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A GUIDE FOR DESIGNING CONCEPT MAP BASED LECTURE PLANNING

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Abstract **Preparing a lecture plan and sharing it with the students is one of the primary responsibilities of an instructor. Lecture plans are usually prepared by scheduling the contents of the syllabus with listing the prerequisite courses. Least attention is paid to highlight the prerequisite topics or the order of the topic delivery based on dependency. Concept map is a good tool in education which is usually used for different purposes such as organizing thoughts, evaluation, analyzing the depth of understanding in students and so on. In this paper we propose a guide for building a concept map to organize the concepts in a course, based on its complexity and dependencies. We propose a new classification for the notion of concept based on complexity. We coin new terminologies such as atomic concept, preliminary concept, composite concept and integrated concepts.**

***Index Terms*— Concept map, Atomic concept, Preliminary concept, Composite concept, integrated concept.**

I. INTRODUCTION

A concept is defined as constituent of thought [1]. They are very important in basic psychological processes like memory, learning, categorization and decision making. There are several definitions for concept, each in context with their respective domain. "Conceptum"is the Latin word for concept meaning, "something conceived". With reference to ontology it is a fundamental category of existence and according to philosophy it is abstract object.

A concept map is a hierarchical graph or a diagram which is used by students and teachers as an effective tool to organize and represent knowledge [2]. The map begins with a central concept or main idea and branch out sub concepts or more specific sub topics. A concept map typically represents ideas and information as boxes or circles, which it connects with labeled arrows in a downward-branching hierarchical structure. Used as learning and teaching technique, concept mapping visually illustrates the relationship between concepts and ideas.

Concept map is a powerful way for students to reach high levels of understanding. It is not just a learning tool, but an ideal evaluation tool for educators measuring the growth of and assessing student learning. When students create concept maps, it will help them to represent their ideas using their own words. It helps the educators to identify the incorrect ideas in the mind of the students. And they can in turn help the students by providing an accurate way to understand and express the concepts to achieve higher levels of cognitive performance.

A. Building a Concept Map

A concept map can be built [3] by following steps.

Step 1: Begin with the main idea, topic or issue to concentrate on.

Step 2: Identify the key concepts and sub concepts of the main topic.

Step 3: Interconnect concepts by using appropriate linking phrases.

Typically hierarchical in nature, concept maps have the main idea or topic as the central concept in the concept map and the sub concepts and in the lower levels of hierarchy**.** This structure allows updating the map by adding, deleting or changing of concepts very easy. A consistent and good concept map is built with at least two to three revisions.

II. EXISTING WORK

The idea of concept maps was proposed decades before and it has been used as an effective tool not only in education but in other domains [4]. The applications of the concept maps in education are as follows [5][6].

A. Evaluation tool

An instructor can use the concept map to asses [7] the knowledge of the students. It can be used to evaluate the previous knowledge to introduce new concepts; it can be used as a standard template to evaluate the current concepts. The students should be introduced to, concept maps and how to build the concept maps before the evaluation. For example an incomplete concept map can be given for completion or students might be asked to build a new concept map for a particular concept.

B. Knowledge organizing tool

An instructor can use the concept map as a knowledge organizing tool. The instructor can start the course delivery of a course by constructing a concept map which organizes the concepts of the prerequisite course and the current. This can be

used more effectively when the instructor builds a concept map in every class organizing the concepts delivered in the previous class with the concepts of the current class. This way of building concept maps to organize knowledge will be more appealing and students can have better understanding.

C. Meaningful learning tool

An instructor can ask a group of students or an individual student to construct concept map for each chapter of the module delivered. Here, the student will actively participate and express his knowledge of the chapter through a concept map. When this activity is done in group or by an individual it brings more meaningful learning than rote learning.

III. PROPOSED WORK

In this paper, we try to apply concept maps for lecture planning. Lecture planning is one of the prime responsibilities of an instructor. The lecture plan typically includes the schedule of the contents in the syllabus, list of prerequisite courses and other mandatory declarations like the assignment list, exercises and internal assessment scheme. The order of topic delivery based on the dependencies in the course is a major issue, which is sidelined at times. We propose to build a single concept map for the entire course to highlight the dependencies among modules which in turn helps in ordering the delivery. We propose a general concept map for a course and apply this structure to develop a concept map for Finite Automata and Formal Languages (FAFL) an undergraduate course in Engineering. All the examples in this paper refer to concepts of FAFL.

Before constructing the concept map we propose a new classification for the notion of concept. The definition of concept is more generic. There is no differentiation between defining simple or complex concepts. The proposed new classification for concept is as follows

i. Atomic Concept
ii. Preliminary Concept
iii. Composite Concept
iv. Integrated Concept

A. Atomic concept

Atomic concept of a subject is an independent, fundamental and unidirectional concept which explains about a single or multiple objects, its behavior or appearance.

