Linnell et al. 2014) and arts (Briscoe and Mulligan 2014). Their effectiveness for student learning

is deemed to produce both positive (Artiles and Wallace 2013; Aungst 2015; Calco and Veeck 2015; Munro 2015; Lara and Lockwood 2016; Matthews 2014) and some negative results (Bowen 2017).

Our results suggest that a hackathon is an effective model for entrepreneurial learning. As the result of a one-day workshop, significant results were achieved for self-reported ability in identifying a viable entrepreneurial concept, and for having the ability to successfully launch a new venture. Further, class standing and prior entrepreneurial courses, as well as gender did not influence the learning outcomes. Importantly, while hackathon-generated increases in entrepreneurial self-efficacy proved to be statistically significant, same gains proved not to be significant in a traditional entrepreneurship class setting. Entrepreneurial self-efficacy gains were found to be independent of age, gender or academic standing.

This study makes several important contributions to the entrepreneurship and vocational behavior literatures that have implications for educators and policy makers. Firstly, this is the first research study known to the authors that addresses teaching effectiveness of a hackathon for the development of entrepreneurial skillset and self-efficacy. Secondly, this research study places hackathons in the context of a problem-based learning instructional approach and advances our understanding of the effectiveness of this teaching method. Finally, this study also offers a comparison between the effectiveness of a hackathon with that of a semester-long entrepreneurial course for the participants' growth in their perceived entrepreneurial skillset and entrepreneurial self-efficacy.

This paper is organized as follows: After explaining the nature and process of hackathons, authors place them in the context problem-based learning methodology. Following this description of the phenomenon being studied, the authors discuss research questions, as well as formulate research hypotheses. Subsequently, we present our methodology and results. The paper concludes with a discussion of the findings in the context of their implications for educators and policy makers.

2. The Pedagogy of Hackathons

2.1. The Hackathon Phenomenon

Hackathons are fast-paced events arranged by a variety of organizations including: Non-profit innovation centers, universities, corporations and online communities. Hackathons invite participants to collaborate, generate new ideas and solve concrete challenges in an intensive experiential setting. Hackathons are either open to the public or are private, meaning they are open only to the members of the group that organizes them.

Lederman (2015) points out that hackathons share four characteristics with real-world contexts for innovation, such as start-ups or R&D departments: (1) During the short bursts of creative work, participants are likely go through the full range of tasks and phases that make up the innovation process: idea generation, testing and validation and designing a complete solution; (2) Teams are required to share knowledge and information, since a change to one area of a business model is likely to affect the design of the other areas, meaning information needs to converge in support of solutions; (3) The decision environment during a hackathon resembles a real-life decision environment which is rife with severe time pressures, rapidly evolving and changing information, high demands on short-term memory, a need for fast-paced and accurate analysis and decision making as well as high information ambiguity. Since a hackathon is analogous to a business environment, this makes it easier for participants to transfer their newly learned behaviors (Krueger and Brazeal 1994); (4) Hackathon participants are motivated to contribute to the team effort because the outcome of the project may directly affect their futures. For some it may create new career opportunities, as participants enjoy networking with mentors and judges (often seasoned businesspeople) and may also improve their professional reputations.

2.2. Hackathons as Problem Based Learning

We believe that hackathons may be conceived as an example of Problem-Based Learning (PBL). Problem-based learning is an instructional approach which "empowers learners to conduct research, integrate theory and practice, and apply knowledge and skills to develop a viable solution to a defined problem" (Savery 2006, p. 12). The Association to Advance Collegiate Schools of Business (AACSB 2013) recognizes the importance of solving real-life problems in business curricula and underscores the necessity of developing reflective thinking skills as a key outcome of an undergraduate business education. PBL has been shown to positively influence knowledge acquisition in some settings, as well as problem solving skills, critical thinking, teamwork and self-directed learning outcomes (Garnjosta and Brown 2018).

