Exploration of the Impacts of Blended Learning In Higher Education Using CBDL$_H$FCM

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Abstract— Digitalization, the fashion of this era has turned the world digital, and its impacts are felt in almost all the fields and education is not an exception to it. The conventional mode of teaching and learning is getting supplemented by online mode of interaction embedded with a variety of advanced technology. Presently the grant of access to online courses in higher education by ministry of Human Resource Development of India has added value to blended learning and emphasizes the need of it. The enhancement of Indian higher education to international standards can be attained by blended learning. It is indeed much essential to analyze the impacts of blended learning in higher education, which is the intention and aim of this paper. Systematic examination and precise inference are the outcomes of employing Fuzzy cognitive Maps, a decision making mathematical tool. In this paper the method of Combined Disjoint Block Hexagonal Linguistic Fuzzy Cognitive Maps CBDLHFCM is used to explore the effects of blended learning in higher education, which is the need of the hour.

Keywords: Blended learning, Impacts, Higher education, Combined disjoint block, Fuzzy cognitive map, Hexagonal fuzzy number

1. INTRODUCTION

Blended learning (B-learning) is the mixture of conventional face to face teaching with technology based learning. It is not a replacing approach to education; relatively it is an initiative of presenting a kind of inclusive strategy. In this digital era, the traditional practices of teaching and learning process is getting completely replaced by online modes which creates haphazard in the student's learning process. Technology based education must not dominate or take an upper hand over conventional methods, rather it must be administered as supplementary to it, for making learning more effective. The same argument was proposed by Viet Anh Nguyen [8] in which the impacts of online learning activities in a blended learning course on student's learning outcomes were substantiated with quantitative analytical results. The author has generalized the impacts of blended learning under four environments such as Learner – learner, Learner – Facilitator, Learner – Subject content, Learner – Technology but not specifically addressed the impacts. This has motivated us to explore the specific impacts of blended learning under each environment using CBDLHFCM and also determine the core impact. Viet has used the statistical concepts to draw results and inferences but in this research work a different advanced mathematical tool is employed to reach the specificity in the results.

Fuzzy cognitive map (FCM) by Kosko [2] is an extended version of cognitive maps by Axelerod [1] to relate the causes of a problem as nodes and its associations by edges to find the major cause and impacts. This FCM is modified and extended by many researchers based on the needs of solving the problem. One such extension is combined block disjoint FCM (CBDFCM), in which the factors of the problem are grouped based on certain criteria and then nexuses into a single matrix. CBDFCM tool was used by many academicians in various fields to discuss about several related factors of an issue under various dimensions. Vasantha Kandasamy [6], the active researcher in the field of FCM has contributed a lot of research works based on CBDFCM, followed by her research scholars, who have dealt with different social issues like fatigue of drivers in roads, effects of smart phones on children, impact of stress in workplace, quality of primary education[7] and so on. Such works addressing various societal and educational contexts have inspired us to use this method for our study, but the edge weightage assigned by them was either simple or weighted, which was not much realistic to us. To the best of our knowledge the linguistic weightage in case of CBDFCM is very few and hardly it is found in the literature. This has inspired us to use linguistic weightage to the edges. In other FCM representation linguistic variables are used and quantified by either triangular or trapezoidal but in CBDFCM the quantification of linguistic variables is made with the aid of fuzzy numbers of higher orders especially; hexagonal fuzzy number is used by us in our study.

The task of exploring the impacts of blended learning in higher education using CBDLHFCM is an inventive effort taken by us in grading the conventional CBDFCM method a step ahead with the inclusion of linguistic approach to deal with the recent trends in the teaching and learning process. The paper is structures as follows: section 2 presents the preliminary concepts; section 3 comprises of the methodology; section 4 encompasses the application of the methodology to the problem considered for study; section 4 discusses the results and the last section concludes the paper.

