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The Design of Academic Scheduling System Using Software Intelligent Components

Ibrahim Albidewi* Hani Alabadi
Faculty of Computing and Information Technology, King Abdulaziz University, PO box 80221, Jeddah, 21589, Saudi Arabia

* E-mail of the corresponding author: ialbidewi@kau.edu.sa

Abstract

The design of academic scheduling is considered a debatable issue that arises at the beginning of every term, whether the educational entity is a school, an institute, or a college. The debate lasts until the middle of the term, or, at times, to the very end. Solving the problem entails examining all the issues related to the teaching schedule. These include determining the conditions, priorities, and restrictions, which are programmed to produce the ideal schedule that realizes the educational institution's ambitions. This study deals with designing teaching schedules for educational institutions by using the recent technology of software intelligent components to develop systems and schedules in various fields.

Keywords: Academic Scheduling, scheduling system, software components, intelligent components.

1. Introduction

The design of the teaching schedule for any educational institution is governed by three main perspectives. The first is the 'teacher.' The number and order of classes in the teacher's schedule is considered one of the most important factors that need to be dealt with in detail. It has been noticed that in some schools the teachers are assigned a teaching load of four or five consecutive classes per day. This results from lack of coordination in the process of designing the schedule, which cannot be harmonized except by using computers. The second perspective is the 'subject.' The subject itself and its characteristics are important in terms of the students' abilities to comprehend the material. For example, some schedules show that science subjects such as mathematics or physics are assigned at the end of the teaching day, whereas humanities' subjects, which rely on reading or narration, such as literature or history, are given the priority by being assigned at the first or second periods. This reflects negatively on achievements. The relationship between the understanding and comprehension of the material taught and the time the class is scheduled represents the third perspective. In this instance, we are faced with the main scheduling problem that cannot be resolved unless we know all the details included within the three interrelated perspectives (as shown in figure 1). The basic required principles to produce the schedule that assigns classes and subjects with minimal possible shortcomings are determined by studying the three perspectives, identifying the conditions included in the policies and by-laws, and consulting experts in the field (Ajanovski, 2013; Pinedo, 2012).

In this field, there are several systems specialized in schedule design. These depend on individual discretion and do not usually satisfy the requirements of the educational institutions (Genesereth, 1993; Mili, Marcotte, & Kabbaj, 1994; Choi et al., 2012). By adhering to follow the rules and procedures detailed in this research, all shortcomings can be avoided, and the teacher's performance and student's learning can be enhanced.

There are several requirements to develop this system, most important of which are inputting the number of teachers, their names, the specifications of the subjects they teach, as well as their teaching load. Then the classrooms' codes are entered so that the system can analyse the priorities according to the subject specification and teachers' teaching load, especially in cases where classes are taught consecutively. The system distributes classes to teachers automatically after the classrooms' numbers are entered. It determines allocation of the daily number of teaching hours for a certain subject, subject priorities for distribution, the number of hours a subject is taught weekly, and the maximum number of consecutive teaching hours to be assigned for each teacher. The system also specifies times of first classes, breaks between classes, class durations, lunch and prayer breaks, and extra-curricular activities (if required). Other requirements are avoiding conflicts such as allocating two classes to the same teacher at the same time, or simultaneous assignment of two different subjects to a class.

The system caters for some exceptions such as considering the availability of a certain teacher who has commitments such as travel, study, or any other commitment. It produces several reports most important of which is the main schedule which shows the names of teachers, the subjects taught by each teacher, as well as daily and weekly allocations of classes to teachers.

