FUZZY EVALUATING MANAGEMENT PERFORMANCE AND MARKETING STRATEGIES IN COMMUNITY COLLEGES

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ABSTRACT. *Recently, worry about the worsening quality of community colleges has become public concerns in Taiwan. Within a high competitive marketing, the managers in community colleges have been expected for better performance in their teaching quality to attract potential students. This study aims to apply fuzzy measurement and propose an effective solution to improve the performance of community colleges. We design a fuzzy model to retrieve management features in community colleges and redefine their performance indicators. The result reveals the important factors for better performance, which are measured by fuzzy, are enrollment, attendance, and satisfaction. Community colleges can select better marketing strategies to evaluate their curriculum design through students' needs using fuzzy measurement.*
Keywords: Performance management, Marketing strategy, Community colleges, Performance indicators

1. **Introduction.** Many countries have promoted life-long learning to respond the changeable world for adults. The related measures have also affected the development of community colleges in Taiwan. In recent years, the establishment of community colleges has been viewed as the chance for reshaping the civil society. Under this circumstance, the community colleges were asked to face the accountability in terms of reviewing their educational goals, participants' needs, and internal curriculum design to achieve their missions. However, many community colleges have experienced hardship to assess management performance only by themselves. In this study, we apply a new way to evaluating the course performance from the adult learners' perspectives to provide new market-driven strategies for the community colleges.

Many adults enter community colleges and take courses through a market mechanism in Taiwan. We have experienced that the local community colleges have encountered two kinds of difficulties recently. One is that their participants have less interests in academic and public affair courses. The other is that their participants over-emphasize the practical courses and lead some market-driven community colleges to provide too many life skills courses. A lot of community colleges have faced the dilemma between maintaining their

ideal core-value to develop civil society and meeting participants' recreational needs to seek survival. In some cases, community colleges have become cram-schools and lose their original purposes. The question is: can we combine the participants' interests with the public good in a community college? By doing what, the participants will feel more meaningful with regard to the services of community colleges? The purpose of this study is to explore the potential factors of course performance in which the factors can be emerged and applied to assessing the effectiveness of management. More precisely, this study tries to solve the following two questions:

(1) How to establish performance management indicators by fuzzy logics for community colleges?

(2) What marketing strategies should we propose for the community colleges?

2. **Managed Performance in Community Colleges.** Many researchers have mentioned the importance of performance management in community colleges [2]. Performance indicators have also become an acceptable tool for measuring institutional effectiveness in community colleges. However, it is still lacking in study to deal with the course performance indicators in community colleges effectively.

2.1. **Measuring the performance of community colleges.** The so-called performance means a kind of level that the individuals achieve their intended goals [2]. Measuring performance can be simply divided into two categories to explain. One is financial indicators, and the other is non-financial indicators. Typically, the community colleges belong to non-profit organizations in Taiwan. Reviewing related literature, we found the Ontario Colleges have identified five measurements to be used as the key performance indicators. They are graduate employment, graduate satisfaction, employee satisfaction, student satisfaction, and graduation rate [2]. The idea of key performance indicators (KPI) is a province-wide accountability tool established by the Ontario government in 1998. It is used to measure and reward purposes for college performance in meeting specific goals and objectives. As we know, the community colleges are different from general universities. Therefore, this study needs to base on the feature of community colleges and provide a multi-dimension model for their performance measurement.

2.2. **Marketing strategy for the community colleges.** Glatsten proposed establishing a strong brand and giving customers the best experiences. Each individual that steps in a community college will encounter a number of touch points. Therefore, brand and marketing have become a chain, and brand image is a promise – a promise that must be kept [6]. Thinking the marketing strategies, we will find the key point is how to maintain the educational quality of community colleges to meet participant's requests. The marketing strategies will provide different thinking about how to run an ideal community college.

3. **Methods.**

3.1. **Research framework.** Figure 1 represents a dynamic process of performance management in community colleges. The idea of community colleges integrated into national, community college herself, and personal benefit in Taiwan. The systems followed the Law of Lifelong Learning 2002. Typically, the community colleges commissioned or self-management by local government to provide life skills, academics courses, and leisure related courses for adults. It is an open enrollment for adults in the community. Their survival is usually determined by their quality of education in a free market. In this study, we try to link the goals of community colleges to their course performance and then to find better marketing strategies for the community colleges.