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2. PRELIMINARIES

The essential definitions and concepts related to this research work is briefed as follows [3,4,5]

2.1 Fuzzy Set

A set B which includes both well defined and not well defined elements with weightage μ defined from X → [0,1] is called as fuzzy set, where X is the universal set.

2.2 Fuzzy Cognitive Maps (FCM)

FCM is a directed graph with nodes as factors taken for study and edges as the casual relationship between the factors.

2.3 Simple FCM

A FCM with edges weight belonging to {-1,0,1} is called simple FCM.

2.4 Weighted FCM

A FCM with edges weight ranging from [-1,1] is defined as weighted FCM.

2.5 Linguistic FCM

A FCM with edges weight as linguistic variable is termed as linguistic FCM.

2.6 Linguistic variable

A variable which assumes linguistic terminology rather than numeric

2.7 On and Off position of a vector

Let X = (a1, a2,….an) where ai ∈ {0,1}, a1 = 1 at any instant states that it is in On position and if it is 0 then it is in off position.

2.8 Fixed point and the Limit cycle

The attainment of the pattern A1 → A2 → ⋯ A1 is the reach of the limit cycle and A1 is the fixed point.

2.9 Connection Matrix

A matrix representing the relationship between the nodes (factors) of the FCM.

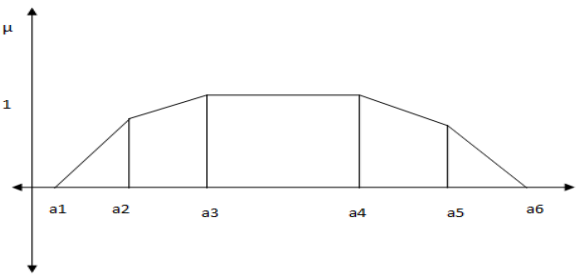
2.10 Combined FCM

The categorization of the factors into blocks and clubbing of the individual connection

matrix of each block into a single matrix is the combined FCM.

2.11 Hexagonal fuzzy number

A depiction of a fuzzy number of the H = (*a1,a2,a3,a4,a5,a6*) such that all ai's are real numbers and *a1≤a2≤a3≤a4≤a5≤a6* is called as Hexagonal Fuzzy number with the membership function as



$$\mu(\tilde{A}x) = \begin{cases} \frac{1}{2}\frac{x-a1}{a2-a1} \; for \; a1 \le x \le a2 \\ \frac{1}{2} + \frac{1}{2}\frac{x-a2}{a3-a2} \; for \; a2 \le x \le a3 \\ 1 \quad for \; a3 \le x \le a4 \\ 1 - \frac{1}{2}\frac{x-a4}{a5-a4} \; for \; a4 \le x \le a5 \\ \frac{1}{2}\frac{a5-x}{a6-a5} \; for \; a5 \le x \le a6 \\ 0 \quad \text{otherwise} \end{cases}$$

3. METHODOLOGY

This section lists the steps to be followed in determining the equilibrium vector.

1. The factors that are taken into account for the study are categorized into zones or blocks.
2. The interconnections between the factors within the group are represented as matrices with elements as linguistic variables based on the literature and expert's opinion.
3. The linguistic variables are quantified by hexagonal fuzzy numbers.
4. The zonal matrices are combined and an unified matrix D is obtained.
5. The initial vector X = (10000000..000) is passed into D and the resultant vector is thresholded into X1 by assigning 1 to the maximum value and 0 to the remaining, which is then again passed into D until Xi = Xj.
6. The equilibrium vector is attained at the end of the iteration process.
7. The value 1 in the equilibrium vector represents the impact of the initial vector and the value 0 represents no impact.

