CLASSROOM LEARNING MODEL - KNOW YOUR LEARNER

Dr. Bipin Bihari Jayasingh

Professor, IT Dept., CVR College of Engineering, Ibrahimpatan (M), RR Dist-501510, Telangana.
Email: bbjayasingh9@rediffmail.com

Abstract-Engineering instructors start the lecture by introducing general principles followed by the mathematical models and make the students to practice in similar derivations. There are varieties of alternative inductive teaching approaches that an instructor must adopt to motivate the student to learn in a broad range. In this paper, an instructor would like to adopt inquiry based learning methodology but how to know the learners are ready to take up the method. An instructor cannot decide manually by asking simple questions, there is a need of specific methodology that will decide the learner characteristics. We develop a classroom learning model to know the kind of learners available in the classroom so that appropriate learning methodology can be adopted by an instructor. We attempt to know the learner characteristics in the classroom by applying the class discrimination mining technique on the relevant data that are collected from the questionnaire. The descriptive mining technique present the discrimination rule that decide the kind of learner available in the classroom. Accordingly teacher must decide to proceed further with inquiry based inductive learning methodology or the traditional deductive learning methods.

Keywords: Inquiry Based Learning; Deductive Learning; Discrimination Mining; Discriminant Weight; Discriminant Rule;

I. INTRODUCTION

The teachers need to know that what we do in the classroom makes any difference to student learning [2, 5]. In order to meet the needs of divorce learners, it is important to have an approach to teach the content. According to the survey, there are two kinds of teaching approach i.e. Deductive and Inductive. Deductive teaching is highly structured contents that create optimal learning, also called direct instruction. Inductive teaching is the knowledge acquisition from the learner's experience, also called the inquiry teaching.

Some students learn best through an inductive approach and some through deductive approach. Inductive learners like making observations and looking for patterns while deductive learners like to have general principles and examples from them. Some instructors have suggested that the deductive learning is quit important for students with learning disabilities [2]. This method has clear and readily apparent structure, easily accommodate student needs, also familiar to students. Deductive learning does not allow for divergent student thinking, nor emphasize student reasoning and problem solving [9]. Inductive approach showed better long term retention of concepts than deductive approach. Such students may have difficulty getting started, understanding their role in the exercise and staying focused on the activity.

An inquiry-based approach is most effective when it is carefully designed and structured by teachers [7, 8]. To be most effective inquiry should be seen as a complex combination of structured learning with intentional opportunities for students to create, design, imagine and develop new possibilities. Just as play requires rules to keep a game going, inquiry needs structure and boundaries to be effective. As compared with more traditional delivery models of teaching and learning that focus only on pre-existing knowledge or skills, inquiry remains open to the unknown, to the 'not yet.' As teachers are considering inquiry in a particular topic it becomes helpful to consider how students might 'play' within in topic, that is, maintain an emphasis on what is already known (the foundational concepts or key-ideas) while allowing for space for the unknown where students can create, design, interpret or participate.

Inquiry based learning is to ask questions, create hypothesis, investigate, construct new knowledge, discuss and reflect on discovery, acquire newly acquired knowledge in your own life, generate new questions. Effective inquiry is more than just asking questions. Inquiry-based learning is a complex process where students formulate questions, investigate to find answers, build new understandings, meanings and knowledge, and then communicate their learnings to others [7, 8]. In classrooms where teachers emphasize inquiry-based learning, students are actively involved in solving authentic (real-life) problems within the context of the curriculum and/or community [6, 10]. These powerful learning experiences engage students deeply.

Research suggests that inquiry-based learning increases student creativity, independence, and problem

solving skills, and it improves student achievement [11]. In this paper we developed a classroom learning model to know the kind of learner available in the classroom that helps a teacher to proceed with an appropriate learning methodology. The rest of the paper is organized as follows: section 2 discusses the various kinds of learning methodology and specifically elaborates the deductive learning methodology and the inquiry-based learning methodology; section 3 analyses the questionnaire data that has collected from the student in a classroom; section 4 presents the results in the form of discriminant rules in order to help the teacher; section 5 discuses the results that we obtain from the sample and provide the concluding remark and section 6 summarizes the work.

II. LEARNING METHODOLOGY

There are various kinds of learning models available for the classroom like the flipped discussion model, the flex model, the lab rotation model, the station rotation model. Also there are various kinds of learning methodology available for the classroom like deductive learning methodology and inductive learning methodology. The deductive learning methodology is traditionally taught in Engineering and science discipline [3, 4]. The inductive learning methodology is an umbrella term that covers a number of other approaches including inquiry based learning, problem-based learning [10,11,12,13], project-based learning, case-based teaching, discovery learning, and just-in-time teaching. These methods have many features in common, besides the fact that they all qualify as inductive. We have discussed rigorously about the inquiry based learning methodology of inductive approach and the deductive learning methodology in this section.

