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Activity (Video to Concept) based Teaching Learning: A Case study in Discrete Mathematical Structures

Nitya N. Kulkarni[1], Nirmala Patil[2], Karibasappa K. G.[3], Meena Maralappanavar [4]
[1,2,3,4]School of Computer Science and Engineering, K. L. E. Technological University
[1]nitya@bvb.edu
[2]nirmalapatil@bvb.edu
[3]karibasappa_kg@bvb.edu
[4]msm@bvb.edu

Abstract: Discrete Mathematical Structures (DMS) is one of the most important foundation courses that a computer science engineering student takes in his/her 2nd year. One of the outcomes of the course is to develop logical reasoning in students. Logic helps students to develop mathematical reasoning that seeds to software development skills. There have been many deliberations on the methods to teach logic. Traditional methods of teaching propositional and predicate logic are being questioned as the methods fall short to develop student's ability to reason. There has been emphasis on the usage of visual methods in the recent years for teaching logic. This is for the reason that current generation learners are mostly visual learners and also for the fact that the ability to reason is directly connected to vision. With this reference, authors of this paper have made an attempt to teach first order logic by amalgamating traditional and visual methods. The basics of first order logic was taught to students using traditional method of chalk and talk in which the examples related to real world and computer science were discussed. After cultivating the basic foundation of logic, students given a task to map the concepts learnt in the class to the content of a video as part of a graded assignment. This new pedagogical activity mainly addressed propositional logic. It involved identifying propositions from the given video, connecting them with logical connectives based on the video content and solving these premises using inference rules and laws of logic. The authors analyzed the effects of the new practice by comparing course attainment of 2016-17 and 2015-16 batches. The study shows that there has been improvement by 22%. However, since the experimentation was conducted for the first time, making decisive conclusions on the method is premature.

Keywords: Logic, Pedagogy, Visual method

1. Introduction

According to the national employability report by AspiringMinds of 2016 , around 95% of the Indian engineers are not fit for the software development jobs. The reason for this is that Indian engineers lack the coding skills. The study shows that only 4.77% candidates can write the correct logic for a program which is a minimum requirement for any programming job. There could be several reasons for this kind of bad performance by the graduates. Some of the reasons could be outdated learning and exam culture, lack of knowledge to apply theoretical concepts on real world problems and also poor soft skills .

Logical reasoning is one of the most important aspects expected by every IT firm in engineering graduates as it plays a vital role in problem solving. Hence, it has been made as one of the traits that a computer science

Nitya N. Kulkarni
School of Computer Science and Engineering,
K. L. E. Technological University
[1]nitya@bvb.edu

graduate must possess. This trait has to be developed in an engineer right from his/her budding stage in engineering education. As a consequence propositional logic and predicate logic are introduced to computer science students in their 2nd year of engineering as part of Discrete Mathematical Structures (DMS) course. The course deals with describing discrete objects and their relationships among themselves and with the other objects. It is the foundation course for all the subsequent courses of Computer science engineering program.

Logical reasoning mainly helps to understand and check the completeness of formal specifications of a system, analysis of mathematical foundation of a system, helps in the design and implementation of a system. Hence, the choice of an educator on the method of teaching logic plays an important role. Teaching logic by using traditional method of chalk and talk helps students to understand the concepts of logic to a certain extent but this method falls short to provide a picture of its application in real world and mainly in software development process. Therefore, students do not see the relevance of the course and its concepts for a software engineer. However, several practitioners have reformed the course structure, contents and method of teaching the course inorder to enhance the logical reasoning in students . Authors of evidently say that ability to reason is directly connected to vision and perception. Also, the current generation learners are visual learners. As a consequence, it is the need of time to adapt to visual method of teaching logic. In this regard, authors have made an attempt to amalgamate both traditional and visual method of teaching logic to 2nd year students of School of Computer Science and Engineering at K. L. E. Technological University, Hubballi, India.