4. APPLICATION TO THE PROBLEM CONSIDERED FOR STUDY

To investigate the impacts of blended learning in higher education, four blocks or zones such as Learner – learner, Learner – Facilitator, Learner – Subject content, Learner – Technology are considered. The factors associated with each zones are presented as below in Table 4.1

Table 4.1 Impacts of blended learning under four zones

IM ZONE 1 - Learner – Learner
IM 1Student interaction in the class is very intense.
IM 2Active participation of the students is high.
IM 3Team spirit is kindled highly.
IM 4Student performance is enhanced.
IM ZONE 2 - Learner – Facilitator
IM 5Relationship between the teacher and the learner becomes more flexible.
IM 6Learner based pedagogy.
IM 7Conducive environment for learning to take place
IM 8Learning is made very easier.

IM ZONE 3- Learner – Subject Content
IM 9Learner centered curriculum
IM 10Design of content is diverse.
IM 11Discussion forums are kept active.
IM 12 ICT aids makes learning joyful and comprehensive
IMZONE 4- Learner – Technology
IM 13Interactive learning activities is highly promoted
IM 14Learner friendly technology is employed
IM 15Easy access of interfaces by the learners
IM 16Learning takes place at one's own pace

Table 4.2 Hexagonal quantification of linguistic terminologies

Linguistic Variable	Hexagonal Weight	Defuzzified Value
Low	(0,0.1,0.2,0.3,0.4,0.45)	0.24
Medium	(0.4,0.45,0.5,0.55,0.6,0.65)	0.53
High	(0.6,0.65,0.7,0.8,0.9,1)	0.8

The individual linguistic connection matrix representing the casual relationship between the factors considered under each zone [8,9,10] and expert's opinion (Academicians and students of the higher education institutions practicing blended learning in the regions of Dindigul, Tamil Nadu, India) along with the quantification in terms of defuzzified Hexagonal fuzzy number based on Table 4.2 is represented as follows.

	IM 1	IM 2	IM 3	IM 4		IM 1	IM 2	IM 3	IM 4
IM 1	0	M	M	H	IM 1	0	0.53	0.53	8
IM 2	M	0	H	H	IM 2	0. 53	0	0.8	0.8
IM 3	M	M	0	H	IM 3	0. 53	0.53	0	0.8
IM 4	L	L	L	0	IM 4	0. 24	0.24	0.24	0

	IM 5	IM 6	IM 7	IM 8		IM 5	IM 6	IM 7	IM8
IM 5	0	M	H	H	IM 5	0	0.53	0.8	0.8
IM 6	H	0	H	H	IM 6	0.8	0	0.8	0.8
IM 7	M	M	0	H	IM 7	0.5 3	0.53	0	0.8
IM 8	L	L	L	0	IM 8	0.2 4	0.24	0.24	0

	IM 9	IM 10	IM 11	IM 12		IM 9	IM 10	IM 11	IM 12
IM 9	0	M	M	M	IM 9	0	0.53	0.53	0.53
IM 10	M	0	M	H	IM 10	0.53	0	0.53	0.8
IM 11	M	M	0	M	IM 11	0.53	0.53	0	0.53
IM 12	L	M	L	0	IM 12	0.24	0.53	0.24	0

	IM 13	IM 14	IM 15	IM 16		IM 13	IM 14	IM 15	IM 16
IM 13	0	M	M	M	IM 13	0	0.53	0.53	0.53
IM 14	H	0	H	H	IM 14	0.8	0	0.8	0.8
IM 15	H	H	0	H	IM 15	0.8	0.8	0	0.8
IM 16	M	M	M	0	IM 16	0.53	0.53	0.53	0

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The combined block disjoint hexagonal quantified linguistic matrix D is as follows

