A study on the causes for the lack of motivation among students using Hexagonal fuzzy cognitive maps (HxFCM)

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Abstract

Our main objective of this paper is to find out the new fuzzy tool called Hexagonal Fuzzy Cognitive Maps to analyze the social problem. Usually in FCM we analyze the causes and effects of the relationships among the concepts to model the behavior of any system. But this new model gives the causes and effect of the relationships among the concepts to model behavior with ranking of any system. In this paper, we analyze the causes for the lack of motivation among students using Hexagonal Fuzzy Cognitive Maps. It has five sections. In the first section, we give the brief introduction to Fuzzy Cognitive Maps (FCM). The second section, gives the basic definitions of Hexagonal Fuzzy Cognitive Maps (HxFCM). In the third Section, we presented hidden pattern of the dynamical system. In the fourth section we analyzed the concept of the problem using Hexagonal Fuzzy Cognitive Maps (HxFCM). We give the conclusion in the final section based on our study.

Keywords: Fuzzy cognitive maps, Hexagonal fuzzy numbers.

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1 Introduction

Lotfi. A. Zadeh (1965) has introduced a mathematical model called Fuzzy Cognitive Maps. After a decade, Political scientist Axelord (1976) used this fuzzy model to study decision making in social and political systems. Then Kosko (1986, 1988 and 1997) enhanced the power of cognitive maps considering fuzzy values for the concepts of the cognitive map and fuzzy degrees of
interrelationships between concepts. FCMs can successfully represent knowledge and human experience, introduced concepts to represent the essential elements and the cause and effect relationships among the concepts to model the behavior of any system. It is a very convenient simple and powerful tool, which is used in numerous fields such as social economical and medical etc. Usually we analyze the number of attributes ON-OFF position. But the thing is here, this gives the weightage of the attributes we call ranking of the attributes. Now we see the basic definitions for FCMs to develop the Hexagonal Fuzzy Cognitive Maps (HxFCM).

2 Preliminaries

In this section, some concepts and methods used in this paper are briefly introduced.

2.1 Fuzzy Set theory

The fuzzy set theory is to deal with the extraction of the primary possible outcome from a multiplicity of information that is expressed in vague and imprecise terms. Fuzzy set theory treats vague data as probability distributions in terms of set memberships. Once determined and defined, sets of memberships in probability distributions can be effectively used in logical reasoning.

2.2 Hexagonal Fuzzy number and the Algebraic Operations

2.2.1 Hexagonal Fuzzy number

A fuzzy number $\tilde{A}_H$ is a hexagonal fuzzy number denoted by $\tilde{A}_H(a_1, a_2, a_3, a_4, a_5, a_6)$ where $a_1, a_2, a_3, a_4, a_5, a_6$ are real numbers and its membership function $\mu_{\tilde{A}_H}(x)$ is given below

$$
\mu_{\tilde{A}_H}(x) = \begin{cases} 
0 & \text{for } x < a_1 \\
\frac{1}{2} \left( \frac{x-a_1}{a_2-a_1} \right) & \text{for } a_1 \leq x \leq a_2 \\
\frac{1}{2} + \frac{1}{2} \left( \frac{x-a_2}{a_3-a_2} \right) & \text{for } a_2 \leq x \leq a_3 \\
1 & \text{for } a_3 \leq x \leq a_4 \\
1 - \frac{1}{2} \left( \frac{x-a_4}{a_5-a_4} \right) & \text{for } a_4 \leq x \leq a_5 \\
\frac{1}{2} \left( \frac{a_6-x}{a_6-a_5} \right) & \text{for } a_5 \leq x \leq a_6 \\
0 & \text{for } x > a_6
\end{cases}
$$
2.2.2 Operation of Hexagonal Fuzzy Number

Following are the three operations that can be performed on hexagonal fuzzy numbers. Suppose $\tilde{A}_H = (a_1, a_2, a_3, a_4, a_5, a_6)$ and $\tilde{B}_H = (b_1, b_2, b_3, b_4, b_5, b_6)$ are two hexagonal numbers then