These are the concepts of independent significance and existence and are usually understood as an integral part of the process of language acquisition. In engineering, these concepts assist us in the perception and description of other complex concepts. An instructor starts her topic delivery by bridging the existing knowledge of atomic concepts with the other concepts of the current course.

As an example let us consider SET .A set according to set theory is a collection of distinct objects. This is an atomic concept for teaching the subject Finite Automata and Formal languages (FAFL) for undergraduates. SET can be defined using keywords “collection”, “distinct” and “objects”. Here the student should be aware of the literal meanings of these keywords to understand the atomic concept. If the concept of SET is clear for students the instructor can go ahead to deliver on other complex concepts in FAFL.

B. Preliminary Concept

A Preliminary concept can be defined or expressed with the help of one or more atomic concepts along with other keywords. It can take the help of other Preliminary concepts as well. Preliminary concepts are like building blocks of a course. As an example let us consider an alphabet in the context of Finite Automata. We define an alphabet as a finite set of input symbols.

Here the SET and INPUT are atomic concepts and the “finite” and “symbols” are the keywords. We are able to express a preliminary concept of the course with the help of Atomic concepts along with other keywords. With this, students can easily understand and appreciate the necessity existing knowledge to gain new knowledge.

C. Composite Concept

Composite concept is a complex concept compared to atomic and preliminary concepts. A composite concept of a course is interconnection/composition of more than one Preliminary concept along with atomic concepts. These concepts form the topics of the course. These topics are usually listed in the syllabus and the lecture plan.

For the course FAFL we choose the concept Deterministic Finite Automata (DFA) as an example. The composite concept Deterministic Finite Automata is composed of preliminary concepts such as, the formal definition, DFA and strings, extended transition functions and Language of a DFA.

DFA is composed of preliminary concepts and atomic concepts. The concept map for DFA is as shown in the figure3.1

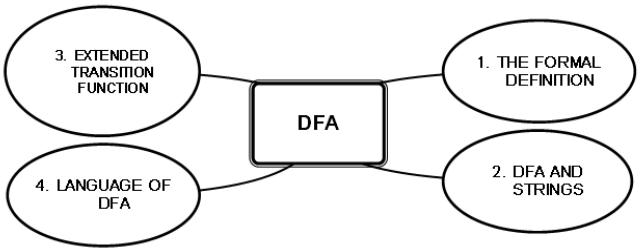

Figure 3.1Concept map for the composite concept DFA

D. Integrated concept

An integrated concept can be defined as a composition of more than one composite concept. Each

integrated concept is a group of interrelated composite concepts. The integrated concept forms the module of the course. A group of interrelated integrated concepts form a course. The interrelations between concepts will be discussed in the next section.

As an example consider a module, Finite Automata. It has composite concepts like

- Deterministic Finite Automata(DFA)
- Non Deterministic Finite Automata(NFA)
- Finite Automata with Epsilon transition(ε-NFA)
- Applications of Finite Automata.

All the above composite concepts together form an integrated concept. Each integrated concept must be independent of the other integrated concept. At certain cases the relation between two integrated concepts must just be a prerequisite. This type of relation helps us to decide or draw a boundary for an integrated concept (i e... topics in a module) and the order of the course delivery. If an integrated concept is totally independent from all other integrated concept then that module can be scheduled at any point of time. Suppose consider an integrated concept A, and A is not depending on any other concept but in turn another integrated concept say B is dependent on the concepts of the A , then A should be delivered before B . Like this the concepts and its dependency can help the instructor to order the delivery. The concept map for the integrated concept is as shown in the figure 3.2

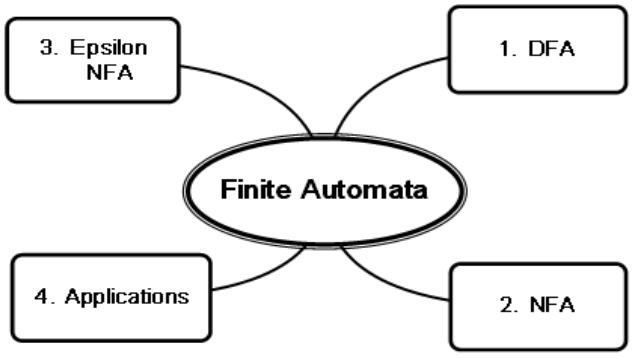

Figure 3.2 Concept map for the Integrated Concept :FA

IV. RELATIONS

Nodes in the concept map are connected to each other through arcs .This connectivity represent some relationship between two nodes(concepts).We propose two types of possible relationships between the connected concepts as follows.

