Evaluating learning effectiveness in collaborative learning environment by using Multi-Objective Grey Situation Decision Making Theory

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Abstract: The learner's learning effectiveness in group encourage each other to ask questions, explain, reasoning with opinions, and elaborate and response their knowledge. It also could enhance critical thinking, because learners could understand more diverse views by sharing different perspectives on a given problem. Collaborative asynchronous learning system could understand more diverse views, if it has the conditional data representation to the user based on the understanding level. For this, the attempt in this paper is to apply Multi-objective Grey Situation Decision Making theory (MGSD) on the collaborative online learning system for measuring the basic understanding level of learner and then accordingly presents the conditional content to the user. To evaluate preliminary learning level of the user in the collaborative environment, we considered multiple parameters of the learner like age, demographic profile, family profile, basic qualification and basic competency scale.

Index Terms: asynchronous learning, collaborative learning, e-Learning, Multi-objective Grey Situation Decision making theory (MGSD), synchronous learning

1. Introduction and Literature Review:

Collaborative learning is a method where two or more learners work together to learn something. It is based on a general platform where learner can share their educational content, can share social interaction, and much more. It is a common platform which allows diversity of knowledge, thoughts, ideas, and experiences being shared amongst the group of learners. This can be achieved by allowing group discussion, discussion leader, clusters, group survey, pair-and-share, critical resource sharing and much more. The aim of the system is not only to emulate a "human tutor" but to provide the personalized content as per the understanding of the learner.

In the past few years, the only way to acquire the material or note was to attend the classes in the university or college. Nowadays, we have entered in an era where, the fast development of the technology; the people move from only classroom learning to digital learning and now it is an era that from only digital learning to collaborative digital learning. As a result users' are able to download the notes or material from the Internet by just a click.

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In era of information technology and vast amount of content available on the Internet, it becomes difficult for the learner to dig out the correct and meaningful information out of it.

For Intelligent Tutoring System (ITS) in 2013, at "Universidad de la Sierra", a project was developed to evaluate the projects developed by the students. It was web based intelligent tutoring system to provide student advice in structuring research projects.

A variety of constructivist and student-centered learning approached can be implemented at different levels of collaborative learning

environment. Inquiry based learning constructivist approach, allowing knowledge construction via question-answer to find the preliminary understanding level of the learner in the domain. The missing part is to identify and understand the psychology of the user in terms of their age, geographical location, their predecessor's details including the qualification and all, and the basic understanding of the learner.

2. OBJECTIVES OF THE STUDY:

Today, we live in an era where children, teens and adults are exposed to digital revolution. This evolving Information Technology has become a driving force of great change in the society. The change and advancement in the digital revolution may touch almost every aspect of modern day to day routine and has transformed the means of communication immensely. The most affected area in which this transformation plays vital role is the education sector. The advancement in technology makes informative content easier to find, access, and disseminate. This increases the expectation of the learner for the more customized content and as a result the developer now has to think more about customization and in terms of learner centric approach in terms of application development. Then the only point to consider is how much customization is applied and implemented in the technology to make the learning fast, effective, and more over interesting for the end user. As the level of understanding differs from learner to learner, the customization factor also being affected in a way that, what content is suitable for which type of learner? as the content pool consists of vast amount of data. This inspired us to propose the technique which uses Multi-objective Grey Situation Decision Making Theory approach. The attempt is to apply this customization in terms of content delivery by taking learner's basic parameters and applying Multi-objective Grey Situation Decision-making theory (MGSD) to find the preliminary understanding level of the user. On the basic understanding level, the content shall be filtered and been presented to the learner.

3. METHODOLOGY:

Multiple criteria decision making (MCDM) is a modeling and methodology tool for dealing with complex problems. Decision makers face many problems with incomplete and vague information in MCDM problem since characteristics of these problems often required this kind of information. Fuzzy set approaches are suitable to use when the modeling of human knowledge is necessary and when human evaluations are needed. Grey situation decision is a method to choose the decision with optimum effect from multiple decision and objectives, with the prerequisite that decision information should have grey elements. In the light of these developments, this study develops a series of models capable of forecasting the understanding level of the user by applying the Grey theory and multi objective programming.

The decision making includes four elements; event, strategy, effect and target. In our case to find the understanding level of the user for the collaborative learning environment, we consider age, geographical location, basic qualification, family background and basic understanding level as a result of small aptitude test result being conducted by the system at the time of registration. The details are stored in user ontology and being used by this theory at the time of content generation and content delivered to the user.

4. The Multi objective Grey Decision-Making Theory

The decision-making includes four elements; event, strategy, effect and target. In our case of checking effectiveness of learner in collaborative learning we considered learner, event, parameters and learning capability. The combination of event pi and strategy qj are called situation, which can be defined as Sij = (pi, qj) [6]. The ratio of the effect measure r_{ij} and situation $r_{ij}/S_{ij} = r_{ij} / (p_i, q_j)$ is called as the decision unit which can be represented by δ_{ij},

where rij is effect measure for sij. There is event cluster A=(p_1, p_2, p_3, … p_n) and strategy cluster B = (q_1, q_2, q_3,…q_n). For the same event pi, there are n strategies. So (p_i, q_1), (p_i, q_2),… (p_i, q_n) turns to be m situation strategies S_{i1}, S_{i2},….S_{im}.

4.1 The Effect Measure

There are three types of effect measures namely upper, lower and central limit measure.