1. Addition: $\tilde{A}_H(+)	ilde{B}_H = (a_1 + b_1, a_2 + b_2, a_3 + b_3, a_4 + b_4, a_5 + b_5, a_6 + b_6)$
2. Subtraction: $\tilde{A}_H(-)	ilde{B}_H = (a_1 - b_1, a_2 - b_2, a_3 - b_3, a_4 - b_4, a_5 - b_5, a_6 - b_6)$
3. Multiplication: $\tilde{A}_H(*)\tilde{B}_H = (a_1 * b_1, a_2 * b_2, a_3 * b_3, a_4 * b_4, a_5 * b_5, a_6 * b_6)$
4. Division: $\tilde{A}_H(/)\tilde{B}_H = (a_1/b_1, a_2/b_2, a_3/b_3, a_4/b_4, a_5/b_5, a_6/b_6)$
5. Symmetric Image: If $\tilde{A}_H = (a_1, a_2, a_3, a_4, a_5, a_6)$ is the hexagonal fuzzy number then $-\tilde{A}_H = (-a_6, -a_5, -a_4, -a_3, -a_2, -a_1)$ which is the symmetric image of $\tilde{A}_H$ is also an hexagonal fuzzy number.

2.2.3 Degrees of the Hexagonal Fuzzy Number

The linguistic values of the Hexagonal fuzzy numbers are

<table>
<thead>
<tr>
<th>Degree</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below Average</td>
<td>(0,0,0.125,0.25,0.375,0.5)</td>
</tr>
<tr>
<td>Average</td>
<td>(0,0.125,0.25,0.375,0.5,0.625)</td>
</tr>
<tr>
<td>Undecided</td>
<td>(0.125,0.25,0.375,0.5,0.625,0.75)</td>
</tr>
<tr>
<td>Agree</td>
<td>(0.25,0.375,0.5,0.625,0.75,0.875)</td>
</tr>
<tr>
<td>Strongly Agree</td>
<td>(0.375,0.5,0.625,0.75,0.875,1)</td>
</tr>
</tbody>
</table>
2.3 Fuzzy Cognitive Maps (FCMs)

Fuzzy Cognitive Maps (FCMs) are more applicable when the data in the first place is an unsupervised one. The FCMs work on the opinion of experts. FCMs model the world as a collection of classes and causal relations between classes.

**Definition 2.1.** When the nodes of the HxFCM are fuzzy sets then they are called as fuzzy Hexagonal nodes.

**Definition 2.2.** Hexagonal FCMs with edge weights or causalities from the set \([-1, 0, 1]\) are called simple Hexagonal FCMs.

**Definition 2.3.** An HxFCM is a directed graph with concepts like policies, events etc., as nodes and causalities as edges. It represents causal relationships between concepts.

**Definition 2.4.** Consider the nodes/concepts \( HxC_1, HxC_2, \ldots, HxC_n \) of the Hexagonal FCM. Suppose the directed graph is drawn using edge weight \( Hxe_{ij} \in \{-1, 0, 1\} \). The Hexagonal matrix \( M \) be defined by \( Hx(M) = (Hxe_{ij}) \) where \( Hxe_{ij} \) is the Hexagonal weight of the directed edge \( HxC_i, HxC_j \). \( Hx(M) \) is called the adjacency matrix of Hexagonal Fuzzy Cognitive Maps, also known as the connection matrix of the HxFCM. It is important to note that all matrices associated with a HxFCM which are always square matrices with diagonal entries as zero.

**Definition 2.5.** Let \( HxC_1, HxC_2, \ldots, HxC_n \) be the nodes of an HxFCM. \( A = (a_1, a_2, \ldots, a_n) \) where \( Hxe_{ij} \in \{-1, 0, 1\} \). \( A \) is called the instantaneous state vector and it denotes the on-off position of the node at an instant.

\[
\text{Instantaneous vector} = \begin{cases} 
Hxa_i = 1 & \text{Maximum(Weight)} \\
Hxa_i = 0 & \text{otherwise}
\end{cases}
\]

**Definition 2.6.** Let \( HxC_1, HxC_2, \ldots, HxC_n \) be the Hexagonal nodes of an HxFCM. Let \( HxC_1HxC_2, HxC_2HxC_3, HxC_3HxC_4, \ldots, HxC_iHxC_j \) be the edges of the HxFCM (\( i \neq j \)). Then the edges form a directed cycle. An HxFCM is said to be cyclic if it possesses a directed cycle. An HxFCM is said to be acyclic if it does not possess any directed cycle.