The paper mainly concentrates on teaching and learning of logic as logic is the foundation stone for other concepts of DMS. The authors used the chalk and talk method to explain the concepts of logic and proofs using real time software development examples. Next, students were given an assignment to watch a video and form propositions from it, connect them using logical connectives and deduce them to conclusion using inference rules and laws of logic. This activity was designed basically with the purpose of exposing the students to apply the laws and rules which they learnt in class to real-world problems/circumstances.

The rest of the paper is divided into following sections. Section II discusses the various methods that are into action to teach DMS and specifically first order logic. Drawing inspiration from the work of the practitioners discussed in section II, authors propose their approach of teaching first order logic in section III. The effectiveness of the approach has been measured and discussed in section IV. Section V concludes with insights drawn from the work.

2. Background Survey

Due to the change in the learning methods of students and problems existing in teaching methodology of DMS course, there have been reforms in teaching and learning of DMS course. According to Zhang and Hui , there is a potential problem that exists in teaching DMS course which they analyze and propose methods to reform teaching it. The methods include stimulating learning in students, heuristic teaching, reveal the internal connection of knowledge, linking theory with practice, improve teaching methods by using multimedia and establish a website for teaching. The authors claim that such reforms in teaching DMS not only will increase the interest of the students but also will increase their understanding of the concepts. Buchele and Suzanne Fox also contribute to make DMS interesting to students through their approach. They allocate half of the class time to discuss on the homework given to students in their previous sessions. Students present their solutions to the homework questions infront of the whole class and later discuss about its appropriateness. The study by the authors on the effectiveness of the approach shows that it is very effective in developing deeper understanding of the concepts in students. On a different note to the above discussions, Gries et al. use equation treatment of propositional and predicate logic. This rigorous representation of logic is used as a persistent tool to explain all the other topics of DMS utilizing the axioms for theory and building up a set of libraries. The feedback from the students (freshman and sophomore) revealed that they lost their fear for mathematics, gained deeper understanding of proofs, acquired formal manipulation skills and gained appreciation for rigor.

It is very much evident from the empirical study that logic is the most essential part of DMS course to develop software development skills of students. Teaching and learning of logic alone also have taken many transformations. Barland et al claim that logic is the underlying foundation to develop safe, secure and robust systems. In order to build such systems,

students should possess strong logical reasoning skills. However, the authors indicate that the current curriculum and method of teaching logic does not achieve this goal. Hence, they propose some methods to improve teaching process of logic. The methods proposed by authors are integrating concrete examples of how logic serves as a valuable tool in practical work, integration and the use of logical software tools and integrating material into several courses. They intend to prepare and provide teaching modules with guidelines on how to integrate them into standard courses. In this digital era logic is being explored to be taught using software tools. One such research endeavor is taken up by Aczel et al . They describe about ongoing research into a computer program called Jape designed to help computer science undergraduate students to learn the natural deduction style of formal reasoning. They discuss on students' experiences using the program to aid proof construction. The effectiveness of the approach was measured through videotapes of the workshop, interviews, written tests, surveys, and logging of program usage. The approach is more suitable for learners who are comfortable with the reflective approach of learning. Considering the new generation students' learning styles which is basically visual, there have been attempts made to teach most of the concepts through visual representation. One such effort is made by San Ginés and Aránzazu . The ability to reason or abstract is mainly related to perception of what is seen. With this hypothesis authors propose a new method of teaching logic through diagrammatic representation of propositions.

Taking the inspiration from the literature on different methods of teaching DMS and logic, authors decided to put an effort on the logic concepts as they play an important role in building logical and programming skills in learners. Considering the current generation of learners' learning styles authors have made an attempt to incorporate a visual aid to facilitate their learners to apply their logical skills on videos.

3. Methodology

Inorder to support the learning style of the current and future generation learners and assist them to acquire the logical skills visually, authors made an attempt of facilitating logical concept learning through videos in their Discrete Mathematical Structure course (15ECSC201). Around 265 students took the course which was taught in 3rd semester across 4 divisions.