Despite these gains, PBL is still rarely used in business education. A common university practice is to adopt an instructor-centered approach that focuses on acquiring knowledge within narrow discipline boundaries. This type of approach prevents students from fully understanding the complexities inherent in real-life situations and developing critical thinking and lifelong learning skills. Within the context of many business courses, students are still required to master business functions and best practices, rather than applying their own knowledge and judgement to draw independent conclusions and create solutions to current business challenges (Christensen 1991).

Student hackathons may offer an alternative to traditional instructor-centered forms of business education because they are focused on solving real-life challenges. These events force students to apply their learning, problem-solving and interpersonal skills and weave together different areas of knowledge to present their ideas tacking important issues. Entrepreneurially focused hackathons present an opportunity for students to create an innovative idea and design an appropriate business model for rolling out this idea into the marketplace.

Evidence related to the effect of PBL on knowledge acquisition remains mixed. While "the research on PBL taught courses in business programs leans toward there not being an increase in knowledge acquisition through PBL over more traditional faculty centric learning environments" (Garnjosta and Brown 2018, p. 123), there is also evidence that "that the better the capacity of an instrument to evaluate the application of knowledge by the student (rather than objective measures developed by the instructors, like course grades—addition by the authors) the greater the ascertained effect of PBL" on knowledge acquisition (Strobel and Barneveld 2009, p. 53). We believe that the application of the PBL methodology may be crucial to boosting the self-assessed level of knowledge and skillsets required to launch a business, because this knowledge is highly practical in nature, while its application is always context-dependent and will be judged as being high only in an event of successful implementation. Also, as PBL has been deemed to improve knowledge integration (Smith 2005) and foster questioning approach (Morgetson 1991; Williams 2001), we believe that its effects on self-assessed knowledge development in the context of entrepreneurial activity, which requires mastery of multiple business domains and critical deliberation, will be particularly beneficial.

The aim of entrepreneurial education is not only to learn about this business field, but also to learn for engaging in entrepreneurial activity (Decker-Lange et al. 2020). Universities create a range of teaching interventions that aim to stimulate entrepreneurial behavior and competency building among students (Ilonen and Heinonen 2018; Packham et al. 2010; Wenninger 2019). Educators apply methods including: Case-based teaching (Finney and Pyke 2008), simulations and games (Fox et al. 2018), prototyping (Noyes 2018), using unfamiliar contexts to probe concept understanding and acquisition (Decker-Lange 2018; Junqueira et al. 2019), entrepreneurial competitions (Brentnall et al. 2018; Chandler and Broberg 2019), cross-institutional distance learning (Apostolopoulos et al. 2018) and critical reflection (Wraae et al. 2020; Pepin 2012). Similarly to hackathons, some of these interventions, like for example simulations or prototyping, can be classified as based on the PBL methodology.

The goals of these interventions involve equipping students with skills and competencies and/or changing students' attitudes towards entrepreneurial activity both in small start-ups, as well as in larger corporations (Kuratko and Morris 2018; Williams 2019; Ustav and Venesaar 2018). As these

changes are internal, they are often regarded as "soft" impacts, as opposed to the "hard" impacts, which relate to actual new business creation (Nabi et al. 2017; Decker-Lange et al. 2020). Therefore, a hackathon may be regarded as a possible teaching intervention aimed at producing "soft" impacts on entrepreneurial education (Nabi et al. 2017).

With regard to hackathons, there is limited evidence suggesting that they can be effective at teaching students important business concepts. For example, results obtained by Calco and Veeck (2015) indicate that participation in a marketing hackathon taught students important marketing concepts and skills, while also contributing to students' engagement with the topics of study. Therefore, we propose that the active and intensive immersion in an entrepreneurial hackathon may facilitate the acquisition of knowledge and skills required to start a new business:

Hypothesis 1 (H1). *Participation in entrepreneurial hackathon will increase the self-assessed level of knowledge and skills required to start a business.*

2.3. Hackathons, Self-Efficacy, and Entrepreneurial Intention

There are theoretical justifications that support the potential impact of hackathons on entrepreneurial intention and entrepreneurial self-efficacy beliefs both attitudinally and behaviorally. According to Ajzen and Fishbein (1977), intended behavior is preceded by a conscious decision to act. Nevertheless, the relationship between attitudes and behavior is not direct; to express a behavior, attitudes need to first generate "intentions" (Brannback et al. 2007). Bagozzi (1981) demonstrated empirically that attitudes influence behavior only through their impact on behavioral intention. Therefore, intention is a strong predictor of planned behavior, including for entrepreneurship (Krueger et al. 2000).