The upper limit measure is used to find the maximum deviation data. Such as primary understanding level, qualification etc. are the higher the better [8] [9].

$$r_{ij} = \frac{u_{ij}}{u_{max}} \quad (4.1.1)$$

Where u_{ij} is the actual effect measure for S_{ij}, is the maximum data in S_{ij}. $u_{ij} \le u_{max}: r_{ij} \le 1$.

The lower limit measure is used to find the minimum deviation data. Such as Geometric location, Age etc. are the lower the better.

$$r_{ij} = \frac{u_{min}}{u_{ij}} \quad (4.1.2)$$

Where u_{ij} is the actual effect measure for S_{ij} and u_{min} is minimum data in S_{ij}.

$u_{ij} \ge u_{min}: r_{ij} \ge 1$.

The central effect measure takes the value near by the specific goal as consideration scope.

$$r_{ij} = \frac{\min(u_{ij}, u_0)}{\max(u_{ij}, u_0)} \quad (4.1.3)$$

Where u_{ij} is the actual effect measure for S_{ij}, u_0 is the reference point and $r \le 1$.

4.2 Situation Decision

Whenever there are several objectives in the given situation the comprehensive consideration on the objective is called multi-objective situation decision-making. The effect measure of k[th] objective is remarked by $r_{ij}^{(k)}$. The corresponding decision unit given by $r_{ij}^{(k)} \Big/ S_{ij}$. The decision column is $\delta_i^{(k)}$, the decision row $\delta_j^{(k)}$ and the decision matrix $D^{(k)}$ [7] [9].

$$\begin{bmatrix} \frac{r_{11}^{(k)}}{s_{11}} & \frac{r_{12}^{(k)}}{s_{12}} & \cdots\cdots & \frac{r_{1m}^{(k)}}{s_{im}} \\ \frac{r_{21}^{(k)}}{s_{21}} & \frac{r_{22}^{(k)}}{s_{22}} & \cdots\cdots & \frac{r_{2m}^{(k)}}{s_{2m}} \\ . & . & & . \\ . & . & & . \\ \frac{r_{n1}^{(k)}}{s_{n1}} & \frac{r_{n2}^{(k)}}{s_{n2}} & \cdots\cdots & \frac{r_{nm}^{(k)}}{s_{nm}} \end{bmatrix}$$

Similarly, the multi-objective situation decision comprehensive matrix $D^{(\Sigma)}$ can be derived by equation (4.2.1).

$$r_{ij}^{(\Sigma)} = \frac{1}{N}\sum_{k=1}^{n} r_{ij}^{(k)} \quad (4.2.1)$$

5. Problem Solving by Multi Objective Grey Situation Decision Making Theory

Considering situation for three students and situation set for parameters Age, Geographical location, Qualification, Family background and Preliminary knowledge level.

For Area and Family background we considered lower limit measure, for Qualification and Knowledge level we considered upper limit measure and for Age we considered central effect measure (for our calculation the value taken for reference point u0=23).

	Age	μ_1	Area	μ_2	Qualification	μ_3	Family Background	μ_4	Basic understanding	μ_5
S: 1	14	μ_{11} =14	Rural	μ_{21} =3	Secondary	μ_{31} =3	Father-Mother Graduate	μ_{41} =2	7	μ_{51} =7
S: 2	21	μ_{12} =21	Urban	μ_{22} =1	Graduate	μ_{32} =4	Father-Mother Schooling	μ_{42} =3	3	μ_{52} =3
S: 3	35	μ_{13} =35	Urban	μ_{23} =1	12th	μ_{33} =3	Father-Mother Post Graduate	μ_{43} =1	8	μ_{53} =8

Table 4.1 Quantitative and qualitative assessment

Define the effect measure under different parameters Age, Area, Qualification, Family Background and Knowledge level will be:

$r_{ij}^{(1)} = \left[\frac{14}{23}, \frac{21}{23}, \frac{23}{23}\right]$, $r_{ij}^{(2)} = \left[\frac{1}{3}, \frac{1}{1}, \frac{1}{1}\right]$, $r_{ij}^{(3)} = \left[\frac{3}{4}, \frac{4}{4}, \frac{3}{4}\right]$, $r_{ij}^{(4)} = \left[\frac{1}{2}, \frac{1}{3}, \frac{1}{1}\right]$, $r_{ij}^{(5)} = \left[\frac{7}{8}, \frac{3}{8}, \frac{8}{8}\right]$.

Calculating the comprehensive effect measure by equation (4.2.1) and selecting most superior

situation by sorting. The comprehensive effect matrix for this example is,

$r_{ij}^{(\Sigma)} = \left[r_{11}^{(\Sigma)}, r_{12}^{(\Sigma)}, r_{13}^{(\Sigma)}\right]$=[0.6134, 0.7242, 0.95]

Obviously there is

$$r_{13}^{(\Sigma)} > r_{12}^{(\Sigma)} > r_{11}^{(\Sigma)}$$

The graph for the comprehensive matrix values with their outcome will be:

This indicates that the value ranges from 0.1 to 0.25 the learning capability will be poor, 0.26 to 0.5 the learning capability will be average, 0.51 to 0.75 the learning capability will be good and 0.76 to 1.00 the learning capability will be excellent.

6. Conclusion:

The formal model is to provide the web based intelligent collaborative environment, which uses the user ontology model that extracts the preliminary information of the user and passes the same to the system which uses the multi-objective grey situation decision making theory on the user data to find the initial understanding level of the user. Here, we applied the same on the secondary data and as per the result we found that S3 is having excellent learning capability compare to S1 and S2. Going further comparing S1 and S2, S2 is having good learning capability and the S1 is having average learning capability.

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