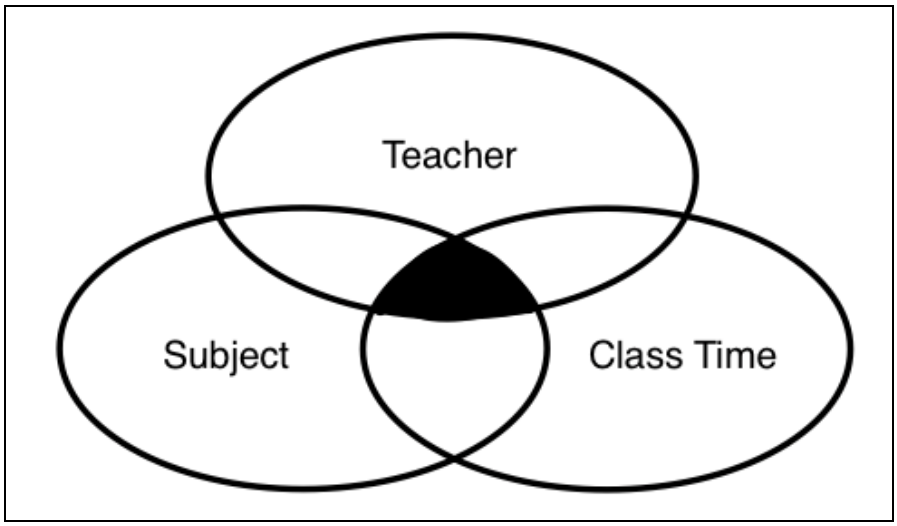


Figure 1: The three main perspectives.

2. Literature Review

The educational institution goes through painstaking efforts, especially at the beginning of the school year, to prepare the teaching schedule which usually consumes a lot of time and effort. Usually a committee of the principal, his assistant, and some other teachers is formed to perform the task. Using the computer in designing the schedule saves a lot of administrative time and effort. It facilitates the production of various versions of the schedule, taking into consideration the teachers' time factor, extracurricular activities, education television sessions, labs, library hours, and any other arrangements specific to the situation. Modifications can be readily effected when required in cases such as transferring a teacher, adding a subject or a class, or adjusting the institutions' organizational structures. Utilizing the computer in this field enables the head of the institution to monitor and follow up teachers' attendance, their performance of their academic duties (Rettig, 2013; Wei, & Ma, 2014).

Intelligent components are of great importance. Used in programming, they are considered part of recently developed technology for building systems. This is due to the advantages it enjoys, most important are being user-friendly, low in cost, and easy to access since it relies on intelligent components. Thus, the user can benefit from one application or more by connecting the text writer he/she wants to the intelligent components used for that application in a short time due to its availability in specialized libraries. Another advantage that distinguishes intelligent components is that in the development process distributed applications and undistributed ones do not overlap while processing. This is because the distributed application is composed of a group of components in separate locations (Rogerson,1997; Wooldridge, Jennings, 1995).

3. System Design

In this research, intelligent components technology is used so that the machine produced schedule is suitable for all school's stages. When we look at the general framework of the system, we can see how data is transferred then processed, and at last, the final outcome is produced. Components' details, interaction, and the intelligent aspect of the system will be dealt with later in the study. First, the part responsible for processing considers the previously inputted priorities as shown in figure (2) below. The first stage is characterized by having a few conflicts that occur during the operation. The second stage, in which some priorities are reconciled, is one in which the operation is incapable of producing the best schedule without overriding these priorities. This takes some time, for the user may have to wait for the output. However, the result after this short delay is the final schedule. In the third stage, where primary priorities are in conflict with the rules that create the schedule, the system may operate in a vicious circle and accordingly does not reach a solution .To avoid this critical stage, all inputs need to be studied and re-entered carefully so that the program can make the best decision and, hence, produce the ideal schedule. The change is effected by increasing the number of teachers, cancelling some classes or overriding some conditions.