- Hierarchical Relationship
- Horizontal Relationship

A. Hierarchical Relationship

The concept map is hierarchical in structure, so there is a hierarchical relationship among the super and sub concept. The concepts which are in the intermediate level are the composition of more than one concept in its lower levels in the hierarchy. The leaves are always the atomic concepts which are independent and the root or the central concept is the course title or the main idea. Concepts at each higher level are the super sets of all the concepts at the lower level till the leaves which are connected to it. Here we can observe that a single Preliminary concept can be related to more than one composite concept and single composite concepts can be related to more than one integrated concept.

More precisely an atomic concept is hierarchically related to one or more preliminary concept, a preliminary concept is hierarchically related to one or more composite concept and a composite concept is hierarchically related to an integrated concept.

B. Horizontal Relationship

Any two concepts at the same level of the hierarchy can still be related to each other. This type of relationship can be defined as horizontal relationship. Consider a concept say X which is a composite concept of a particular module say A, this concept X is used to define another composite concept say Y of another module say B, at this stage the X which is composite concept in A will become a preliminary concept in module B. This implies that the concept X is delivered before Y is delivered. Therefore there is a linear and absolute difference in hours between delivery of the concepts X and Y. We term this relationship as horizontal relationship. This horizontal relationship is extended to the delivery of modules A and B as well. That is Module A has to be delivered before module B**.**

C. Some special relations

At times, a single concept can be overlapping among modules. This is treated as redundancy. At these situations the ordering of topics might lead to ambiguity. A special concept like this can be considered with highest complexity when it is delivered first time and when later referred should be considered as lower complexity in the hierarchy.

Consider a concept say P, which is a common concept in two modules C and D, it is a preliminary concept in module D and composite in module C, here module D is delivered after module C. If the instructor reorganizes his delivery based on this, the students can refer the topic already delivered as a prerequisite for the current concept and can prepare accordingly. This notion should not be mistaken with the first occurrence of the term but the first occurrence of the concept.

V. The CONCEPT MAPS AND LECTURE PLANNING

An instructor has to provide the lecture plan before the commencement of the course. She can develop a single concept map for the entire course before preparing the lecture plan and provide these as deliverable to the students. In this Single concept map, the main idea will be the course title. the modules which are the integrated concepts will be in the level 1 of the hierarchy, the topics which are the composite concept are at the level 2 in the hierarchy, the sub topics which are the preliminary concepts of the course at the level 3.The atomic concepts are not added to the concept amp but listed in the

lecture plan. When such a map is constructed it includes all the hierarchical relationships as described in the previous section. Now the horizontal relationships between concepts of the same module or different module have to be identified and added to the concept map. The concepts have to be numbered based on dependencies. Based on the numbering, the instructor has to order the delivery and prepare the lecture plan. The macro map [3] of the concepts in the course FAFL is as shown in the figure 5.1.The dependency between each module is highlighted with directed arcs. The numbering of the integrated concepts is done based on these dependencies.

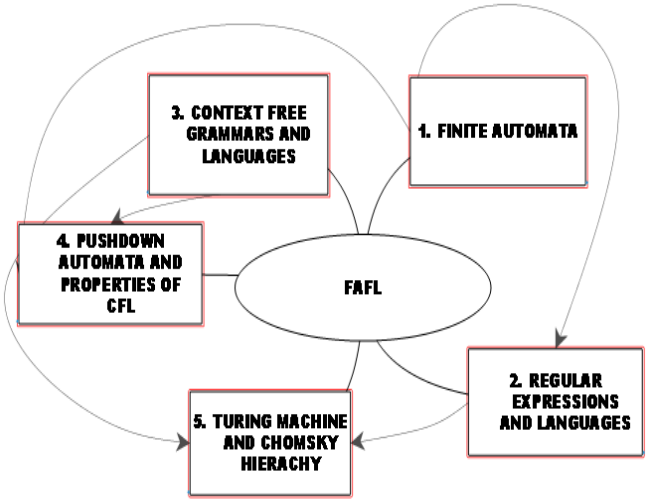

Figure 5.1: The macro map for the course FAFL

One of the integrated concept Finite Automata is zoomed and is as shown in the figure 5.2. Such a map is called micro map [3]. The connecting phrases are hidden to bring more clarity in the maps. This concept map includes all the hierarchical relationships by default without direction and all the horizontal relationships with direction indicating the dependency in delivery.

