

## RELATIONSHIPS BETWEEN ONLINE BEHAVIORS AND ENTREPRENEURIAL INTENTIONS EXPLAINED BY FUZZY STATISTICS

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**ABSTRACT.** *The impact of web startups on economic innovation and job creation has increased as the functionalities of Internet expand. The new web businesses could be as one of the primary creators of economic growth and new jobs for the young generation. Knowledge the trend of new development, this study aims to realize the relationship between college students' online behaviors and entrepreneurial intentions to enhance the related promoting programs. We selected six universities as our target group and invited 1,500 college students to participate in this survey. In this study, the collected fuzzy interval data have been transformed by fuzzy statistics to interpret their fuzzy means, centers, radius, and correlation with the fuzzy format. The relationships between online activities and entrepreneurial intentions have shown from low to moderate positive fuzzy correlations. Males' online behaviors are similar to those of females according to the fuzzy centroids. The gender differences have shown in the entrepreneurial intentions. The results of fuzzy correlations demonstrate that the students' online behaviors and entrepreneurial intentions have positive relationships. Both online behaviors and entrepreneurial intentions might reinforce each other. This study suggests that the higher education institutions can engage more workable actions to enhance students' entrepreneurship.*

**Keywords:** Online behaviors, Entrepreneurial intention, Entrepreneurship, Fuzzy statistics, Fuzzy correlation

**1. Introduction.** Web businesses are one of the primary creators of innovation and new jobs in this century. The impact of web startups on economic growth and job creation will further increase as the functionalities of Internet expand shortly. We do believe entrepreneurs are the key drivers of tomorrow's innovations and integral to creating a thriving economy. In response to this trend, the higher education institution has also shifted its attention towards using the institution as a means to promote entrepreneurship. However, in this regard, Said et al. found the lack of financial support to higher education institutions for the development of social entrepreneurship. By their review, they recommend that there must be a strong political and financial support for the higher education institutions for the promotion of social entrepreneurship [1]. Furthermore, Stuetzer et al. found there is no direct link between regional knowledge creation, the economic context and an entrepreneurial culture on the one side and individual business start-up intentions and start-up activity on the other side. Their findings pointed to the importance of an indirect effect of regional characteristics as knowledge creation, the economic context, and an entrepreneurial culture has an effect on the individual perception of opportunities, which in turn predicted start-up intentions and activities [2]. The survey of 512 students at the

MIT School of Engineering broadly confirms the model. Personality traits have a strong impact on the attitude towards self-employment. The entrepreneurial attitude strongly links with the intention to start a new venture. The students' personality, therefore, shows an indirect effect on intentions. Moreover, the entrepreneurial intention is directly affected by perceived barriers and support factors in the entrepreneurship-related context. The findings have important implications for policy makers inside and outside universities [3]. Using 20,046 observations from the adult population survey (APS) collected according to the global entrepreneurship monitor (GEM) methodology, a logistic regression analysis controlling for robust interaction term was used to determine the direct and interaction effect of perceived entrepreneurial ability and actual ability in influencing the decision to initiate entrepreneurial activities. The study found the evidence of a positive interaction effect suggesting that perceived entrepreneurial ability is a key determinant of entrepreneurial initiatives among those with the high actual ability [4]. Although connections between university enterprise courses and entrepreneurial activities have been examined, less work has investigated the intended timing of future entrepreneurial activities [5]. Ozaralli and Rivenburgh found although students hold a positive attitude towards entrepreneurship, they show a low level of entrepreneurial intention. Their findings also indicate that there is a statistically significant relationship among personality attributes of optimism, innovativeness, risk-taking propensity and entrepreneurial intention [6].

Previous studies have focused on entrepreneurial attitude, entrepreneurial intentions, or wider entrepreneurial culture. However, the relationship between students' online behaviors and entrepreneurial intentions has little been mentioned in the literature. The behaviors and intentions for persons belong to ambiguous domains. Fuzzy has been found an effective way to tackle the ambiguous issues compared to the traditional method. It can be applied to this field. This study aims to determine the relationships between the behaviors of activities on the web and students' entrepreneurial intentions in this new area. Given this purpose, this study addresses the following questions:

- (1) What are the popular online behaviors among these students?
- (2) What are the main online entrepreneurial intentions among these students?
- (3) What kind of relationships exert between online behaviors and entrepreneurial intentions?