In this study, we propose a research framework following the goal values of community colleges to evaluate their course performance. In our design, the performance indicators, which use to evaluate the courses performance in community college, can be defined by the financial, internal, and customers factors. We invited five experts in this field to help us to select the main performance indicators. Finally, we select enrollment, attendance, and satisfaction as our performance indicators to transform the fuzzy data collected from the participants (see Figure 2).
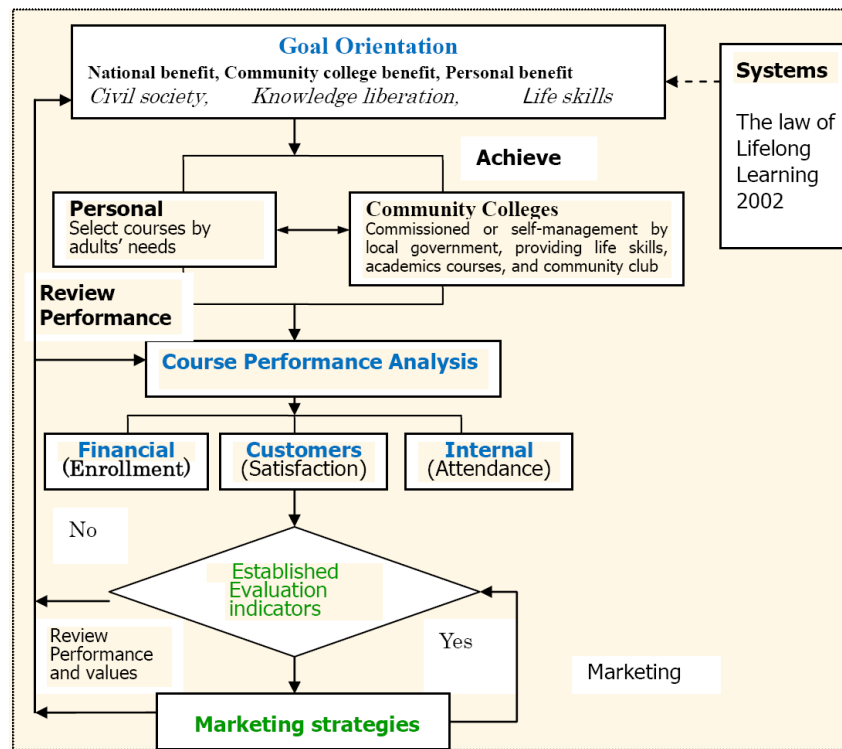
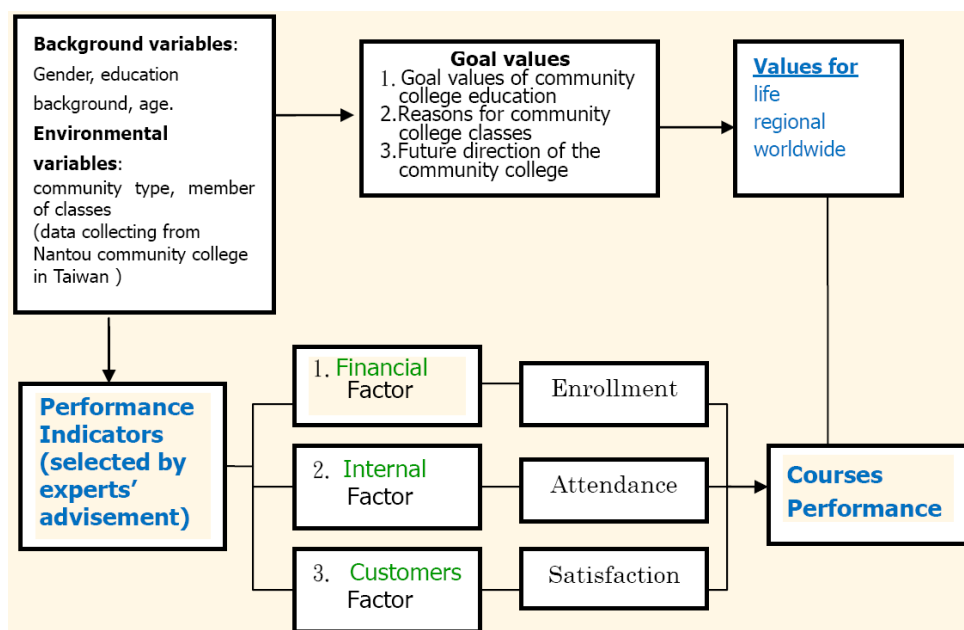FIGURE 1. Dynamic process of community college in Taiwan