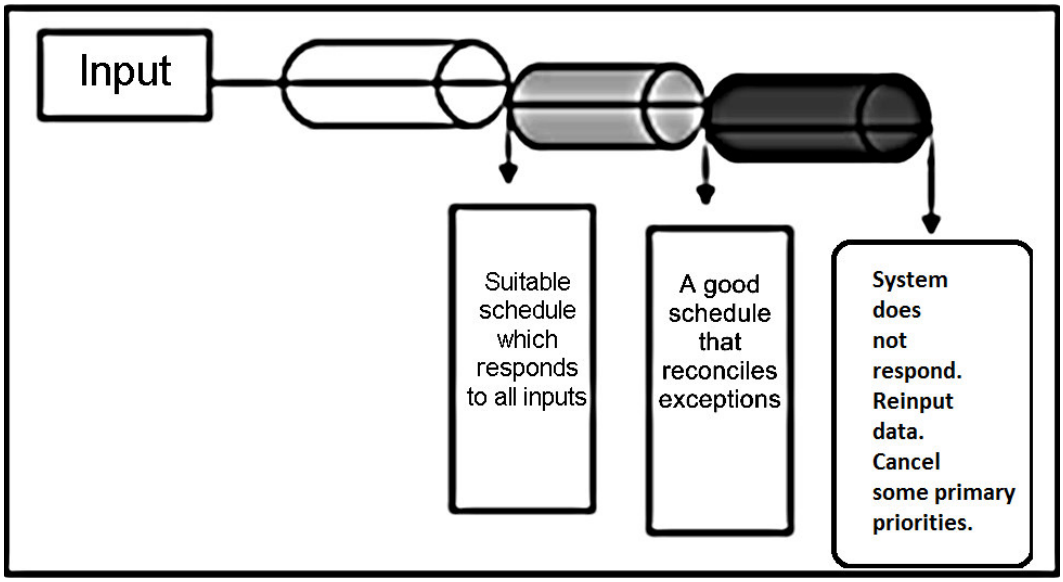


Figure (2): Mechanism of Input Processing

There are several components that control processes in the system. The most important component is the one responsible for filling in the schedule where it adheres to certain rules and primary priorities and exceptions. Primary priorities result from study and analysis while exceptions result from entering some changes and/or assign privileges for subjects, teachers, or classrooms. Figure (2) shows data input, storage and processing in accordance with priorities and then the schedule as an output.

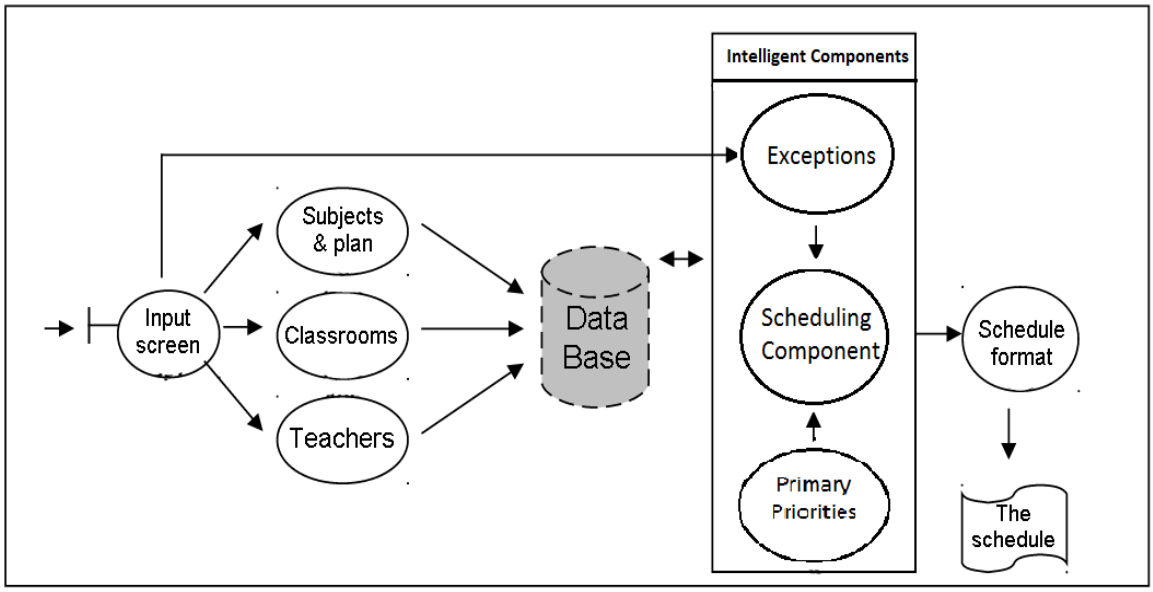


Figure (3) :Intelligent Components in the System

The processing stages illustrated in the previous figure are:

One: Data Entry Stage

The data entered include subjects, the weekly number of classes for each subject, the classrooms assigned for each level and finally, the teacher's name, teaching load and the subject(s)and sections he/she.