	IM 1	IM 2	IM 3	IM 4	IM 5	IM 6	IM 7	IM 8	IM 9	IM 10	IM 11	IM 12	IM 13	IM 14	IM 15	IM 16
IM 1	0	0.53	0.53	8	0	0	0	0	0	0	0	0	0	0	0	0
IM 2	0.53	0	0.8	0.8	0	0	0	0	0	0	0	0	0	0	0	0
IM 3	0.53	0.53	0	0.8	0	0	0	0	0	0	0	0	0	0	0	0
IM 4	0.24	0.24	0.24	0	0	0	0	0	0	0	0	0	0	0	0	0
IM 5	0	0	0	0	0	.53	0.8	0.8	0	0	0	0	0	0	0	0
IM 6	0	0	0	0	0.8	0	0.8	0.8	0	0	0	0	0	0	0	0
IM 7	0	0	0	0	0.53	0.53	0	0.8	0	0	0	0	0	0	0	0
IM 8	0	0	0	0	0.24	0.24	0.24	0	0	0	0	0	0	0	0	0
IM 9	0	0	0	0	0	0	0	0	0	0.53	0.53	0.53	0	0	0	0
IM 10	0	0	0	0	0	0	0	0	0.53	0	0.53	0.8	0	0	0	0
0	0	0	0	0	0	0	0	0	0.53	0.53	0	0.53	0	0	0	0
IM 12	0	0	0	0	0	0	0	0	0.24	0.53	0.24	0	0	0	0	0
IM 13	0	0	0	0	0	0	0	0	0	0	0	0	0	0.53	0.53	0.53
IM 14	0	0	0	0	0	0	0	0	0	0	0	0	0.8	0	0.8	0.8
IM 15	0	0	0	0	0	0	0	0	0	0	0	0	0.8	0.8	0	0.8
IM 16	0	0	0	0	0	0	0	0	0	0	0	0	0.53	0.53	0.53	0

By following the methodology as in section 3 the equilibrium point i.e the fixed point is attained for each initial vector containing only one factor in on position.

X = (1000000000000000)

X*D = (0 0.53 0.53 0.8 000000000000)

↪ = (0001000000000000) = X1

X1*D = (0.53 0.53 0 0.8 000000000000)

↪ = (0001000000000000) = X2

X = (0100000000000000)

X*D = (0.53 0 0.8 0.8 000000000000)

↪ = (0011000000000000) = X1

X1*D = (0.77 0.77 0.24 0.8 000000000000)

↪ = (0001000000000000) = X2

X2*D = (0.53 0.53 0 0.8 000000000000)

↪ = (0001000000000000) = X3

X = (0010000000000000)

X*D = (0.53 0.53 0 0.8 000000000000)

↪ = (0001000000000000) = X1

X1*D = (0.53 0.53 0 0.8 000000000000)

↪ = (0001000000000000) = X2

X = (0001000000000000)

X*D = (0.24 0.24 0.24 0000000000000)

↪ = (1110000000000000) =X1

X1*D = (1.06 1.06 1.33 0.96 000000000000)

↪ = (0010000000000000) = X2

X2*D = (0.53 0.53 0 0.8 000000000000)

↪ = (0001000000000000) = X3

X3*D = (0.53 0.53 0 0.8 000000000000)

↪ = (0001000000000000) = X4

X = (0000100000000000)

X*D = (0 0 0 0 0 0.53 0.8 0.8 00000000)

↪ = (0000001100000000) = X1

X1*D = (00000.77 0.77 0.24 0.8 00000000)

↪ = (0000000100000000) = X2

X2*D = (0000 0.24 0.24 0.24 000000000)

↪ = (0000 111 000000000)= X3

X3*D = (00001.33 1.06 1.6 2.4 00000000)

↪ = (0000000100000000) = X4

Repeating in the same fashion, the fixed point is attained for all the ON positions of the factors representing the nodes of FCM as in Table 4.3

Table 4.3 Fixed points of the Initial vectors

Initial Vector	Fixed Point
(1000000000000000)	(0001000000000000)
(0100000000000000)	(0001000000000000)
(0010000000000000)	(0001000000000000)
(0001000000000000)	(0001000000000000)
(0000100000000000)	(0000000100000000)
(0000010000000000)	(0000000100000000)
(0000001000000000)	(0000000100000000)
(0000000100000000)	(0000000100000000)
(0000000010000000)	(0000000000100000)
(0000000001000000)	(0000000000100000)
(0000000000100000)	(0000000000100000)
(0000000000010000)	(0000000000100000)
(0000000000001000)	(0000000000001000)
(0000000000000100)	(0000000000001000)
(0000000000000010)	(0000000000001000)
(0000000000000001)	(0000000000001000)