FIGURE 2. Research framework

3.2. **Fuzzy statistics and weighting.** The fuzzy statistics has become a useful tool for measuring ambiguous concepts in science and social science [1,4,8,9]. Why the traditional numerical model cannot explain complex and ambiguous human and social phenomena properly? Previous researchers reminded the risk is too many limitations for digital data and over-interpretation [3]. Using fuzzy data transform, we try to avoid such kind of risks. However, the ambiguous data are consistent with human logics, and we need a powerful way to deal with the fuzzy data during computing process. The concepts of fuzzy set are proposed by Zadeh and applied to fuzzy measurement to deal with the dynamic environment. It will give a more reasonable description for many data transform [1,5,7]. In this study, we designed fuzzy questionnaire to collect data and transform the data to further interpretation.

Definition 3.1. Fuzzy weighting. *In order to investigate the weights of each impact factors in community college, we apply the fuzzy set theory and its survey technique to collect weighting data. We propose the process of entity fuzzy weighting as follows:*

   Step 1: *First, determine the effective factors $A = \{A_1, A_2, \ldots, A_k\}$ for the real impact factor assessment;*

   Step 2: *Let m_{ij} be the membership of importance of factor j for the i of the reviewers;*

   Step 3: *Cumulate the fuzzy weighting w_j of A_j by $w_j = \dfrac{\sum\limits_{i=1}^{n} m_{ij}}{\sum\limits_{j=1}^{k} \sum\limits_{i=1}^{n} m_{ij}}$.*

In this study, we invited five experts to weigh the influential factors of performance indicators related to Nantou community college, the result shows as Table 1.

TABLE 1. Fuzzy weights of the influential factors of performance indicators

experts \ factors	Number of registered students	Rate of attendance	Satisfaction
1	0.25	0.25	0.5
2	0.25	0.3	0.4
3	0.3	0.25	0.6
4	0.1	0.4	0.5
5	0.1	0.3	0.5
Total membership	1	1.5	2.5
weight	0.2	0.3	0.5

The weights are followed the formulae to compute: $w_1 = \dfrac{\sum\limits_{i=1}^{5} m_{11}}{\sum\limits_{k=1}^{3} \sum\limits_{i=1}^{5} m_{11}} = \dfrac{1}{5} = 0.2, \ldots,$

$w_3 = \dfrac{\sum\limits_{i=1}^{5} m_{33}}{\sum\limits_{k=1}^{3} \sum\limits_{i=1}^{5} m_{33}} = \dfrac{2.5}{5} = 0.5.$

3.3. **Ranking fuzzy data.** We proposed a method not only relatively easy in computing but also fewer limitations to fuzzy data. The following definition is to transform the fuzzy data to an internal fuzzy number for ranking purpose.

Definition 3.2. Defuzzification for an interval fuzzy number. *Let $A = [a, b]$ be an interval on U with its centric $c = (a + b)/2$. Then the defuzzification number RA of $A = [a, b]$ is defined as follows:*

$$RA = c + \left(1 - \frac{\ln(1+r)}{r}\right),$$

where $r = |b - a|$ is the length of the interval.

3.4. **Nonparametric test for fuzzy data.** The use of nonparametric methods was introduced to test the hypotheses of median which identical in the Wilcoxon rank sum test. This suggests the test of statistics $W =$ the sum of the rank in the combined samples associated with X observations. If W is less than the critical value the null hypothesis of the same median, it will be rejected. Another question is the inconsistency of the scores, which is thought to be the biggest barrier to reliable assessment [3]. To answer this question, we use the nonparametric method to test the hypotheses of median which identified in the Kruskal-Wallisi one-way analysis of variance. We can let $N = \sum_{i=1}^{k} n_i$ be the total number of observations in the k treatments. When we assigned the rank 1 to the smallest of pool scores, then the rank 2 to the next, and so on to the largest one, which was given the rank N. The Kruskal-Wallis test used in this study is defined as follows:

$$K = \frac{12}{N(N+1)} \sum_{i=1}^{k} \frac{R_i^2}{n_i} - 3(N+1)$$

Here R_i is the sum of the ranks assigned to observations in the kth treatment. Since K follows a $\chi^2(k-1)$ distribution, the null hypothesis of equal means (median) is rejected when K exceeds the critical value.