Because self-efficacy is task specific, Chen et al. (1998) proposed the construct of entrepreneurial self-efficacy (ESE). ESE refers to the specific belief in one's own abilities to engage in entrepreneurial activities (Chen et al. 1998; De Noble et al. 1999; McGee et al. 2009) and may impact the readiness to engage in future entrepreneurial behavior.

Multiple scholars deem entrepreneurial self-efficacy to be a critical factor influencing the development of entrepreneurial intentions (Barbosa et al. 2007; Boyd and Vozikis 1994; Cardon and Kirk 2013; Drnovsek and Erikson 2005; Krueger et al. 2000; Liñán and Fayolle 2015; Solesvik 2017; Tsai et al. 2016; Zhao et al. 2005). The concept of self-efficacy (Bandura et al. 1961), which is defined as the perceived personal ability to successfully execute a particular behavior, overlaps with the concept of control over the outcomes of the behavior (Krueger et al. 2000). Control over behavioral outcomes is a key factor shaping individual intentions toward behavior (Armitage and Conner 2001). Further studies identified mediating effects of additional variables on the relationship between entrepreneurial self-efficacy and entrepreneurial intentions. These factors included personal initiative (Solesvik 2017), as well as attitude and perceived behavior control (Tsai et al. 2016).

Judgments about one's own efficacy influence both behavior and goal attainment; they shape entrepreneurial intentions and the likelihood that intentions translate into actions (McGee et al. 2009; Pajares 2008; Tsai et al. 2016). When an entrepreneur is confident in their abilities to perform the tasks needed to develop a new venture, they are more likely to initiate those tasks and to continue their efforts to succeed in their endeavor (Cardon and Kirk 2013). This effect is likely to be even stronger in the presence of positive affect that has been linked to increased effort towards future entrepreneurial goals (Foo et al. 2009). The authors argue that the conditions needed for an increase in personal entrepreneurial self-efficacy, as well as positive feelings, are created in a course of an entrepreneurial hackathon event, therefore, positively influencing entrepreneurial intentions of the participants.

According to Bandura et al. (1961), self-efficacy is acquired in four ways: Experiences of personal mastery, modeling or learning through observation, social persuasion and emotional arousal. These conditions closely resemble the intensive immersion in entrepreneurial experience during a hackathon. The very short time span in which business models are created is likely to

facilitate the feeling of personal mastery and strong emotional arousal. Additionally, this intense positive effect generated by accomplishing a complex task in a very short time span (building a fully-fledged, real-world business model) has been demonstrated to lead to greater persistence (Houser-Marko and Sheldon 2006; Pham 2004) that is at least partially facilitated by the feelings of self-efficacy.

Therefore, the authors posit that the experience of participating in an entrepreneurial hackathon may contribute to increased feelings of entrepreneurial self-efficacy. Accordingly, entrepreneurial self-efficacy is likely to positively influence individual intentions for seeking entrepreneurial careers. Consistent with presented arguments, the authors formulate the following proposition:

Hypothesis 2 (H2). *Participation in entrepreneurial hackathon will increase the feelings of entrepreneurial self-efficacy.*

3. Methods

3.1. The Participants

Creating the intensive simulation event involved a multi-step process; the first step was to identify a target group of students. The students chosen to participate were drawn from a state university in Michigan, United States. The University population was roughly 9800 students and the College of Business (AACSB accredited) had roughly 1200 students pursuing degrees in four departments: Accounting, Economics, Management and Marketing as well as Finance. Major industry sectors in the local area were manufacturing and agriculture, along with services.

The authors purposefully oversampled first and second year students to partial out the effects of advanced academic courses. All the students had received some level of university supported leadership training. To minimize the demand effects on the program evaluation, students were informed that the one-day workshop centered primarily on leadership development.