A. Inquiry based learning

This approach is student centric learning approach where the teacher presents a variety of examples for a given concept without giving any preamble about how the concept is used. The student will notice how the concept is to be used and determine the abstract rule. The teacher then asks the students to explain the abstract rule as a final check that they understand the concept. It is a cyclical process where the student asks questions, these questions lead to the desire for answers to the question (or for solutions to a problem). The result in the beginning of exploration and hypotheses creation lead to an investigation to test the hypothesis or find answers and solutions to the question. The investigation leads to the creation or construction of new knowledge. Based on investigation findings and the student discusses and reflects on this newly-acquired knowledge, which, in turn leads to more questions and further investigation.

Inquiry-based learning is an interconnected nature of knowledge construction for both teachers and students to collaboratively build, test and reflect on their learning. Teachers are the learning facilitator where the students are the learning element of interest. Teacher teaches the problem-solving, critical thinking skills, disciplinary content and how to learn and build self-directed learning skills. Students acquire and analyze information, develop and support propositions, provide solutions, and design technology and arts products that demonstrate their thinking and make their learning visible.

Inquiry-based instruction is a student-centered and teacher-guided instructional approach that engages students in investigating real world questions that they choose within a broad thematic framework [1]. It is a learning process where questions generated from the interests of the students. If the question, investigation, and outcome(s) are truly meaningful to the student, she or he will apply this newly-acquired knowledge in her or his own life by sharing knowledge and by taking concrete action in the world.

Inquiry is not merely 'having students do projects' but rather strives to nurture deep, discipline-based way of thinking and doing with students [8]. The main components of inquiry-based learning include: a question(s) related to the topic of inquiry to be explored (problem statement), followed by an investigation and gathering of information related to the question (data collection), continuing with a discussion of findings (analysis).

Inquiry involves students to include the following:

1. tackling real-world questions, issues and controversies
2. developing questioning, research and communication skills
3. solving problems or creating solutions
4. collaborating within and beyond the classroom
5. developing deep understanding of content knowledge
6. participating in the public creation and improvement of ideas and knowledge

For inquiry to be effective requires significant intellectual investment on the part of teachers to design learning tasks that are connected to the disciplines, to their students' lives, and to the world, while focused toward clear and achievable learning targets [7]. It requires that teachers see themselves as learners and researchers of both

the subjects they teach and their professional practice as a whole.

Inquiry is an umbrella term that covers a number of other approaches to teaching and learning. Teaching practices that utilize a disposition of inquiry learning include:

1. problem-based learning: learning that starts with an ill-structured problem or case-study
2. project-based learning: students create a project or presentation as a demonstration of their understanding
3. design-based learning: learning through the working design of a solution to a complex problem

B. Deductive learning

This approach is teacher centric learning approach where teachers introduce the concepts and explain to the students. The students practice the concepts to complete the task of a teacher. For an example, when teaching a new concept, the teacher will introduce the concept, explain the rules related to its use, and finally the students will practice using the concept in a variety of different ways [2]. The deductive teaching is an isolated way of teaching where little attention is paid to the students and the practice is often mechanical. This approach may be a workable in certain situations when dealing with highly motivated students, teaching a particularly difficult concept, or for preparing students to write exams.

III. ANALYSIS OF QUESTIONNAIRE DATA

We have collected the data samples of 50 students (i.e. a class of 60 students) based on the questionnaire that are stored in a table. The table split into target class that belongs to inquiry based learning and contrast class that belongs to deductive learning for discrimination mining. The rating provided by the student for a question belongs to 1 or 2 is generalized to 1 and the rating provided by the student for a question belongs to 3 or 4 is generalized to 4 that are maintained in target class as well as in contrast class. We fill the missing values by the mean value of the questionnaire. The questionnaire that contains 5 questions of inquiry based learning as well as 5 questions of deductive learning is given below:

These are the parameters for rating the learning methodology.

1 – By definition, 2 – always, 3 – usually, 4 – possibly

a. How often you want to involve actively in solving real time problems?
b. How often you want to ask questions to the teachers?
c. How often you want to answer the questions?
d. How often you want to investigate to find answers?
e. How often you want to communicate the learning with others?
f. Do you expect the teacher to introduce the concept and solve the problems?
g. Do you expect a question from the teacher?
h. Do you expect the answers from the teacher?
i. Do you explore to find answers?
j. Do you isolate the learning with others?

The initial target class working relation for Inquiry based learning that stores the rating provided by the student shown in table 1.