Example 3.1. *A random sample of 22 participants, it was separated into three age groups, who have registered in a community college. Each participant is fitted a report about the rate of attendance in related courses in past year. The data and calculations are summarized in Table 2. At the $\alpha = 0.05$ level of significance, can we say there is a difference in terms of attendance rate existing in these groups?*

TABLE 2. The rate of attendance in community college in different age groups

Observations	1	2	3	4	5	6	7	8	9	R
Group 1	$(2,4)$	$(3,4)$	$(2,3)$	$(3.5,4)$	$(5,6)$	$(5.5,7)$	$(3,3.5)$	$(1.5,2)$	$(2.5,4)$	66
	4	7	3	8	14	18	6	1	5	
Group 2	$(5,6.5)$	$(3.5,4.5)$	$(4.5,6.5)$	$(1.5,2.5)$	$(5,7)$	$(4.5,6)$	$(4,6)$			84
	16	9	15	2	17	13	12			
Group 3	$(3.5,4)$	$(6.5,7)$	$(3.5,6.0)$	$(6.5,8)$	$(6,8)$	$(6,7)$				103
	10	20	11	22	21	19				

$K = \frac{12}{22(22+1)} \left(\frac{66^2}{9} + \frac{84^2}{7} + \frac{103^2}{6} \right) - 3(22+1) = 8.32 > \chi_{0.05}^2(2) = 5.99.$

Under significance level $\alpha = 0.05$, $\chi^2 > \chi_\alpha^2(k-1)$, then we reject H_0.

4. **An Empirical Study.**

4.1. **Research samples.** This study used a fuzzy questionnaire to collect data from Nantou Community College in 2009. There are ten affiliated institutions in Nantou Community College, and their locations are in the central area of Taiwan. The questionnaire included eight items, and the participants were asked to answer by fuzzy forms in terms of selecting their possible responses with an interval of 1 to 5 scale. The study distributed 100 questionnaires, with 75 copies returned, totaling 64 valid samples. Table 3 shows the sample distribution in this case study.

TABLE 3. The distribution of selected participants in Nantou Community College

Gender	Female 41 (64.1%), Male 23 (35.9%)		
Age	20-40 years old	41-60 years old	61 year old or over
	6 (9.4%)	49 (76.6%)	9 (14.1%)
Educational background	High school or under high school level	College level	Graduate school level
	27 (42.2%)	37 (73%)	0 (0%)

4.2. **Fuzzy weighting and calculation.** In this study, we focus on financial, internal, and customer perspective to evaluate management performance. We consider the number of registered students, rate of student attendance, and students' satisfaction as main factors which will impact on the management performance of community colleges. We calculate the fuzzy weighted values to reflect the real values in the community college. The fuzzy testing formula for evaluating values (EV_t) and its meanings are as follows:

$$EV_t = R_t^{0.2} \cdot A_t^{0.3} \cdot S_t^{0.5}$$

$R_t = 0.8 + (x - 20) * 0.0$, x = number of registered students < 40;
A_t = rate of student attendance;
S_t = degree of satisfaction.

According to the weights of influence indicators reviewed by the five experts, we found that "numbers of registration" would be accounted for 0.2 power, the "rate of student attendance" was accounted for 0.3 power, and "satisfaction with courses" would be accounted for 0.5 power (see Table 1).

The selected performance indicators are applied to evaluating the community college courses which at least provided for three consecutive years, that is six semesters in our system. According to the 64 participants and their six semesters attending the three courses, we collect the fuzzy data and transform their values. The average of "Calligraphy Art", course that belongs to community club domain, is 0.9385. The average of "Life and Law", which belongs to academic domain, is 0.9373. The average of "Ballroom Dancing", which belongs to life skill domain courses, is 0.90815 (see Table 4). In these three kinds of courses, the performance indicators of "Calligraphy Art" in community club domain is the highest, the next is "Life and Law" in academic domain, and the " Ballroom Dancing" (life skill domain courses) is in the last. The current fuzzy calculation of the variances in different courses is listed in Table 4. The differences of the three courses are listed in Figure 3.