**Definition 2.7.** An HxFCM is said to be cyclic is said to have a feedback.

**Definition 2.8.** When there is a feedback in an HxFCM, i.e., when the causal relations flow through a cycle in a revolutionary way, the HxFCM is called a dynamical system.

**Definition 2.9.** Let \( HxC_1HxC_2, HxC_2HxC_3, HxC_3HxC_4, \ldots, HxC_iHxC_j \) be a cycle. When \( HxC_i \) is switched ON and if the causality flows through the Hexagonal edges of a cycle and if it again causes \( C_i \), we say that the dynamical system goes round and round. This is true for any Hexagonal node \( HxC_i \) for \( i = 1, 2, \ldots, n \). The equilibrium state for this dynamical system is called the hidden pattern.
Definition 2.10. If the equilibrium state of a dynamical system is a unique state vector, then it is called a fixed point. Consider a HxFCM with \( HxC_1, HxC_2, \ldots, HxC_n \) as nodes. For example let us start the dynamical system by switching on \( HxC_1 \). Let us assume that the HxFCM settles down with \( HxC_1 \) and \( HxC_n \) ON i.e., in the state vector remains as \((1,0,0,\ldots,0)\) is called fixed point.

Definition 2.11. If the HxFCM settles down with a state vector repeating in the form \( A_1 \rightarrow A_2 \rightarrow \cdots \rightarrow A_i \rightarrow A_1 \) then this equilibrium is called a limit cycle.

2.4 METHOD OF DETERMINING THE HIDDEN PATTERN OF HEXAGONAL FUZZY COGNITIVE MAPS (HxFCMs)

Step 1: Let \( HxC_1, HxC_2, \ldots, HxC_n \) be the nodes of an HxFCM, with feedback, Let Hx(M) be the associated adjacency matrix.

Step 2: Let us find the hidden pattern when \( HxC_1 \) is switched ON. When an input is given as the vector \( A_1 = (1,0,\ldots,0) \), the data should pass through the relation matrix M. This is done by multiplying \( A_i \) by the Hexagonal matrix M.

Step 3: Let \( A_i Hx(M) = (a_1, a_2, \ldots, a_n) \) will get a Hexagonal vector. Suppose \( A_1 Hx(M) = (1,0,\ldots,0) \) it gives a Hexagonal weight of the attributes, we call it as \( A_1 Hx(M)_{\text{weight}} \).

Step 4: Adding the corresponding node of the three experts opinion, we call it as \( A_1 Hx(M)_{\text{sum}} \).

Step 5: The threshold operation is denoted by \((-\rightarrow)\) ie., \( A_1 Hx(M)_{\text{Max(weight)}} \). That is by replacing \( a_i \) by 1 if \( a_i \) is the maximum weight of the Hexagonal node (ie., \( a_i = 1 \)), otherwise \( a_i \) by 0 (ie., \( a_i = 0 \)).

Step 6: Suppose \( A_1 Hx(M) \rightarrow A_2 \) then consider \( A_2 Hx(M) \) weight is nothing but addition of weightage of the ON attribute and \( A_1 Hx(M)_{\text{weight}} \).

Step 7: Find \( A_2 Hx(M)_{\text{sum}} \)(ie., summing of the three experts opinion of each attributes).

Step 8: The threshold operation is denoted by \((-\rightarrow)\) ie., \( A_2 Hx(M)_{\text{Max(weight)}} \). That is by replacing \( a_i \) by 1 if \( a_i \) is the maximum weight of the Hexagonal node (ie., \( a_i = 1 \)), otherwise \( a_i \) by 0 (ie., \( a_i = 0 \)).

Step 9: If the \( A_1 Hx(M)_{\text{Max(weight)}} = A_2 Hx(M)_{\text{Max(weight)}} \). Then dynamical system end otherwise repeat the same procedure.