In the beginning, this study addresses research purposes and questions; then the research framework has been displayed and the self-designed fuzzy questionnaire to collect interval data has been demonstrated. Following the fuzzy statistics section, this study interprets how students' online behaviors will relate to their entrepreneurial intentions. Finally, the conclusion has been drawn and suggestions for further studies will be proposed.

## 2. Method.

**2.1. Research framework.** In this study, a self-designed fuzzy questionnaire was used to collect data from the target group. First, fuzzy interval data were transformed by using fuzzy mean, center, and radius to catch the whole picture of the data set. Then, the gender was considered to compare the group's differences. Finally, the fuzzy correlation was used to determine the relationship between students' online behaviors (OB) and their entrepreneurial intentions (EI). OB includes info browsing (OB1), social media using (OB2), online games (OB3), run personal web page/Facebook, etc. (OB4), and online investment (OB5). While EI includes online auction (EI1), design Apps (EI2), design teaching related Blogs (EI3), blog marketing (EI4), open and maintain YouTube channels (EI5), manage professional Facebook (EI6), Internet advertising links (EI7). The research framework was displayed as Figure 1.

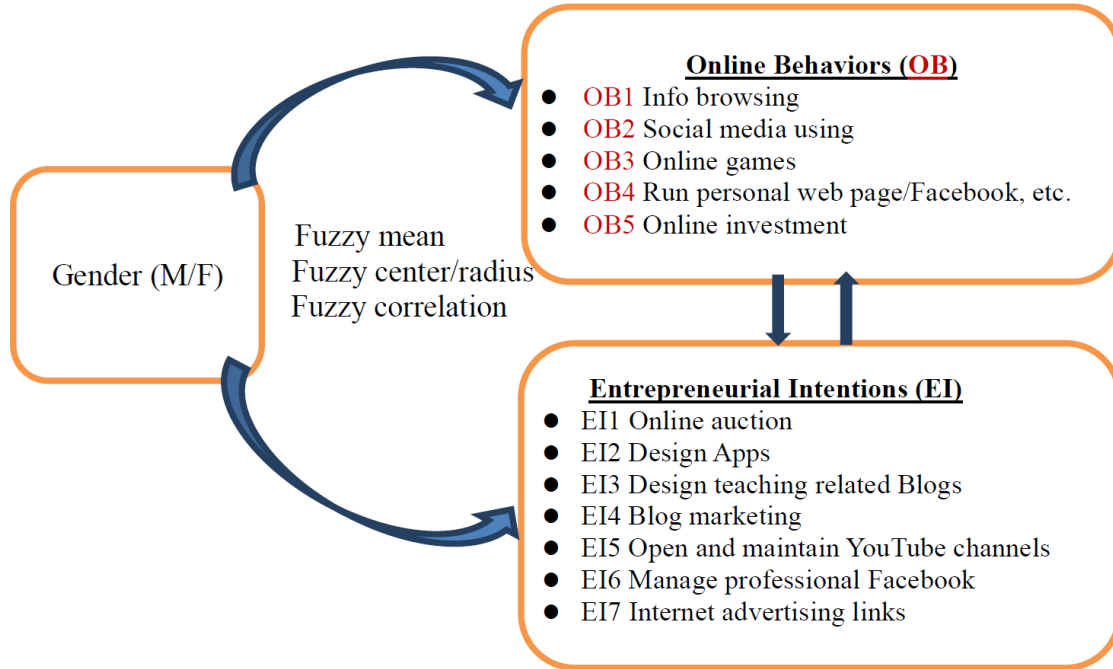


FIGURE 1. Research framework

Intention of entrepreneurship

1	2	3	④	5	⑥	7
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FIGURE 2. An example of fuzzy questionnaire

**2.2. Data collection.** A fuzzy self-designed questionnaire was used to collect data from the target group. Each item of the questionnaire was designed by using a scale of 1 (minimum weight) to 7 (maximum weight) to fit fuzzy interval data format. In this scale, the weights in the interval of 1-7 are equal. The participants will be asked to fill the questionnaire following the fuzzy format. For example, if N student’s intention of entrepreneurship is from 4 to 6, s/he needs to circle 4 and 6 to represent the range of intention on this scale. The example of the fuzzy questionnaire is shown in Figure 2.