TABLE 4. Descriptive statistics of performance indicators evaluating in Nantou Community College

Statistics/ Courses	Calligraphy Art (community club domain)	Life and Law (academic domain)	Ballroom Dancing (life skill domain)
Average	0.9385	0.9373	0.90815
Minimum	0.91	0.9036	0.8583
Max	0.9586	0.9534	0.9504
Standard Deviation	0.01864	0.01807	0.03207
Variance	0.000347608	0.000326616	0.001028655

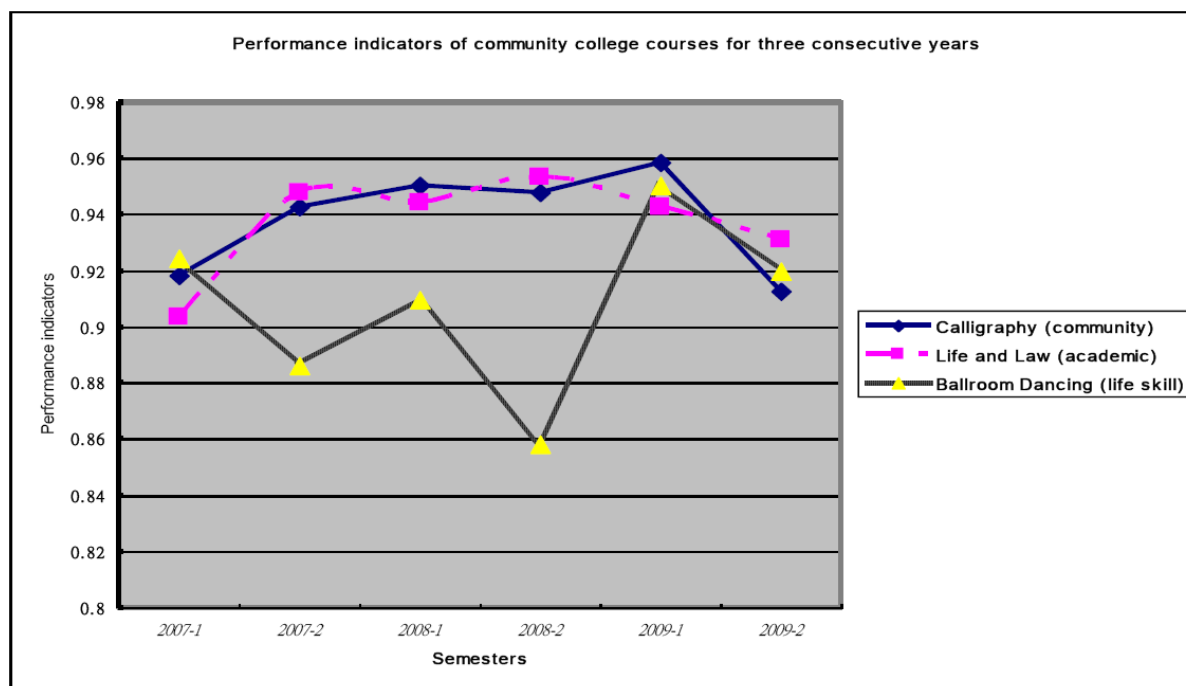**Note**: Courses have been keeping running for three consecutive years.

FIGURE 3. Fuzzy evaluating the three courses in three consecutive years (six semesters)

4.3. **Fuzzy statistical analysis the values of community colleges.** Participants indicated the core values of community colleges including prepare for civil society, liberal knowledge, and life skills. Their fuzzy modes are 9.5, 23, 31.7 and their fuzzy memberships are .15, .36, and .49 respectively. The result reveals that the community college students ranked the life skill courses with the highest value.

4.4. **Message for creating marketing strategies.** The findings in Table 5 show that the item "too busy"(.41) is the main reason to drop out classes and then "no interesting" or "no one goes with ..."(.23). The finding also shows that propaganda/advertisements, recommended by friends, and through Internet are the main channels that participants can get information from the community college.