Step 10: This procedure is repeated till we get a limit cycle or a fixed point.
3 CONCEPT OF THE PROBLEM

We have taken the following fourteen concepts \( \{ HxC_1, HxC_2, \ldots, HxC_n \} \) to analyze to find the causes for the lack of motivation among students using linguistic questionnaire and the expert’s opinion. The following concepts are taken as the main nodes of our problem.

- \( HxC_1 \) - Age - Adolescents
- \( HxC_2 \) - Overloading Syllabus
- \( HxC_3 \) - Health problems
- \( HxC_4 \) - Not like challenging question
- \( HxC_5 \) - Less interested in the lesson
- \( HxC_6 \) - Difficulty in concentrating on the lesson
- \( HxC_7 \) - Attention distracters
- \( HxC_8 \) - Not warm and appreciating attitude
- \( HxC_9 \) - Ineffective Intrinsic teaching and learning
- \( HxC_{10} \) - Depression.
- \( HxC_{11} \) - Fear of failure
- \( HxC_{12} \) - Low self-esteem
- \( HxC_{13} \) - Lack of interest
- \( HxC_{14} \) - Procrastination habit

Now we give the connection matrix related with the HxFCM.

**LINGUISTIC VARIABLES FOR THE HEXAGONAL FUZZY NODES**

<table>
<thead>
<tr>
<th>( HxC_1 )</th>
<th>( HxC_2 )</th>
<th>( HxC_3 )</th>
<th>( HxC_4 )</th>
<th>( HxC_5 )</th>
<th>( HxC_6 )</th>
<th>( HxC_7 )</th>
<th>( HxC_8 )</th>
<th>( HxC_9 )</th>
<th>( HxC_{10} )</th>
<th>( HxC_{11} )</th>
<th>( HxC_{12} )</th>
<th>( HxC_{13} )</th>
<th>( HxC_{14} )</th>
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</table>
## LINGUISTIC VARIABLES FOR THE HEXAGONAL FUZZY NODES

<table>
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<th>( \text{HxC}_2 )</th>
<th>( \text{HxC}_3 )</th>
<th>( \text{HxC}_4 )</th>
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</tr>
</tbody>
</table>
Attribute $HxC_1$ is ON:

$$A^{(1)} = (1 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0)$$

$$A^{(1)}Hx(M)_{Weight} =$$

$$\begin{align*}
(0, & \ 0.25, 0.375, 0.5, 0.625, 0.75, 0.875), \\
(0.25, & \ 0.375, 0.5, 0.625, 0.75, 0.875), \\
(0.25, & \ 0.375, 0.5, 0.625, 0.75, 0.875), \\
(0.125, & \ 0.25, 0.375, 0.5, 0.625, 0.75, 0.875), \\
(0.25, & \ 0.375, 0.5, 0.625, 0.75, 0.875), \\
(0.375, & \ 0.5, 0.625, 0.75, 0.875, 1), \\
(0.25, & \ 0.375, 0.5, 0.625, 0.75, 0.875), \\
(0.25, & \ 0.375, 0.5, 0.625, 0.75, 0.875))
\end{align*}$$

$$A^{(1)}Hx(M)_{Average} =$$

$$\begin{align*}
(0, & \ 0.5625, 0.5625, 0.5625, 0.4375, 0.5625, 0.5625, 0.4375, \\
0.5625, & \ 0.675, 0.675, 0.5625, 0.675, 0.675) \\
A^{(1)}Hx(M)_{Max(Weight)} = (0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 1 \ 1 \ 0 \ 0 \ 0) = A^{(1)}_1 \\
A^{(1)}_1 Hx(M)_{Average} =$$