5. DISCUSSION

Table 4.3 clearly picturizes the fixed point or the equilibrium point of each factor under each zone is same. The fixed point of the first zone is (0001000000000000) which strongly emphasize that the major impact of blended learning under the first zone is the enhancement of student's performance. In case of the second zone the fixed point is (0000000100000000) which corresponds to the factor that learning is made easier, in case of the third zone it is (0000000000100000) which points to the factor that the use of ICT makes learning joyful and comprehensive, in the last zone the impact is concentrated at promotion of interactive learning activity. The four fixed points corresponds to the major and core impact of blended learning.

CONCLUSION

This research work has presented a primary study on the impacts of blended learning from the perspectives of academicians and student community. The method of CBDLHFCM is used to analyze the impacts of B-learning under four zones to have a comprehensive outlook. The method can be extended with the application of other fuzzy numbers and the validity of the results can be tested by carrying out as an extension of this research work. The results obtained correlate highly with the expectations of the present learning community, which indeed support or favours the onset of blended learning in higher education. To promote and sustain the standards of teaching and learning in higher education, the B-learning has to be encouraged and implemented in all the higher education institutions with the necessary infrastructure and financial support for its long run.

REFERENCES

1. Axelrod,"Structure of decision: The cognitive maps of Political Elites", New Jersey: Princeton University Press.1976.
2. Kosko.B, ―Fuzzy Cognitive Maps‖, International Journal of man-machine studies, January, (1988), 62-75.
3. Lilly Merline.W, Aleeswari.D,Nivetha Martin, "An Analysis of Traditional Catastrophe in Tamil Nadu Using NEDIFVAM", Middle East Journal of Scientific Research, Volume 25,No.2 358-361, 2017
4. Nivetha Martin., C.Mabel Joshaline , "An Analysis of the influential advantage of bio treatment over mechanical processing in conversion of Cr (VI) to Cr (III) in Leather Industry using Fuzzy Cognitive Maps", International Journal of Advanced Engineering,Management and Science, Volume 2, No .7, pp 1037- 1040,2016
5. Nivetha Martin., P.Pandiammal, "Reasons for Adolescent's Social Network addiction and its impact on Academics -An Analysis using Induced Linked Fuzzy Relational Mapping Using Hexagonal Fuzzy number", Elixir, Educational Technology, Volume 20,No.1,41914-41917,2016.
6. Vasantha Kanthasamy, Florentine Samandache, Analysis of Social Aspects of Migrant Labourers Living with HIV /AIDS using Fuzzy theory and Neutrosophic Cognitive Maps with Special Reference to Rural Tamilnadu in India. Published by Xiquan, Phoenix, USA,2004.
7. Victor Devadoss.A, M.Clement Joe Anand, "A Solution to Control Suicide in the Domestic Violence using Combined Disjoint Block Fuzzy Cognitive Maps (CDBFCM)", International Journal of Scientific & Engineering Research, Volume 3, Issue 6, June-2012.
8. Viet Anh Nguyen, The Impact of Online Learning Activities on Student Learning Outcome in Blended Learning Course ,Journal of Information and knowledge management, 10.1142/S021964921750040X
9. Yang, J., Yu, H., Chen, S. J., & Huang, R. .Strategies for smooth and effective cross-cultural online collaborative learning. Educational Technology & Society,2014, 17(3), 208-221.
10. Yuan, J., & Kim, C. Guidelines for facilitating the development of learning communities in online courses. Journal of Computer Assisted Learning, 2015, 30, 220-232.