To construct the student teams, the authors utilized the Clifton StrengthsFinder™ assessment tool that measures the presence of the 34 individual talent themes, or strengths, divided into four domains: executing, influencing, relationship and strategic thinking. Talents are one's naturally recurring patterns of thought, feeling or behavior that can be productively applied; the more dominant a theme is in a person, the greater the impact on their behavior and performance (Rath 2007). Using the assessment, teams were formed by placing students together to ensure that all four domains outlined in Clifton StrengthsFinder™ assessment tool were covered in each team; this placed students with complementary as well as contrasting strengths together. The pedagogical intent was to emulate a real work environment where similarities and differences of opinions must be worked through to succeed as a group.

3.2. Hackathon Event

At the start of the workshop, each student was provided with a pre-assembled packet with their team assignment, materials for the simulation, an introduction of the goals and an agenda for the day. Before and after the workshop, students completed a short survey (Appendix A). Entrepreneurial knowledge development was assessed with the question: "Before (after) participating in this workshop, I felt I had the knowledge and skill required to start a business. A. Yes, B. No, C. Don't know". Entrepreneurial self-efficacy was assessed with the question: "Before (after) participating in this workshop, I felt that I could come up with a viable business idea". A. Yes, B. No, C. Don't know.

The program began with a series of interactive "Icebreaker" activities designed to help them build chemistry as a group that would be working together all day. The icebreakers require high levels of collaboration and communication in a short amount of time followed by a brief public presentation. Following the Icebreakers, students were introduced to the Business Model Canvas (BMC), a strategic management and lean startup template for developing new or documenting existing business models

(Osterwalder and Pigneur 2010). The canvas is a visual framework with elements describing a firm's or products value proposition, infrastructure, customers and finances that produces a glimpse of the bigger picture. The premise of the BMC is that an entrepreneur should be able to describe the economic and business logic of their business concept on a single page.

Groups worked as cohesive teams that processed significant diversity of opinions and leadership styles while designing and evaluating a response to an entrepreneurial opportunity. Each team was assigned a business startup opportunity that included a fictional story describing how the idea was generated; it also included the basic business opportunity premise. Teams then breakout with their coach to separate rooms to build a BMC for their assigned idea over 3 h. Students were provided with blank canvases, colored sticky notes, pens, markers and large papers to hang on the wall. They had access to consultants for brief specific questions. These consultants included two seasoned entrepreneurs and two faculty members from the college of business.

The idea was to generate a fully-fledged business model that would be appropriate for the described business opportunity. While the business opportunity was singular, there were many possible ways to develop the offering and commercialize the business. Therefore, students were encouraged to brainstorm different "roads to" commercialization and choose one business model that they deemed the most promising.

During lunch, students received their next set of instructions: Put together an investor pitch where they will present their ideas to a panel of entrepreneurial minded judges who will be acting as "investors". The teams' goal was to pitch their idea with enough merit and enthusiasm to get the judges to select them as the best idea in which to "invest". The students were informed how the judges would evaluate them, as well as some tips on how to best frame their presentations.

The teams returned to their breakout rooms and were given 45 min to work together on building their pitch. All teams returned to the main room to pitch their ideas to the judges, in random order. Judges could ask questions and provide feedback on their ideas as well as their pitch. Finally, all teams were scored using agreed upon rubrics, which were returned to the students with comments. In conclusion of the simulation, winners were announced and prizes were awarded.

In conclusion of this event description, it is important to note some critical elements of the hackathon process: All groups had a mix of ages, the same tool based on a lean startup model and a very limited time frame to complete the fully-fledged investor pitch presentation. Certain steps were taken to avoid threats to face validity such as the short length of time, the consistent use of Business Model Canvas methodology and the team composition in order to maximize diversity of ideas and leadership styles.

4. Data Analysis Methods

As part of our program evaluation, the authors received survey feedback from 71 of the 74 student participants (surveys were voluntary resulting in N = 71). The authors collected data on class ranking, gender, whether they had taken entrepreneurship courses and on specific attributes of the experience. Tables 1 and 2 display the frequency of response for each variable.