TABLE 1: Initial target class working relation (Inquiry based learning)

Involvement _Solving_Pro blems	Asking _Questi ons	Answer _Questi ons	Investig ate_Ans wers	Commun icate_Ot hers
2	3	2	2	2
3	3	3	2	2
…	…	…	…	…
2	3	3	3	2

The initial contrast class working relation for Deductive learning that stores the rating provided by the student shown in table 2.

TABLE 2: Initial contrast class working relation (Deductive learning)

Involvement _Solving_ Problems	Asking _Quest ions	Answer _Questi ons	Investig ate_Ans wers	Commun icate_Ot hers
2	4	2	2	2
2	2	2	2	4
…	…	…	…	…
2	2	2	3	3

We use information gain method to quantify the relevance of an attribute out of five attributes. Let S be a set of training samples and S_1, S_2 are the sample belongs to target class and contrast class. The expected information for a given sample is

$$I(S_1, S_2, \ldots, S_m) = -\sum_{i=1}^{m} \frac{s_i}{s} \log_2 \frac{s_i}{s}$$

Where m is the number of classes and s_i is the samples in class C_i with probability $\frac{s_i}{s}$

Let s_j contain s_{ij} samples of class C_i, the expected information based on this partitioning by attribute A is known as the entropy of A.

Entropy of A is $E(A)=\sum_{j=1}^{v}\frac{s_{1j}+s_{2j}+\cdots+s_{mj}}{s} I(s_{1j}+s_{2j}+\cdots+s_{mj})$

Where v is the number of distinct values in the attribute A and s_{ij} is the samples in class C_i with attribute value j.

The information gain obtained by this partitioning on A is defined by

Gain (A) = $I(S_1, S_2, \ldots, S_m) - E(A)$

We compute the information gain for each of the attributes, the attribute with highest information gain is considered most discriminating attribute of the given set. The attributes that are not relevant to the task are removed based on users threshold value.

After removing the attributes we kept the data in a prime generalized relation table for the target class as well as contrasting class shown in table3 &4. If there are a minimum of three 1s that are present in a tuple, the other attribute values are generalized to 1. If there are a minimum of three 4s that are present in a tuple, the other attribute values are generalized to 4.

TABLE 3: Prime generalized Relation for the target class ((Inquiry based learning)

Involvement_Solving_Problems	Asking_Questions	Answer_Questions	Investigate_Answers	Communicate_Others	Count
1	1	1	1	1	24
4	4	4	4	4	26

TABLE 4: Prime generalized Relation for the contrasting class ((Deductive learning)

Involvement_Solving_Problems	Asking_Questions	Answer_Questions	Investigate_Answers	Communicate_Others	Count
1	1	1	1	1	20
4	4	4	4	4	30

IV. PRESENTATION OF CLASS DISCRIMINATION

Let q_a be a generalized tuple and c_j be the target class, where q_a covers some tuples of target class. the d_weight (discriminant weight) for q_a is the ratio of the number of tuples from the prime generalized relation for the target class that are covered by q_a to the total number of tuples in both prime generalized relation for the target

class and prime generalized relation for the contrast class that are covered by q_a.

d_weight= Count $(q_a \in c_j)/\sum_{i=1}^{m}(qa \in ci)$

where m is the total number of target and contrast classes and Count$(q_a \in c_i)$ is the number of tuples of c_i class that are covered by q_a. The range of d_weight is 0% to 100%.

We made the observation for the prime generalized relation of both the tables and count the generalized tuple with by definition (1) and generalized tuple with possibly (4) that are shown in table 5 &6.

TABLE 5: Count Distribution between inquiry based learning and the deductive learning for generalized tuple with by definition (1)

Teaching Learning Methods	Involvement_Solving_Problems	Asking_Questions	Answer_Questions	Investigate_Answers	Communicate_Others	Count
Inquiry based	1	1	1	1	1	24
Deductive	1	1	1	1	1	20

TABLE 6: Count Distribution between inquiry based learning and the deductive learning for generalized tuple with possibly (4)

Teaching Learning Methods	Involvement_Solving_Problems	Asking_Questions	Answer_Questions	Investigate_Answers	Communicate_Others	Count
Inquiry based	4	4	4	4	4	26
Deductive	4	4	4	4	4	30

We observed that the d_weight for a generalized tuple with by definition (1) is 55% with respect to target class and 45% with respect to contrasting class. Also we get the d_weight for a generalized tuple with possibly (4) is 46% with respect to target class and 54% with respect to contrasting class. So we present two quantitative discriminant rules in the form given below.