Two: Primary Priorities

Based on analysis of the findings of a questionnaire conducted at a group of schools, primary priorities are:

1.There should not be a conflict by assigning two classes to the same teacher at the same time.

2.There should not be a conflict by assigning to different subjects for the same class at the same time.

3.The system should not assign more than four consecutive classes to the same teacher.

4.A subject should not be assigned twice in the same day except for subjects that are assigned two consecutive sessions per day, or those that are assigned more than five sessions per week.

Three: Exceptions

These are determined and entered by the user. They include:

1.Identifying teachers who are loaned (seconded)

2.Identifying teachers with time restrictions, such as hospital appointments, so that lessons of those teachers are not scheduled at those times.

3.Exceptions to facilitate allocation of more than one subject to one teacher.

Four: Intelligent Component

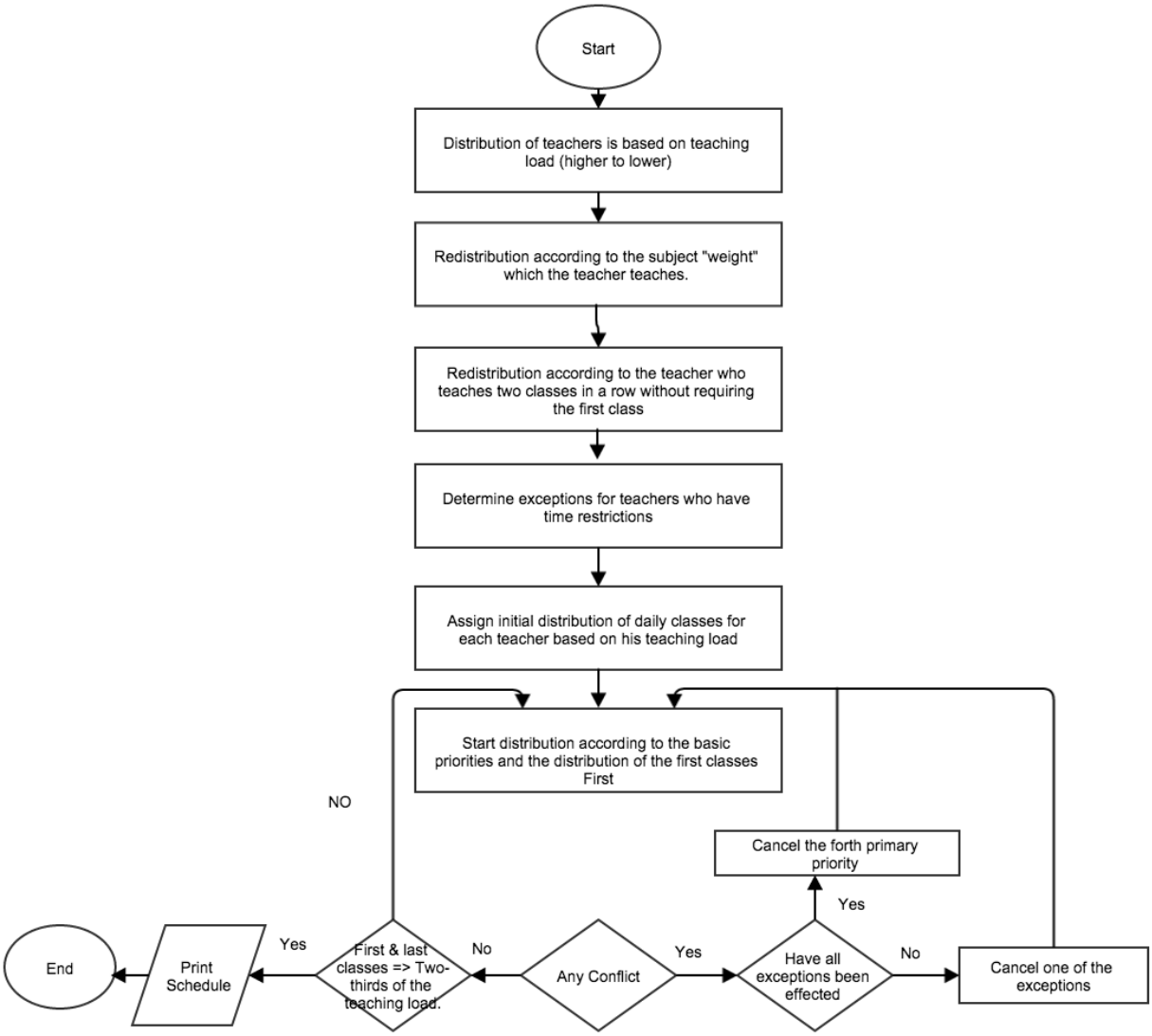
“Intelligent component” is the program responsible for the data scheduling process before the final format is produced. Modelling in this stage depends on some steps. These are distribution of names of teachers based on teacher’s load in descending order; then rearrangement of names according to subject "weight" taught by the teacher. Exceptions are also considered to determine critical class times for each teacher. Teachers who teach two consecutive classes are given priority when classes are distributed. The priority to assign early classes is not stated as a condition but the teacher can be assigned first and second classes for each level in a term (Guilfoyle, & Warner, 1994). The program at first assigns the first, second or third class to the teacher daily according to the classes he teaches. Then it distributes classes to teachers as per sections and classrooms while always referring to the primary priorities. However, the fourth priority can be reconciled if the produced schedule shows conflict only.