$$\begin{align*}
(0.8594, & \ 0.6016, 0.8594, 0.8594, 0.6785, 0.8594, 0.5156, 0.6785, \\
0.7734, & \ 0.3867, 0.4727, 0.4440, 0.7734, 0.7734) \\
A^{(1)}_1 Hx(M)_{Max(Weight)} = (1 \ 0 \ 1 \ 1 \ 0 \ 1 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0) = A^{(1)}_2
\end{align*}$$
\[ A_2^{(1)} Hx(M)_{\text{Average}} = \]
\[
(1.3428, 1.5040, 1.2354, 1.3428, 1.8262, 1.3428, 1.3428, 1.8262, 1.8262, 1.8262) \]
\[ A_3^{(1)} Hx(M)_{\text{Max(Weight)}} = (0 0 0 0 0 0 0 0 0 0 1 0 0 0) = A_3^{(1)} \]
\[ A_3^{(1)} Hx(M)_{\text{Average}} = \]
\[
(1.1481, 1.1481, 1.1481, 1.1481, 0.8930, 1.1481, 0.8930, 0.6378, 0.8930, 1.1481, 1.1481) \]
\[ A_4^{(1)} Hx(M)_{\text{Max(Weight)}} = (0 0 0 0 0 0 0 0 0 0 1 0 0 1 1) = A_4^{(1)} \]
\[ A_4^{(1)} Hx(M)_{\text{Average}} = \]
\[
(4.6642, 3.5161, 4.2336, 4.2336, 5.1665, 4.5206, 4.5924, 4.7359, 5.1665, 4.3771, 5.5970, 4.7598, 4.2336, 4.3771) \]
\[ A_5^{(1)} Hx(M)_{\text{Max(Weight)}} = (0 0 0 0 0 0 0 0 0 0 1 0 0 0 0) = A_5^{(1)} = A_3^{(1)} \]

**Attribute HxC\(_2\) is ON:**

\[ A^{(2)} = (0 1 0 0 0 0 0 0 0 0 0 0 0 0 0) \]
\[ A^{(2)} Hx(M)_{\text{Weight}} = \]
\[
((0.375, 0.5, 0.625, 0.75, 0.875, 1), 0 (0.125, 0.25, 0.375, 0.5, 0.625, 0.75),
(0.25, 0.375, 0.5, 0.625, 0.75, 0.875), (0.375, 0.5, 0.625, 0.75, 0.875, 1),
(0.25, 0.375, 0.5, 0.625, 0.75, 0.875), (0.125, 0.25, 0.375, 0.5, 0.625, 0.75),
(0, 0.125, 0.25, 0.375, 0.5, 0.625), (0.375, 0.5, 0.625, 0.75, 0.875, 1),
(0.375, 0.5, 0.625, 0.75, 0.875, 1), (0.375, 0.5, 0.625, 0.75, 0.875, 1),
(0.25, 0.375, 0.5, 0.625, 0.75, 0.875), (0.25, 0.375, 0.5, 0.625, 0.75, 0.875),
(0.25, 0.375, 0.5, 0.625, 0.75, 0.875)) \]
\[ A^{(2)} Hx(M) Hx(M)_{\text{Average}} = \]
\[
(0.6875, 0, 0.4375, 0.5625, 0.6875, 0.5625, 0.4375, 0.3125, 0.6875, 0.6875, 0.6875, 0.5625, 0.5625, 0.5625) \]
\[ A^{(2)}_1 Hx(M)_{Max(Weight)} = (1 \ 0 \ 0 \ 0 \ 1 \ 0 \ 0 \ 0 \ 1 \ 1 \ 0 \ 0 \ 0) = A^{(2)}_1 \]

\[ A^{(2)}_1 Hx(M)_{Average} = \]

\[ (1.5469, \ 1.5898, \ 1.9336, \ 1.9336, \ 1.2891, \ 1.9336, \ 1.5898, \ 1.5039, \ 1.5469, \ 1.5469, \ 1.5469 \ (1.4323, \ 1.9336, \ 1.8477) \]

\[ A^{(2)}_2 Hx(M)_{Max(Weight)} = (0 \ 0 \ 1 \ 1 \ 0 \ 1 \ 0 \ 0 \ 0 \ 0 \ 0 \ 1 \ 0 \ 0) = A^{(2)}_2 \]

\[ A^{(2)}_2 Hx(M)_{Average} = \]

\[ (4.1089, \ 3.1421, \ 2.7796, \ 2.7796 \ 4.3506, \ 3.0213, \ 4.1089, \ 4.1089, \ 3.8672, \ 3.6255, \ 4.3506, \ 4.3503, \ 2.7796, \ 4.1089) \]