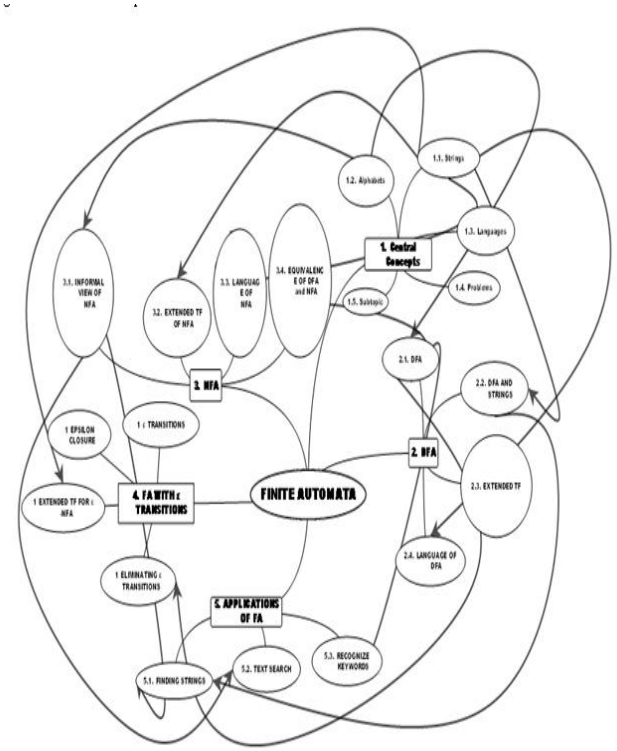

Figure: 5.2 The micro map of the integrated concept Finite Automata

The horizontal and hierarchical relationship shown in the concept map of Finite automata a can be shown as a part of the lecture plan. This is as shown in the table 5.1.This table is constructed for the integrated concept Finite Automata. This method can be extended to all the integrated concepts of the course. This lecture plan shows that the integrated concept (module) of the course Finite Automata will be delivered in 8 hours. It lists all the composite concepts, preliminary concepts and atomic concept in it. The horizontal relationships in the concept map are shown as pre-requisite topics in the table. The atomic concepts required are listed for each composite concept.

Table 5.1: A concept map based lecture plan for Finite Automata

Class number	Integrated concept: **Finite Automata**(Module 1)		Total number of classes:8	
	Composite concept	**Preliminary concepts**	**Pre-requisite concepts**	**Atomic concepts**
1	Central Concepts of Automata Theory	Alphabet Strings Language Problem	----	Set Input Finite Power Identity Epsilon
2 3	Deterministic Finite Automata(DFA)	Formal Definition of DFA DFA and strings Extended transition function Language of DFA	Strings Language	State Start state Final state Accept string Reject string
4 5	Non deterministic Finite Automata(NFA)	Informal view Formal definition Extended transition function Language of NFA NFA to DFA	Strings Language DFA	Null Power Set Start state Final state
6 7	Non deterministic Finite Automata(NFA) WITH ε transitions	ε- transitions ε-closure Extended transition function Eliminating ε-transitions ε-NFA to DFA	Strings DFA NFA to DFA	Epsilon Power Set
8	Applications of Finite Automata	Text Search Recognizing keywords Finding Strings in Text	DFA NFA Strings	-------

VI. APPLICATIONS

A. Benefits for the students

This type of single concept map can give a lot of information visually to the students when students have it in hand before the commencement of the course. Some of the benefits what students can get from this are as follows

- Student can become familiar (in the context of the course) with the keywords and the atomic concepts required for the new course prior to attending the classes to get deeper understanding of the concepts delivered.
- Student can use this concept map as a revision tool to revise the concepts.
- The pictorial representation of topics along with the dependencies will bring better understanding in the students.

B. Benefits for the instructor

If an instructor builds a lecture plan after building a concept map for the course, she can get the following benefits

- The lesson planning becomes easy to order the concepts based on their dependency than just as listed in the index of the textbook prescribed.
- The instructor can highlight the importance of the basic concepts of the prerequisite topic from a prerequisite course as well as from the same course.
- The students can understand how important a concept is for his understanding of the course as a whole and can pay enough importance to central concepts of a course,
- The instructor can align the syllabus by restructuring the modules/integrated concepts based the delivery and dependency of the topics.

VII. CONCLUSION

In this paper we have made an attempt to split the generic term concept to four categories as atomic concept, preliminary concept, composite concept and integrated concept, and proposed a customized concept map showing the dependencies of the concepts. We have defined the possible relation between the concepts in hierarchical and horizontal direction. We have given a sample concept map for a subject FAFL and shown the dependencies on the concepts of different complexities. We have showed that when a lecture plan is developed by first building a concept map for any course the planning will be effective and can bring more meaningful learning among students.

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