The program allocates first classes to teachers who have the highest teaching load, then moves down to the lowest. The higher the teaching load and the more "weight' a subject has, the more first classes are assigned. “First classes” here means the first to the fourth periods. The program must also consider the percentage of first classes a teacher has. This should not exceed two-thirds of his teaching load. Similarly, the program must consider the percentage of "last classes" ensuring that they do not exceed two-thirds of the teaching load. Finally classes are redistributed by ascending or descending order. The program assumes a preliminary distribution of the teacher's weekly teaching-load and determines the daily maximum number of assigned classes, as shown in figure (4).

Sunday	6	6	6	5	5	5	5	5	4	4	4	4	4	3	3	3	3
Monday	6	6	5	5	5	5	5	4	4	4	4	4	3	3	3	3	3
Tuesday	6	5	5	5	5	5	4	4	4	4	4	3	3	3	3	3	2
Wednesday	5	5	5	5	5	4	4	4	4	4	3	3	3	3	3	2	2
Thursday	5	5	5	5	4	4	4	4	4	3	3	3	3	3	2	2	2
Teaching Load	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12

Figure(4): Weekly Class Distribution asper Teaching Load.

The number of classes to be taught daily does not necessarily need to be ordered chronologically. Two values belonging to two different days can be rotated. For example, six classes in one day can be rotated to another day, whose numberof classesreplaces those rotated on condition that such rotation does not affect the weekly totalload. The idea of the intelligent component is illustrated as a flow chart as shown in figure (5).