\[ A^{(2)}_3 Hx(M)_{Max(Weight)} = (0 \ 0 \ 0 \ 0 \ 1 \ 0 \ 0 \ 0 \ 0 \ 0 \ 1 \ 1 \ 0 \ 0) = A^{(2)}_3 \]

\[ A^{(2)}_3 Hx(M)_{Average} = \]

\[ (7.3416, \ 6.7978, \ 9.3416, \ 4.3506, \ 6.7978, \ 5.7102, \ 5.7102, \ 6.2540, \ , \ 7.3416, \ 4.3506, \ 3.8068, \ 7.3416, \ 7.3416) \]

\[ A^{(2)}_4 Hx(M)_{Max(Weight)} = (1 \ 0 \ 1 \ 1 \ 0 \ 0 \ 0 \ 0 \ 1 \ 0 \ 0 \ 1 \ 1) = A^{(2)}_4 \]

\[ A^{(2)}_4 Hx(M)_{Average} = \]

\[ (20.6483, \ 20.1894, \ 20.6483, \ 19.7306, \ 23.8602, \ 24.7799, \ 22.0248, \ 23.8602, \ , \ 24.7799, \ 19.7306, \ 26.6133, \ 22.177751, \ 18.8129, \ 19.7306) \]

\[ A^{(2)}_5 Hx(M)_{Max(Weight)} = (0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 1 \ 0 \ 0 \ 0 \ 0 \ 0) = A^{(2)}_5 \]

\[ A^{(2)}_5 Hx(M)_{Average} = \]

\[ (14.9700, \ 14.9700, \ 14.9700, \ 14.9700, \ 11.6433, \ 14.7900, \ 11.6433, \ 8.3167, \ , \ 11.6433, \ 14.9700, \ 0, \ 11.6433, \ 14.9700, \ 14.9700) \]

\[ A^{(2)}_6 Hx(M)_{Max(Weight)} = (1 \ 1 \ 1 \ 1 \ 0 \ 1 \ 0 \ 0 \ 0 \ 1 \ 0 \ 0 \ 1 \ 1) = A^{(2)}_6 \]

\[ A^{(2)}_6 Hx(M)_{Average} = \]

\[ (60.8156, \ 45.8456, \ 55.2019, \ 55.2019, \ 67.3650, \ 58.9444, \ 59.8800, \ 61.7813, \ , \ 67.3650, \ 57.0731, \ 72.9788, \ 62.0626, \ 55.2019, \ 57.0731) \]

\[ A^{(2)}_7 Hx(M)_{Max(Weight)} = (0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 1 \ 0 \ 0 \ 0) = A^{(2)}_7 = A^{(2)}_5 \]
Do the process for the remaining attributes