In this study, we invited 1,500 students from 6 universities to join in this survey based on their voluntary participation in Taiwan. After deleting the incomplete questionnaires, the final questionnaires are 1,129 with 75.27% valid rate. Specifically, there are 553 males (49%), and 576 females (51%).

**2.3. Fuzzy statistics.** Interval fuzzy data can be defined as a well-distributed membership function with fuzzy numbers. The symbol of “[ ]” represents a closed interval. If  $a, b \in R$  and  $a < b$ ,  $[a, b]$  is interval fuzzy number. We consider  $a$  the lower bound of  $[a, b]$  and  $b$  is the upper bound of  $[a, b]$ ; If  $a = b$ ,  $[a, b] = [a, a] = [b, b] = a = b$ , and  $a$  (or  $b$ ) is a real number. Similarly, a real number  $k$  can be defined as  $[k, k]$  [7-9].

**Definition 2.1.** If  $[a, b]$  is a fuzzy interval set,  $c_o = \frac{a+b}{2}$  and  $s_o = \frac{b-a}{2}$ , which represent the center and radius, respectively. Also, a set of interval fuzzy numbers for fuzzy calculation can be expressed as follows:

$$[c_o, s_o] \Rightarrow [c_o - s_o, c_o + s_o] = [a, b]. \text{ The length of the interval data is } \ell = b - a.$$

In this study, the center represents the point that might take the largest fuzzy membership function, and the radius is the variance of the fuzzy interval data.

**Definition 2.2.** If we consider  $(x_i, y_i)$  as the first  $i$  sample value,  $i = 1, 2, \dots, n$ ;  $x_i, y_i$  are interval fuzzy numbers; then  $\bar{x}, \bar{y}$  represent their sample means. Let  $l_{x_i}$  be the length of continuous interval sample  $x_i$ ,  $l_{y_i}$  be the length of the sample interval  $y_i$ , then the corrected length of the correlation coefficient can be expressed as follows:

$$r_l = \frac{\sum_{i=1}^n (l_{x_i} - \bar{l}_x) (l_{y_i} - \bar{l}_y)}{\sqrt{\sum_{i=1}^n (l_{x_i} - \bar{l}_x)^2} \sqrt{\sum_{i=1}^n (l_{y_i} - \bar{l}_y)^2}} \quad (1)$$

Then we can calculate  $\delta$  by using  $r_l$  as Formula (1). The formula for  $\delta$  can be listed as follows:

$$\delta = 1 - \frac{\ln(1 + |r_l|)}{|r_l|} \quad (2)$$

Since  $0 < r_l < 1$ , the range of  $\delta$  is  $0 < \delta < 0.3069$  [10,11].

**Definition 2.3.** Fuzzy relevant interval (Method for taking the center and the length of the interval fuzzy numbers). Let  $C_{x_i}, C_{y_i}$  be samples from the interval fuzzy matrix central point,  $l_{x_i}, l_{y_i}$  for the interval length. The  $r$  is the center of the correlation coefficient,  $\delta$  is the fitter to be used to correct the length of the correlation coefficient. The relevant interval is defined as follows [10-12]:

- (i)  $r \geq 0, r_l \geq 0, (r, \min(1, r + \delta))$
- (ii)  $r \geq 0, r_l < 0, (r - \delta, r)$
- (iii)  $r < 0, r_l \geq 0, (r, r + \delta)$
- (iv)  $r < 0, r_l < 0, (\max(-1, r - \delta), r)$

**3. Results.** Based on the research questions, first, this study will present which one is the popular online behavior. Then, the main online entrepreneurial intention among these students will be displayed. Finally, the relationships between online behaviors and entrepreneurial intention with fuzzy formats will be determined.