Table 1. Frequency Table of outcomes measures for Hackathon Event.

Variable Name/Response	No	Yes	% Yes
Pre-test—had the knowledge and skill required to start a new business	59	12	16.9
Post-test—had the knowledge and skill required to start a new business	24	47	66.2
Pre-test—could come up with a viable business idea	35	36	50.7
Post-test—could come up with a viable business idea	11	60	84.5

Table 2. Frequencies of covariate measures for Hackathon event (class rank, gender).

Class Rank				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Year 1	28	39.4	39.4	39.4
Year 2	18	25.4	25.4	64.8
Year 3	4	5.6	5.6	70.4
Year 4	21	29.6	29.6	100.0
Gender				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Female	39	54.9	54.9	54.9
Male	32	45.1	45.1	100.0
Completed at Least One Course in Entrepreneurship				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
No	65	91.5	91.5	91.5
Yes	6	8.5	8.5	100.0
Total	71	100.0	100.0	

Relative to the research propositions, the authors were interested in determining the efficacy of a hackathon approach to entrepreneurial learning and self-efficacy outcomes. Specifically, the authors were interested in whether students felt more confidence in their knowledge and skills relative to starting a business because of completing the workshop. Using a pre-test/post-test ANOVA model, we found a significant outcome, F = 7.997 with a p value of 0.006 (See Table 3). Further testing revealed that prior entrepreneurial course work or rank in class were not significant (*p*-values of 0.98 and 0.212). There was a significant gender effect on this question ($p = 0.01$); post-hoc evaluation however found that both men and women saw significant improvements but one group improved more than the other. The program evaluation evidence then strongly supports that the gains were not from other variables but from the workshop.

Table 3. Knowledge and Skills ANOVA Table for the Hackathon Event.

		Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Post-testing the knowledge and skills required to start a business * Pre-testing the knowledge and skills required to start a business	Between Groups (Combined)	1.650	1	1.650	7.997	0.006
	Within Groups	14.237	69	0.206		
	Total	15.887	70			

Since the problem/idea to pursue was provided in the workshop packet, the authors were interested in whether the student felt more confidence in their ability to generate a viable business model as the result of completing the workshop. Using the same pre-test/post-test ANOVA model, the authors also found a significant outcome, F = 16.035 with a p value of 0.000 (See Table 4). Further testing revealed that prior entrepreneurial course work, rank in class, and gender were not significant (*p*-values of 0.28, 0.27 and 0.978 respectively) to our findings.

Table 4. Business idea ANOVA Table for the Hackathon Event.

		Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Post-testing the Business Idea * Pre-testing the Business Idea	Between Groups (Combined)	1.753	1	1.753	16.035	0.000
	Within Groups	7.543	69	0.109		
	Total	9.296	70			

5. Discussion

Prior research in other fields found that hackathons had an impact on knowledge development and self-efficacy in a variety of organizational settings (Aungst 2015; Calco and Veeck 2015; Lara and Lockwood 2016; Munro 2015; Olson et al. 2017). This evaluation found evidence to support that a brief intensive approach in a form of a hackathon may also work in an entrepreneurial setting.

In order to better understand the effect of a hackathon format on entrepreneurial learning, we have compared its outcomes to that of a traditional entrepreneurial class[1]. Even though different groups of students participated in the hackathon event and in the entrepreneurial class, making the results not completely comparable, we believe that this comparison still offers valuable insights into the effectiveness of a hackathon for entrepreneurial learning in the areas of knowledge acquisition and potential improvement of perceived entrepreneurial self-efficacy. In evaluating students' classroom experience we used the same questionnaire and pre-test/post-test ANOVA model that was used to analyze the effects of a hackathon. Tables 5–8 summarize our findings.

Table 5. Frequency Table of outcomes measures for entrepreneurial classes.