The authors taught the concepts related to logic such as “Equivalence and Implication Equivalence of statements, Truth tables, DeMorgan's Laws, Implication, Variables and Quantifiers, Variables and universes, Quantifiers, Standard notation for quantification, Negation of quantified statements, Implicit quantification, Proof of quantified statements, Inference, Direct Inference (Modus Ponens) and Proofs, Rules of inference for direct proofs, Contrapositive rule of inference, Proof by contradiction” using chalk and talk strategy. At the end of the chapter students were given an assignment to apply the skills that they learnt in the chapter on video. Three videos were distributed across 4 divisions. Students belonging to one division had to work on a single video. The videos given as part of the assignment involved a sort of deduction. They were given a week's time to submit the assignment in written form. The assignment was to define propositions using appropriate logical operators for the actions made in the video. Apply laws of logic and inference rules to the defined proposition and predicate statements to deduce inferences of the video . There was no limitation put up on the number of propositional statements to be defined. Students could come up with propositions according to their perspective. An example of some of the frames of a video and propositions for them are as shown below.

The propositions that were expected to be defined for frame shown in Fig 1 are:

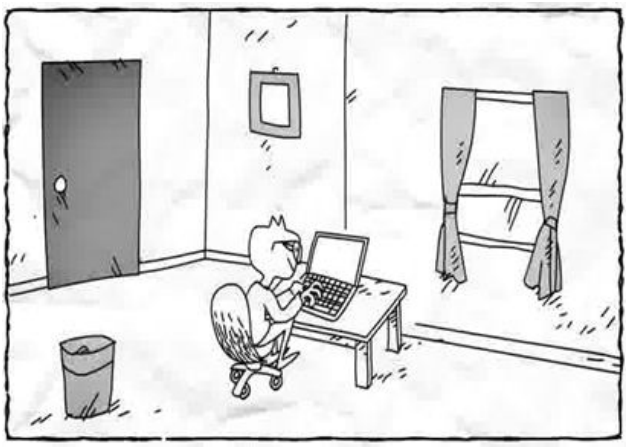

Figure1. Frame 1

p: Raju is sitting on a chair in his room., q: Raju is using his laptop. (Here Raju is the assumed name for the person in the frame.)

The frame is basically showing the statement p^q

In frame 2 shown in Figure 2, a new action is indicated which leads to new propositions to be defined.

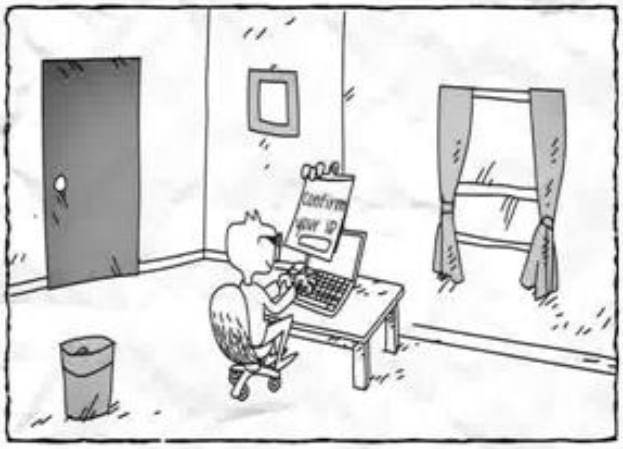

Figure2. Frame 2

- r: Raju visited a website.
- s: A website is asking Raju to confirm his id.

Frame 3 shown in Fig 3 leads to following proposition,

- t: Raju confirms his id to the website

Similarly for the following set of frames the propositions are shown from Fig 4. to Fig 9.