Discriminant Rule1: $\forall x$, Inquiry Based Learning $\Leftarrow$ Deductive Learning [d: 55%]

Discriminant Rule2: $\forall x$, Inquiry Based Learning $\Leftarrow$ Deductive Learning [d: 46%]

$\forall x$ is with respect to satisfying the condition with by definition (1) and possibly (4).

We present the result in the form of pie chart that is shown in fig1 and fig 2. In fig 1 it shows that 55 % of learners want inquiry based learning methodology while

45% of learners want Deductive learning methodology. in fig 2 it shows that 46 % of learners do not want inquiry based learning methodology and 54% of learners do not want Deductive learning methodology.
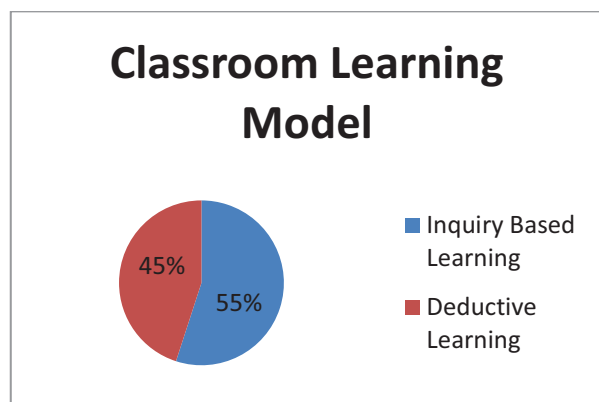
Classroom Learning Model

45% 55%
■ Inquiry Based Learning
■ Deductive Learning

Figure 1 Learner want Inquiry based VS Deductive

Classroom Learning Model

46% 54%
■ Inquiry based Learning
■ Deductive Learning
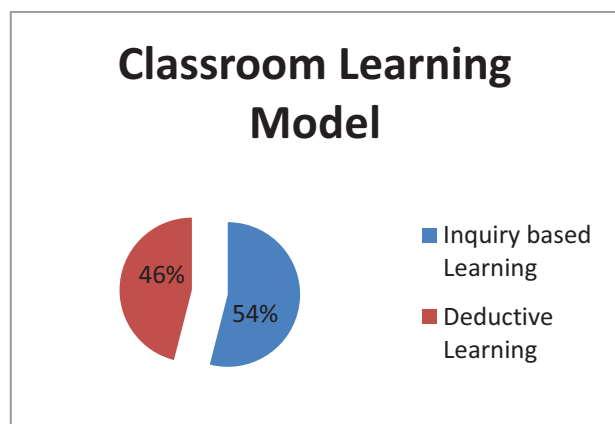
Figure 2 Learner do not want Inquiry based VS Deductive

V. RESULT DISCUSSION

We analyzed the sample and found the result as the 55% of learners would like to pursue inquiry based learning methodology and 45% of learners would like to pursue Deductive learning methodology. Also we got another result that the 46% of learners do not like to pursue inquiry based learning methodology and 54% of learners do not like to pursue Deductive learning methodology.

There is an argument arise from the result that need to resolve and reach to conclusion. As per the previous discussion there are 55% of the students would like to pursue inquiry based learning methodology, in the other way there are 45% of the students do not like to pursue inquiry based learning methodology. Now we would like to compare with the discriminant rule-2, where it is found that the 46% of learners do not like to pursue inquiry based learning methodology which is matching with a small error to discriminant rule-1.

We want to have another argument where 45% of the students would like to pursue Deductive learning methodology, in the other way there are 55% of the students do not like to pursue Deductive learning methodology. Now we would like to compare with the discriminant rule-2, where it is found that the 54% of learners do not like to pursue Deductive learning methodology which is matching with a small error to discriminant rule-1.

The resulting class comparison is presented as the 55% of the students would like to pursue inquiry based learning methodology while only 45% of the students would like to pursue Deductive learning methodology. Now it is trades off for an instructor to proceed further with inquiry based inductive learning methodology or the traditional deductive learning methodology or the combination of both.

VI. CONCLUSION

Teacher may prefer to go with inductive learning methods rather deductive learning, when the students are active, asking questions and responding with answers. The teacher must know the kind of learning methodology the students expect in the classroom. In order to meet the requirements of divorce learners, the teacher must adopt some kind of learning methodology like inquiry based or deductive learning. We develop a classroom learning model to know the kind of learner available in the classroom to help the instructor before the session starts. Accordingly teacher can decide to proceed further with inquiry based learning methodology or the deductive learning methodology. In this research we collected the sample of 50 students out of 60 students in a classroom and concluded that there are 55% of the students would like to pursue inquiry based learning methodology while only 45% of the students would like to pursue Deductive learning methodology. In future, we will compare one learning methodology with all other learning methodology and try to justify the suitable methodology for a teacher in the classroom.

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