Variable Name/Response	No	Yes	% Yes
Pre-test—had the knowledge and skill required to start a new business	26	16	38.1
Post-test—had the knowledge and skill required to start a new business	8	25	75.7
Pre-test—could come up with a viable business idea	9	34	79.1
Post-test—could come up with a viable business idea	5	32	86.5

Table 6. Frequencies of covariate measures for entrepreneurial classes (class rank, gender).

Class Rank				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Year 1	0	0	0	0
Year 2	1	2.1	2.1	2.1
Year 3	12	25.0	25.0	27.1
Year 4	35	72.9	72.9	100.0
Gender				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Female	18	30.0	30.0	30.0
Male	29	70.0	70.0	100.0
Completed at Least One Course in Entrepreneurship				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
No	27	57.4	57.4	57.4
Yes	20	42.5	42.5	100.0
Total		100.0	100.0	

Table 7. Knowledge and Skills ANOVA Table for entrepreneurial classes.

		Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Post-testing knowledge and skills required to start a business * Pre-testing the knowledge and skills required to start a new business	Between Groups (Combined)	0.516	1	0.516	2.207	0.149
	Within Groups	6.312	27	0.234		
	Total	6.828	28			

[1] Data was collected in 2 senior entrepreneurship classes held at Saginaw Valley State University in Winter 2018. The overall number of students in these classes was 48. The assessment included the level of entrepreneurial skills and ability to come up with a viable business idea. Response format was: "Yes", "No" and "Do not know". "Do not know" responses were coded as missing data.

Table 8. Business idea ANOVA Table for entrepreneurial classes.

		Sum of Squares	df	Mean Square	F	Sig.
Post-test Business Idea * Pre-test Business Idea	Between Groups (Combined)	0.025	1	0.025	0.160	0.692
	Within Groups	4.917	33	0.154		
	Total	4.941	32			

While students reported gaining more entrepreneurial skills and a greater ability to come up with a viable business idea as a result of their involvement in a hackathon, the same learning gains proved not to be statistically significant in a traditional class format (See results in Tables 7 and 8). We think that this result may have partially to do with self-selection of students enrolling in traditional entrepreneurial classes; a large number of students choosing entrepreneurial curriculum come with formulated business ideas and believe that they have the knowledge and skills required to start a new business (for frequencies please refer to Table 5, for frequencies of covariate measures including gender and class rank please refer to Table 6). Further testing revealed that prior entrepreneurial course work, rank in class and gender were also not significant to findings related to the effectiveness of a traditional class format. While this result is at odds with a number of studies on the development of an entrepreneurial skillset which found that an entrepreneurial curriculum that generally found significant benefits (Westhead and Solesvik 2016), especially for practical skillset development oriented courses (Piperopoulos and Dimov 2014), a number of social scientists reported mixed results of an entrepreneurial curriculum on the development of entrepreneurial intentions (Krueger and Brazeal 1994; Souitaris et al. 2007; Walter et al. 2011), with some studies even reporting possible negative outcomes (Oosterbeek et al. 2010).

The authors believe that a hackathon approach may be an effective entrepreneurial learning tool for the general student population, which includes students with limited knowledge and interest in entrepreneurship. Students who participated in the hackathon event outlined in this research study did not self-select to participate in an entrepreneurial class. The effectiveness of a hackathon as methodology useful in entrepreneurial learning has potential implications for educators, scholars and policy makers. For educators, a hackathon approach may outperform a number of traditional entrepreneurship pedagogies in the form of lectures, case studies, class discussions or a business plan development over a semester-long class that often constitutes the learning methods used in an entrepreneurial course. This might in part result from the emotional context and the connectivity with the business setting; entrepreneurs are often noted for their passion, as well as their flexibility and reactiveness to changes occurring in the business environment. All of these elements are hard to re-create in a large, or even medium-sized classroom setting. It is important that students associate entrepreneurial activity with creative endeavor and a life challenge, rather than with academic coursework.