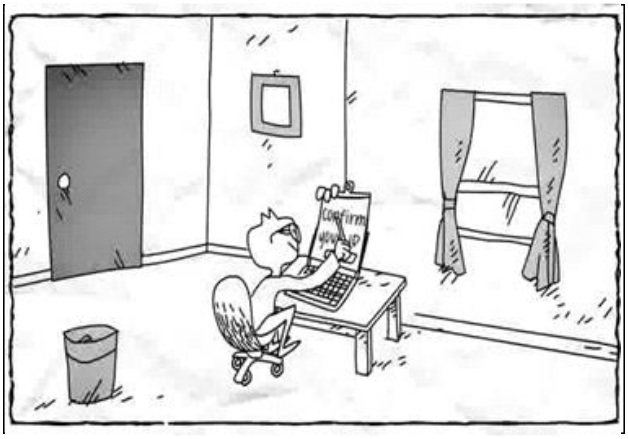

Figure 3. Frame 3

a: The website asks for Raju's birth date.
b: Raju writes his birth date in website's form.

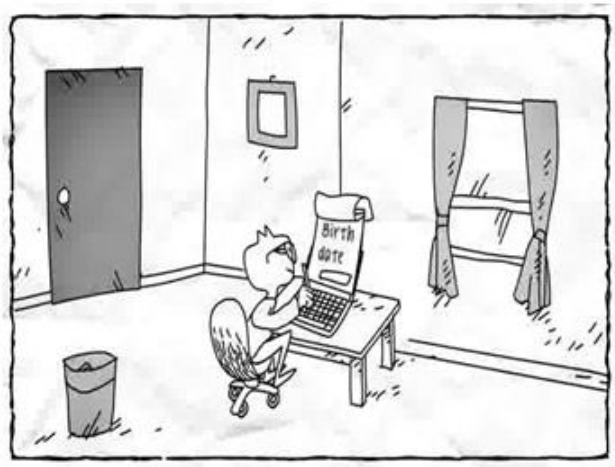

Figure4. Frame 4

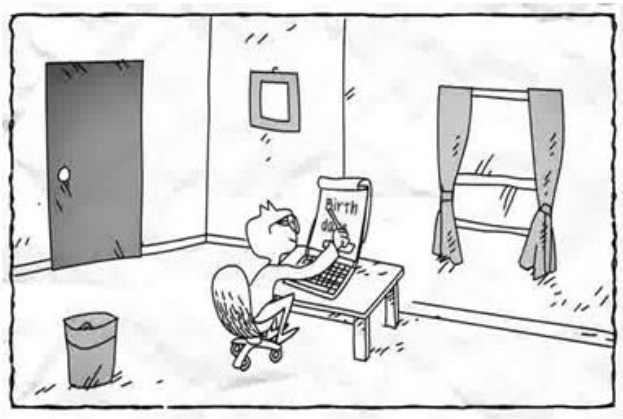

Figure5. Frame 5

c: The website asks for Rraju's mobile number.

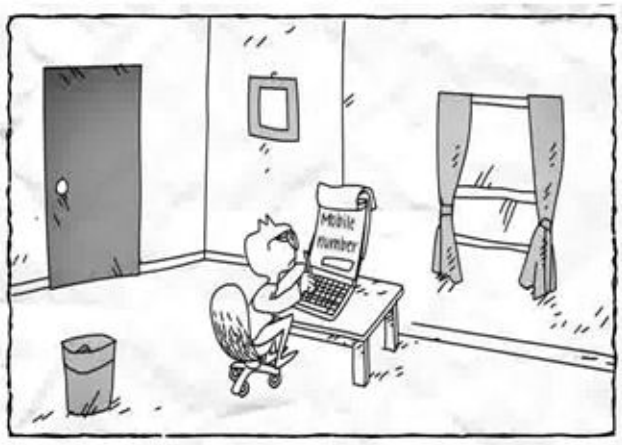

Figure 6.Frame 6

d: Raju writes his mobile number in website's form.