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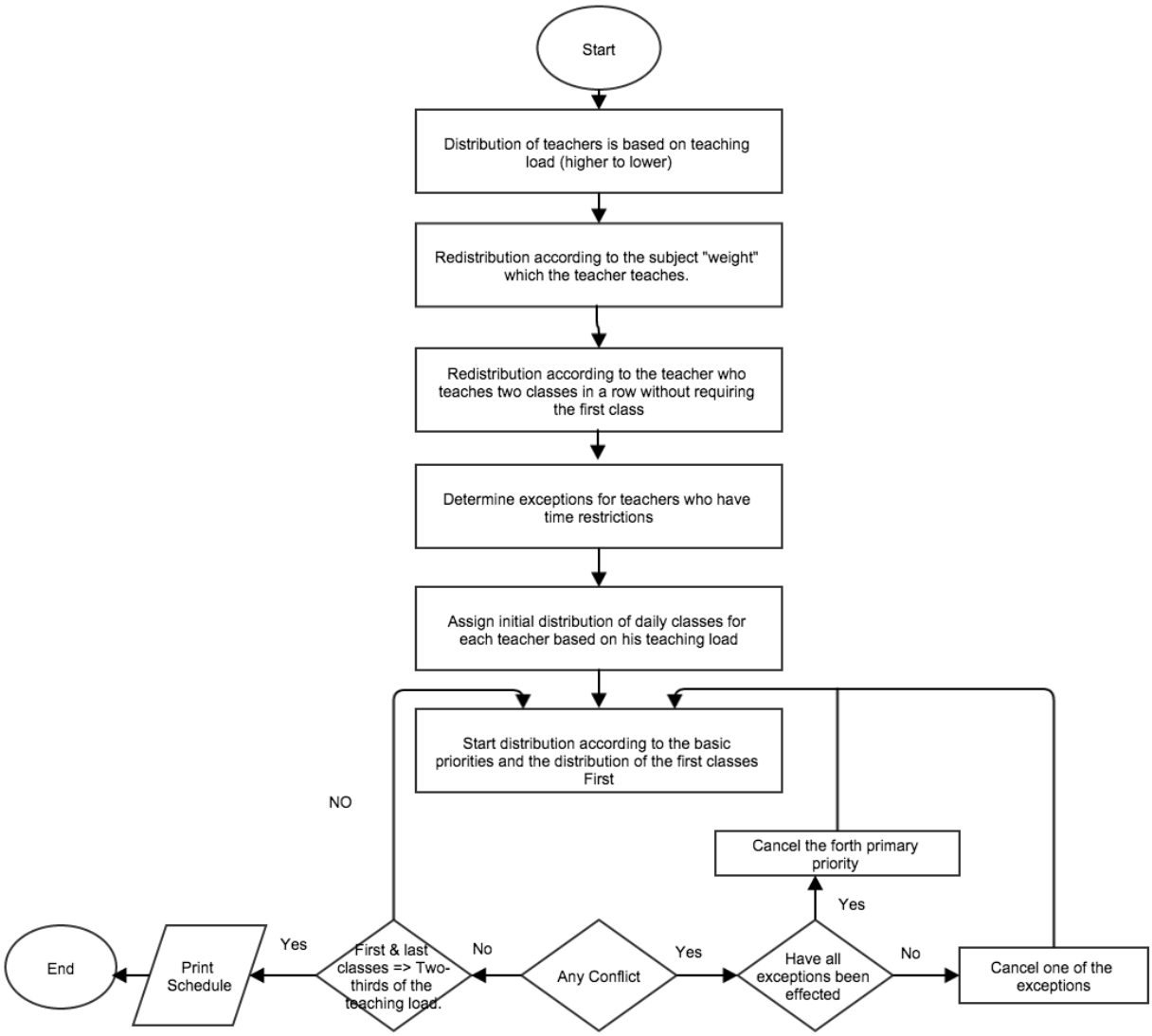


Figure 5 :Program's Flow Chart.

As Figure (5) above shows, the program is flexible for it can bypass some problems related to the nature of the inputted data that may arise during processing. The flow chart exhibits the basic queries which the program seeks answers for from the data stored during processing. This happens to modify the processed models of the schedule and eventually produce the desired format. The below interaction diagram, illustrated in figure (6) details the program operation. Data are entered and stored in a database upon which the scheduling component processes these data and produces the required final schedule.

The system distinguishes itself by its ability to utilize the features of intelligent components and hence function as an independent processing entity, for example, its ability to interact with any educational level and its capability to apply certain rules that depend on intelligence. When a human designs a schedule, he/she is faced with conflicts or errors pertaining to those situations, but using his intelligence enables him/her to solve problems. This is what we aspire to achieve. We aim at developing a system that has developed intelligent components that can design a schedule without making any mistakes that reflect on the quality of the final product. Figure (6) shows the link between the intelligent component and the database where a series of processes related to distribution or ordering followed by another series of queries and so on. Ordering of sessions in the teacher's schedule is affected by assigning classroom numbers to the times of classes in accordance with the primary and added priorities. "Queries" is the stage in which distribution and redistribution are affected to achieve the ideal schedule. Thus, this stage is considered the most important and delicate one in the mechanism of the system operation. At the end of the ordering and query processes, the final schedule is produced and

displayed to the user so that he/she can add the final touches. These include the schedule format showing class assignments in a teaching day, breaks between classes, prayer, launch and dismissal time.