**3.1. Presentation by fuzzy means, center, and radius.** Table 1 represents all variables of the research framework with fuzzy means, fuzzy center ( $C_o$ ) and radius ( $S_o$ ) among 1,129 participants. According to the  $C_o$  which were transformed by fuzzy means, the most popular online behavior is info browsing ( $C_o = 5.40$ ), then social media using ( $C_o = 5.28$ ). While online investment is the least engaged online activity ( $C_o = 2.96$ ) reported by the participants. The main online entrepreneurial intentions include manage professional Facebook (EI6), online auction (EI1), and open and maintain YouTube channels (EI5) with centers 4.79, 4.70, and 4.62, respectively. Based on Table 1, the ranges of center variances ( $S_o$ ) are from .62 to .76, which also reflect the fluctuation of the various  $C_o$ .

**3.2. Gender difference.** In this study the participants consist of 49% males and 51% females. The online behaviors of males are similar to those of females according to the fuzzy center ( $C_o$ ). Info browsing (OB1) has been listed on top of online behaviors by both males and females. However, online investment (OB5) has been listed in their least engaged online behaviors. The results reveal males intend to engage in design Apps (EI2), while females would like to manage professional Facebook (EI6). In general, the males' lists of entrepreneurial intentions are designed Apps (EI2), following manage professional Facebook (EI6), online auction (EI1), and open and maintain YouTube channels (EI5). While the females' lists are managed professional Facebook (EI6), following online auction (EI1), open and maintain YouTube channels (EI5), and then design Apps (EI2). The details of gender differences are listed in Table 2.

**3.3. Fuzzy correlation.** Following Definition 2.1 and Definition 2.2, this study calculated the related  $\delta$  as the filter to adjust the fuzzy  $r$ . The calculated  $\delta$  has been presented in Table 3, which will be further processed to format the fuzzy correlation. The result reveals that the range of  $\delta$  is from .108 to .173. According to fuzzy correlation transformation (Formula (1)), all  $r \geq 0$ ; therefore the fuzzy  $r$  will be represented as  $(r, \min(1, r + \delta))$ , which is followed Definition 2.3. The details of fuzzy correlation between online behaviors (OB) and entrepreneurial intentions (EI) are displayed in Table 4.

This study employed the following criteria to judge the meaning of fuzzy correlation:  $r > .65$  for the high correlation,  $.35 < r < .65$  for the moderate correlation,  $r < .35$  for the low correlation. The result reveals info browsing (OB1) is a prevalent online behavior, but OB1 only demonstrates low fuzzy correlation with different entrepreneurial intentions. Social media using (OB2), online games (OB3), and run personal web page/Facebook (OB4) played crucial roles with entrepreneurial intentions (EIs) when considering that most of the moderate fuzzy correlations have connected in these items. Nonetheless, the relationships between online investment (OB5) and entrepreneurial intentions (EI) only show

TABLE 1. Fuzzy means, fuzzy centers, and variances

Variables in Corr. model	Fuzzy means	$C_o$	$S_o$
OB1 Info browsing	[4.73, 6.08]	5.40	0.67
OB2 Social media using	[4.62, 5.95]	5.28	0.66
OB3 Online games	[3.48, 4.76]	4.12	0.64
OB4 Run personal web page/Facebook	[3.34, 4.69]	4.01	0.68
OB5 Online investment	[2.35, 3.58]	2.96	0.62
EI1 Online auction	[3.94, 5.47]	4.70	0.76
EI2 Design Apps	[3.92, 5.34]	4.03	0.71
EI3 Design teaching related Blogs	[3.62, 5.06]	4.34	0.72
EI4 Blog marketing	[3.35, 4.77]	4.06	0.71
EI5 Open and maintain YouTube channels	[3.90, 5.33]	4.62	0.71
EI6 Manage professional Facebook	[4.08, 5.50]	4.79	0.71
EI7 Internet advertising links	[3.35, 4.73]	4.04	0.69

TABLE 2. Gender differences of students' online behaviors and entrepreneurial intention