4.5. **Testing the hypothesis with nonparametric methods.** We use Wilcoxon rank-sum test and the Kruskal-Wallis (one-way ANOVA for nonparametric method) to test the difference of study purposes among different groups [3]. We consider the variables such as participants (gender, age, and education background), school location (city or county), and three categories of courses (civil society courses, academics courses, and life skill courses). According to Table 6, we list the related findings as follows:

(1) Adults who study in city community college show more acceptable the idea of civil society;
(2) Adults with lower education background tend to be more acceptable the idea of civil society than do those with higher education background;
(3) Adults with higher education background are more likely to take life skill related courses;
(4) Men express more wanted to join academics courses than do women;
(5) Adult learners, in 20-40 years old, hope to obtain diploma;
(6) Adult learners, in 41-60 years old, tend to select vocational training.

TABLE 5. Participants' perspectives provide for community colleges to set their marketing strategies

Responses	Fuzzy memberships				Fuzzy mode
The reason why participants drop out classes	Never drop out	No interesting or no one goes with, too far, or have had bad experiences	No response	Too busy	No response (35.2)
	0.16	0.23	0.19	0.41	
How participants select community colleges	By friends	By TV, promotion car, newspapers, radio or recommended by the chief of village	Propaganda/ advertisement	Internet	Propaganda advertisements (24.2)
	0.32	0.09	0.38	0.23	

TABLE 6. Wilcoxon rank-sum test and Kruskal-Wallis test ranks $N = 64$

Courses	Group variables	N	Testing with nonparametric statistics	Decision $\alpha = .05$
Civil society	city	35	Rank sum of $W = 1327$ $Z = 2.56 > Z_{0.05} = 1.65, p = 0.035$	**Reject H$_0$**
	county	29		
Liberal knowledge	Female	41	Rank sum of $W = 1194$ $Z = -1.94 < Z_{0.05} = -1.65, p = 0.047$	**Reject H$_0$**
	Male	23		
Civil society	High school	27	Rank sum of $W = 1002.5$ $Z = 1.7 < Z_{0.05} = 1.65, p = 0.0365$	**Reject H$_0$**
	College	37		
Life skill	High school	27	Rank sum of $W = 724.5$ $Z = -2.08 > Z_{0.05} = -1.65, p = 0.0177$	**Reject H$_0$**
	College	37		
Life skill	20-40 years old	6	$K = 0.25 > \chi^2_{0.05}(2) = 5.991,$ $p = 0.88$	**Accept H$_0$**
	41-60	49		
	61 $\sim$	9		
Diploma	20-40 years old	6	$K = 6.756 > \chi^2_{0.05}(2) = 5.991,$ $p = 0.034$	**Reject H$_0$**
	41-60	49		
	61 $\sim$	9		
Vocational training	20-40 years old	6	$K = 10.166 > \chi^2_{0.05}(2) = 5.991,$ $p = 0.006$	**Reject H$_0$**
	41-60	49		
	61 $\sim$	**9**		

5. **Conclusions.** This study examines the performance of goal values in community colleges with respect to life skills, civic society, regional cultures, and the world perspectives. Using a fuzzy questionnaire and its statistical transformation, this study addressed the membership functions of core values in community colleges according to participants' demands, attendances, and their satisfactions. The results are as follows: (1) Most of participants are not interested in civil society courses; (2) There is a tendency to overvalue the life skill courses in the community college; (3) The life skill courses are the most popular courses and the 40-year-old group was the main participants; (5) Advertisement

is the largest source for adults to reference to select their community college and the related information got from friends put in the second.

Based on the findings, this study provides the following suggestions for the community college. (1) Offer life skill courses need to balance with civil society courses. (2) Enhance local characteristics in courses to rebuild regional values. (3) Design special courses for students over the age of 40 years old. (4) Increase public budgets for community colleges to subsidize selected courses and more focused on the civil society courses.

Analyzing the marketing strategy, this study found the vocational training has become an important component in community colleges. The result reveals that preparing students' second expertise for a better job, designing field-related vocational training, and preparing special courses for future are very important. Following these views to make changes, the community college has showed more clear their goals for future and the enrollment is increased significantly in the following semester.

Finally, we may indicate the idea of fuzzy evaluating is a useful tool which considered the three important weighting dimensions: financial, internal, and customer in community colleges. The model also focuses on critical factors in community colleges, such as enrollment, students' attendance, and their satisfaction which could create a practical performance indicator system to reboot culture in community colleges.

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