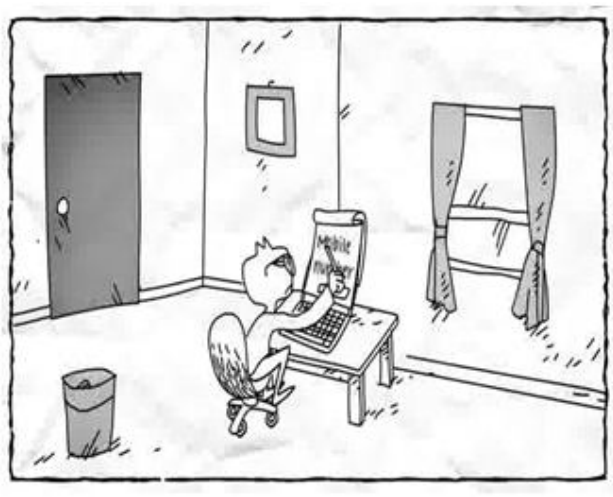

Figure 7 Frame 7

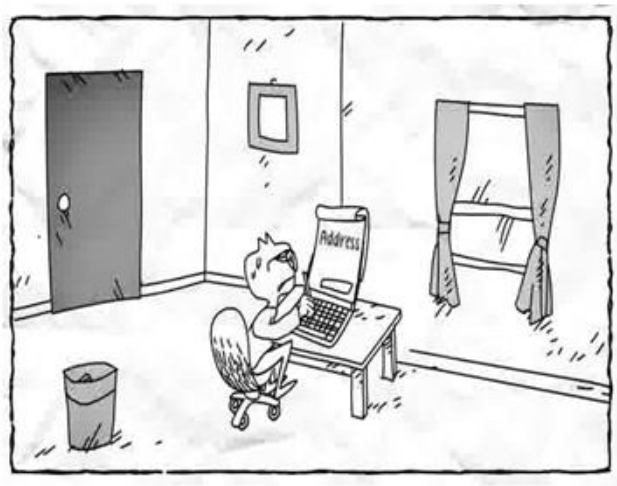

Figure 8. Frame 8

The propositional statements that could be formed by connecting these propositions using logical connectives are,

· (t^b^d^g)→i : If Raju confirms his id to the website and writes his birthdate and write his mobile number and writes his address in the website's form then his identity is not any more safe.

· (s^a^c^e)→h: If the website is asking to confirm id and provide birthdate and provide mobile number and provide address then Don't publish info that identifies you at the website.

Negations of such statements that bring out different meaning within the context of the video have to be

Figure 9. Frame 9

g: Raju writes his address in the website's form.
h: Don't publish info that identifies you at the website.
i: Raju's identity is not any more safe.

defined. Laws of logic and rules of inference have to be applied to simplify these statements.

This activity will ultimately help the students to represent the formal specifications of a system using propositions and logical operators.

4. Result Analysis and Discussion

The effectiveness of the approach followed to teach logic was determined by measuring the level of understanding on logics built into students. This was defined and deduced by students for a given video and also from End Semester Assessment (ESA). As a result of this pedagogical activity, students' attainment is 66% with an average score of 22 out of 30 in the year 2016-17 as compared to 54% with an average score of 18 out of 30 in 2015-16 batch. Since the experiment was conducted for only once, deriving any conclusion from the activity is premature. However, the activity proved to be effective in cultivating the mindset of logical reasoning in students.

5. Conclusion

Logic is the most significant concept of DMS that builds the software development skills in students. Teaching logic using only chalk and talk method to students who are visual learners is not effective in developing logical reasoning in them. Hence, an attempt has been made to amalgamate the traditional and visual learning methods. After teaching students

the concepts of logic using chalk and talk method a task to frame propositions from the content of a video and applying laws of logic and inference rules on them was assigned. The method was followed with intent to help students to gain the ability to apply the concepts of first order logic on real time scenarios. The approach showed its effectiveness in student's performance in their end semester assessment with 22% improvement from last academic year batch.

The authors intend to extend the practise of learning logic visually to predicate logic as well for the upcoming academic year.Acknowledgement
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