A significant increase in the feelings of entrepreneurial self-efficacy that is likely to occur during a course of an entrepreneurial hackathon may also lead to creative "reframing" of one's-own self-image and career ambitions. According to Lindh (2017), reflection is a process in which students assess their dreams in relation to the environment in which these dreams can be realized. This reflective process is an important part of entrepreneurial education which should go beyond merely learning about entrepreneurship, but should also involve learning how to be an entrepreneur, and even beyond that, how to gain "the life skills necessary to live productive lives" (Neck and Corbett 2018, p. 10) and how to display enterprising characteristics when facing life's challenges (Gibb 2011; Wiklund et al. 2011).

This perspective is consistent with the latest conceptual model of entrepreneurial education by Kakouris and Liargovas (2020) that identifies instructional differences between the so-called "about," "for" and "through" approaches. According to these authors, the "about" mode follows the positivistic paradigm, the "for" mode follows the vocational education and training objectives while the "through" mode is focused on personal transformation through reflection and reassessment of one's own abilities. The authors of this study think that the hackathon method is likely to combine all these modes by teaching new and important business model concepts to students (the "about" mode), applying these

concepts to create practical business model solutions (the "how" mode) and increasing feelings of entrepreneurial self-efficacy (the "through" mode).

From a practical standpoint of delivering business and organizational-related education, a hackathon may also allow students to gain entrepreneurial skills and self-confidence much quicker and using less resources than in a traditional entrepreneurial course. As entrepreneurship is generally a difficult endeavor, riddled with challenges and multiple failures, presenting students with a shorter path to gaining valuable entrepreneurial knowledge and equipping them with self-confidence to embark on developing an idea into a business is a highly advantageous option for educators. Additionally, there are noteworthy implications in using an alternative delivery system, e.g., early, and frequent engagement may result in more students choosing entrepreneurship as a viable career option.

This study has important limitations. Firstly, the sample size of students who participated in the hackathon event was relatively small (N = 71). A larger sample size would have had greater statistical power that could also allow for more in depth analysis of student characteristics possibly influencing the outcomes, like, for example: Family background, gender, class standing, major and minor, prior knowledge and experience related to entrepreneurial activities, just to name a few possibly important variables. In addition to that, a larger sample size would also make it possible to comfortably employ more advanced statistical methods including logistic regression; that method would have been well suited for the analysis of dichotomic dependent variables present in this study.

Logistic regression typically requires large sample sizes. Unfortunately, the sample size in this research study was too small to meet all the statistical requirements for this method as outlined by Long (1997), who recommends a sample no smaller than 100 in each case of employing a logistic regression method. Because of this small sample size, the authors opted for a less sophisticated, but still statistically robust ANOVA method. The authors sincerely hope that these results can be tested and refined by other scholars.

Therefore, this study has also important research implications. This evaluation captured pre- and post-workshop outcomes focusing only on limited number of survey questions and dichotomic outcomes for the dependent variables. Future scholars may choose to expand survey questions, as well as expand outcomes for dependent variables turning them, for example, into ordinal variables. As previously mentioned, this approach may be particularly fruitful for large sample sizes, providing greater levels of statistical power and more data that can be analyzed using complex statistical methods.

It would also be valuable to test this model against other types of entrepreneurial learning, e.g., pitch competitions, and/or entrepreneurial internships. While this research was limited to US students, further research is needed to determine whether the effects found in this study are generalizable to other settings. Research is also needed to assess the efficacy of alternative delivery systems. In a world with increasing interconnectedness, there is potential for developing virtual and virtual-reality versions of hackathons and other intensive engagements. Currently there is little research that evaluates physical and virtual delivery systems in hackathon settings. We hope that future research will identify the best delivery systems for this highly promising approach to teaching and inculcating entrepreneurship.

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Appendix A. Survey Questions

1. I had taken at least 1 course in entrepreneurship.

   A. Yes
   B. No

C. Don't know

2. Before (after) participating in this workshop, I felt I had the knowledge and skill required to start a business.

   A. Yes
   B. No
   C. Don't know

3. Before (after) participating in this workshop, I felt that I could come up with a viable business idea.

   A. Yes
   B. No
   C. Don't know

4. I am a ... Freshman Sophomore Junior Senior MBA
5. What is your gender? Male Female Other

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