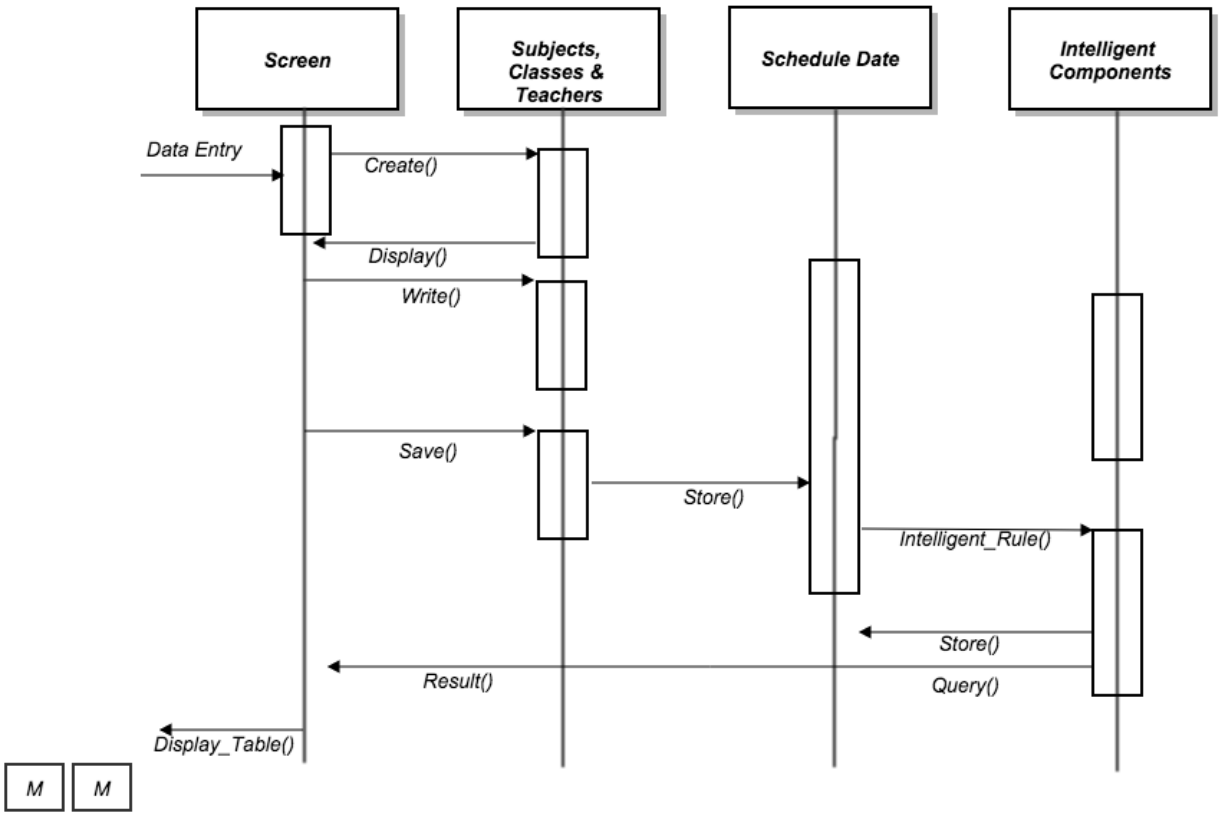


Figure (6): Interaction Diagram

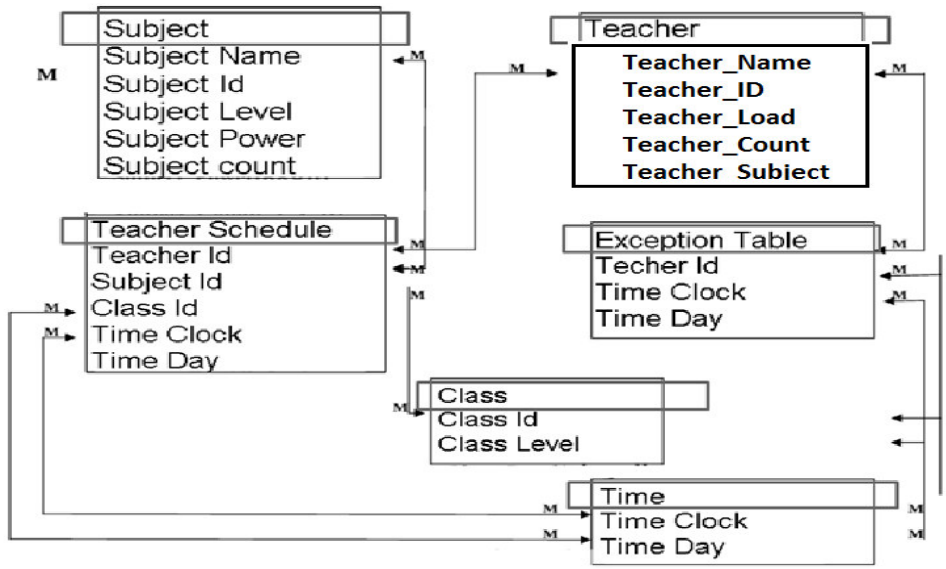
"Intelligent components" means the conditions that govern the pre-sets priorities in the schedule distribution stage and how some of these priorities can be either reconciled or kept based on the system's operation and its requirements. These rules that are based on " What-if?" conditional clauses satisfy the user's needs and coordinate among priorities according to their importance and the nature of the data entered into the database that is linked to the schedule to produce the ideal schedule. The interaction diagram shows how the system manages inputs where data are entered and saved, then how intelligent components govern priorities and conduct queries about these priorities while in the process of ordering and distributing classes and subjects to teachers.

Finally, the final version of the schedule has the names of the teachers, times and days of the classes, section members and subjects and all the information the employee responsible for scheduling needs. Through relations and interactions among areas in the data base, various formats of the schedule can be displayed for, as will be explained in data base design below, a schedule for each teacher can be displayed containing the teacher's data only, that is, the teacher's name, subject and classes. In addition, the comprehensive schedule, which was mentioned earlier, is also displayed showing the names of all the teachers, all classes and all subjects.

4. Database Design

To design the database one should consider all types of schedules and fields and the size of each field. One should build relationships among schedules and link them as shown in figure (7). All the previous contribute to the establishment and design of the database. Hence, its effectiveness relies on the method used to keep the data and conduct queries.