Table: 1 Weightage of the attributes

<table>
<thead>
<tr>
<th>Attributes</th>
<th>( H_{x}C_7 )</th>
<th>( H_{x}C_8 )</th>
<th>( H_{x}C_9 )</th>
<th>( H_{x}C_{10} )</th>
<th>( H_{x}C_{11} )</th>
<th>( H_{x}C_{12} )</th>
<th>( H_{x}C_{13} )</th>
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<tbody>
<tr>
<td>( (100000000000000000000000000000) )</td>
<td>4.6642</td>
<td>3.5161</td>
<td>4.2336</td>
<td>4.2336</td>
<td>5.1665</td>
<td>4.5206</td>
<td>4.5924</td>
</tr>
<tr>
<td>( (010000000000000000000000000000) )</td>
<td>60.815</td>
<td>45.845</td>
<td>55.201</td>
<td>55.2019</td>
<td>67.365</td>
<td>58.944</td>
<td>59.8800</td>
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<tr>
<td>( (001000000000000000000000000000) )</td>
<td>3.4399</td>
<td>3.6643</td>
<td>3.2904</td>
<td>3.4399</td>
<td>4.2625</td>
<td>3.4399</td>
<td>4.2625</td>
</tr>
<tr>
<td>( (000010000000000000000000000000) )</td>
<td>2.2852</td>
<td>1.7227</td>
<td>2.0742</td>
<td>2.0742</td>
<td>2.5313</td>
<td>2.2148</td>
<td>2.2500</td>
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<tr>
<td>( (000000010000000000000000000000) )</td>
<td>4.5187</td>
<td>3.4064</td>
<td>4.1016</td>
<td>4.1016</td>
<td>5.0054</td>
<td>4.3797</td>
<td>4.4492</td>
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<tr>
<td>( (000000000100000000000000000000) )</td>
<td>1.7430</td>
<td>0.7923</td>
<td>1.7430</td>
<td>1.7430</td>
<td>1.4261</td>
<td>1.7430</td>
<td>0.7923</td>
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<tr>
<td>( (000000000001000000000000000000) )</td>
<td>233.93</td>
<td>249.18</td>
<td>223.76</td>
<td>233.932</td>
<td>289.87</td>
<td>233.93</td>
<td>289.8724</td>
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<tr>
<td>( (000000000000100000000000000000) )</td>
<td>4.7721</td>
<td>5.1392</td>
<td>4.5274</td>
<td>4.7721</td>
<td>6.1181</td>
<td>4.772</td>
<td>5.8734</td>
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<td>2.0171</td>
<td>2.0171</td>
<td>2.0171</td>
<td>1.5688</td>
<td>2.0171</td>
<td>2.017</td>
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<tr>
<th>Total Weight</th>
<th>355.1</th>
<th>354.7</th>
<th>336.2</th>
<th>348.0</th>
<th>429.4</th>
<th>352.9</th>
<th>418.9</th>
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<tbody>
<tr>
<td>Average</td>
<td>25.3</td>
<td>25.3</td>
<td>24.0</td>
<td>24.8</td>
<td>30.6</td>
<td>25.2</td>
<td>29.9</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Attributes</th>
<th>( H_{x}C_9 )</th>
<th>( H_{x}C_{10} )</th>
<th>( H_{x}C_{11} )</th>
<th>( H_{x}C_{12} )</th>
<th>( H_{x}C_{13} )</th>
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</thead>
<tbody>
<tr>
<td>( (100000000000000000000000000000) )</td>
<td>4.7359</td>
<td>5.1665</td>
<td>4.3771</td>
<td>5.5970</td>
<td>4.7598</td>
</tr>
<tr>
<td>( (010000000000000000000000000000) )</td>
<td>61.751</td>
<td>67.365</td>
<td>57.073</td>
<td>72.9788</td>
<td>62.062</td>
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<tr>
<td>( (001000000000000000000000000000) )</td>
<td>3.1408</td>
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<td>4.4121</td>
<td>3.7391</td>
<td>4.1130</td>
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<tr>
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<td>3.8700</td>
<td>4.2386</td>
<td>5.4365</td>
<td>4.6072</td>
<td>5.0679</td>
</tr>
<tr>
<td>( (000010000000000000000000000000) )</td>
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<td>2.1445</td>
<td>2.7422</td>
<td>2.3320</td>
</tr>
<tr>
<td>( (000001000000000000000000000000) )</td>
<td>4.5683</td>
<td>5.0034</td>
<td>6.4174</td>
<td>5.4384</td>
<td>5.9823</td>
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</table>
4 Conclusion

Using A new fuzzy model Hexagonal Fuzzy Cognitive Maps (HxCFM) gives the ranking for the causes for the lack of motivation among students thought in Less interested in the lesson are 30.6753- Depression, 30.5969- Attention distracters, 29.9233- Low self-esteem, 29.2882- Procrastination habit, 28.8091- Lack of interest, 28.7231- Fear of failure, 28.0341- Ineffective Intrinsic teaching and learning, 26.1470- Age - Adolescents, 25.3662- Overloading Syllabus, 25.2073- Difficulty in concentrating on the lesson, 25.2073- Not like challenging question, 24.8576- Health problems, 24.0168- Not warm and appreciating attitude, 23.7223. When we use Fuzzy Cognitive Maps (FCM) the above causes are ON stage. But this new model gives the ranking of the causes of the problem. This is the beauty of this Hexagonal Fuzzy Cognitive Maps (HxCFM).

References


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