OB & EI	<b>Males</b>	$C_o$	$S_o$	<b>Females</b>	$C_o$	$S_o$
	Fuzzy means			Fuzzy means		
OB1 Info browsing	[4.74, 6.15]	<b>5.44</b>	0.70	[4.74, 6.01]	<b>5.36</b>	0.65
OB2 Social media using	[4.60, 5.97]	5.29	0.69	[4.65, 5.92]	5.28	0.64
OB3 Online games	[4.11, 5.45]	4.78	0.67	[2.86, 4.11]	3.49	0.62
OB4 Run personal web page/Facebook	[3.40, 4.79]	4.10	0.70	[3.28, 4.59]	3.93	0.66
OB5 Online investment	[2.50, 3.76]	<b>3.13</b>	0.63	[2.20, 3.40]	<b>2.80</b>	0.60
EI1 Online auction	[3.86, 5.39]	4.63	0.77	[4.01, 5.53]	4.77	0.76
EI2 Design Apps	[4.06, 5.51]	4.78	0.73	[3.78, 5.18]	4.48	0.70
EI3 Design teaching related Blogs	[3.50, 4.99]	4.25	0.74	[3.73, 5.14]	4.43	0.70
EI4 Blog marketing	[3.25, 4.68]	3.96	0.71	[3.45, 4.86]	4.16	0.70
EI5 Open and maintain YouTube channels	[3.90, 5.37]	4.63	0.73	[3.90, 5.29]	4.60	0.69
EI6 Manage professional Facebook	[4.00, 5.45]	4.73	0.72	[4.16, 5.56]	4.86	0.70
EI7 Internet advertising links	[3.37, 4.79]	4.08	0.71	[3.33, 4.68]	4.00	0.67

TABLE 3. The fuzzy correlation  $\delta$  transformed by  $C_o$  and  $S_o$ 

Filter $\delta$	OB1	OB2	OB3	OB4	OB5
EI1	0.124	0.157	0.173	0.156	0.135
EI2	0.132	0.160	0.167	0.161	0.140
EI3	0.120	0.153	0.144	0.156	0.134
EI4	0.111	0.137	0.160	0.152	0.144
EI5	0.128	0.148	0.143	0.153	0.126
EI6	0.131	0.168	0.159	0.141	0.132
EI7	0.108	0.128	0.140	0.139	0.121

TABLE 4. Fuzzy correlation between online behaviors and entrepreneurial intentions

Online behaviors & Entrepreneurial intentions	OB1	OB2	OB3	OB4	OB5
EI1	(.296, .420)	(.394, .551)	(.445, .618)	(.390, .546)	(.329, .464)
EI2	(.319, .451)	(.403, .563)	(.426, .593)	(.408, .569)	(.343, .483)
EI3	(.285, .405)	(.382, .535)	(.354, .498)	(.392, .548)	(.326, .460)
EI4	(.260, .371)	(.334, .471)	(.405, .565)	(.379, .531)	(.354, .498)
EI5	(.308, .436)	(.365, .513)	(.352, .495)	(.381, .534)	(.302, .428)
EI6	(.317, .448)	(.430, .598)	(.401, .560)	(.345, .486)	(.320, .452)
EI7	(.252, .360)	(.307, .435)	(.343, .483)	(.339, .478)	(.286, .407)

low and moderate fuzzy correlations. The results of fuzzy correlations demonstrate that the students' online behaviors and entrepreneurial intentions have positive relationships. Both online behaviors and entrepreneurial intentions might reinforce each other.

**4. Conclusions.** This study provides an example for higher education institutions to tackle the issue of students' online behaviors and entrepreneurial intentions. The results of fuzzy correlations demonstrate that the students' online behaviors and entrepreneurial intentions have positive relationships. The findings are different from previous studies, for instance, Ozaralli and Rivenburgh argument that students hold a positive attitude towards entrepreneurship, they show a low level of entrepreneurial intention; Stuetzer et al. claimed there is no direct link between regional knowledge creation, the economic context, and an entrepreneurial culture. This study suggests creating wider capacity for students to engage online activities, and the intention of entrepreneurship will increase.

For future studies, this study suggests more feasible items related to the online entrepreneurial activities needed to be developed to enrich the current content of the questionnaire. Furthermore, the selected items for fuzzy questionnaire should be reconsidered to fit the different settings which might confront dissimilar issues.

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