Figure (7): Data Base Relation



It is clear from the data base relation that establishing the system would be difficult without ensuring the accuracy in connecting the schedules and tables and the feasibility of this process. The objective is to produce the teacher's schedule and then the teaching schedule for classes or the specific schedule for each class. The system produces six schedules. The first one is the teacher's schedule that shows the teacher's name, his number, teaching load and the number of subjects he teaches. The second is the subject schedule that shows the subject name, number, load, level, weight or power, and subject frequency in the same day for the same class. The third is the class schedule that shows the level/section this class is assigned for. The fourth is the times schedule which details subjects' times and dates. Then, there is the exception table that shows the teacher Id, the time the subject is taught and the day that the teacher has as an exception. Finally, the final version of the teacher's schedule, from which the teaching schedule is prepared, is produced. In order to view the system in a comprehensive manner, we need to consider the primary priorities that haven't been illustrated in a table in figure (7). These can be listed, though, as programs using the "What-if" conditions as previously explained in a flow chart.

5. Conclusion

Since the system is thoroughly analysed and designed, we have a document that can be used to create a comprehensive system for creating the teaching schedule while avoiding problems related to scheduling mechanism and method of distribution. Accordingly, the program can be developed and the feasibility of disseminating it to all educational institutions using this system is viable to better serve the educational process by producing an error free teaching schedule in a timely manner.

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