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Redesigning the Schedule Time Slots for Qatar University to Cope with Local Specificities

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Abstract: This study is concerned with the redesign of the class meeting pattern at Qatar University. It examines the existing meeting pattern based on its operational efficiency, its alignment with the strategic plan of the University, and its perception by the students and the faculty members. The analysis reveals serious limitations and shows the need for a new pattern with a full non-teaching day and no one-hour lectures. A capacity analysis proves the feasibility of such a pattern. Taking into consideration the specifications of the Qatari society, it was judged that the non-teaching day be split in two-half days. The present research recognizes the distinction between scheduling and class meeting patterns and aims to address the under-researched theme of having the meeting pattern as a variable rather than just an input to scheduling.

Keywords: Class meeting pattern; time slot/block; course/class scheduling/ timetabling; higher education.

I. INTRODUCTION

A course schedule (also referred to as course timetable, class schedule or class timetable) is a table assigning a group of students and a teacher to one room and one time slot (also called period or block); it may also include more details such as the subject of the class, and the type of classrooms available (e.g. science laboratories). A time slot is a block of time allocated for one class and defined by specific instructional days of the week as well as specific start and end times on each day. The set of all possible time slots for the full week is referred to as meeting pattern. The meeting pattern, which is one of the most important inputs for any course schedule, is a template that defines all possible time slots where a course can be scheduled. Figure 1 shows the current meeting pattern of the University subject of this study, which is composed of 19 time slots. The meeting pattern determines the length of the lecture and the number of lectures per week by determining the possible location of each lecture within the days of the week and within the hours of the day.

Traditionally, a three-credit semester-based course includes approximately three hours of classroom instruction per week. These three hours can be effectuated in just one long session (of three hours), or alternatively spread over two days (with the length of the lecture being one hour and a half) or even three days (one-hour lecture each day). Each university designs its own pattern taking into consideration its own preferences and its own constraints.

It is likely that an adequate course schedule will impact students' performance and satisfaction. The beneficial outcomes of robust and efficient class schedules have been consistently ascertained in the literature. The reported benefits include: (i) increasing flexibility in staffing and minimizing slack in operational resources (Boronico, 2000), (ii) enhancing students' performance (Hughes et al., 2008; Dills and Hernandez-Jullian, 2008), (iii) contributing to increased students' attendance rates (Marburger, 2006; Romer, 1993), (iv) increasing retention rates while decreasing courses' drop rates (Ali et al. , 2004), and (v) decreasing students' attrition (Becker and Powers, 2001) to list few.

In this research, we recognize that a meeting pattern affects the quality of the generated class schedule and, therefore, indirectly impacts students' performance. We attempt to address the indirect link between class meeting patterns and students' performance and reinforce the idea that a meeting pattern is an important input for generating an effective class schedule. The research question for the present study is how to develop a better class meeting pattern for Qatar University that is geared to overcome any existing inefficiencies. A relevant debate to our discussion then is how the three hours of class room instruction are to be distributed weekly in order to optimize learning and meet the scheduling preferences of students (Reardon and Galindo, 2009). The present study additionally aims to investigate the existing meeting pattern at Qatar University in order to assess whether it is aligned with the University's strategic direction. A series of research objectives are set to identify alternative class meeting patterns that respect the specifications of the Qatari society without jeopardizing the University's capacity and quality constraints.

It is worth mentioning that the decisions related to the design of the meeting pattern are high-level (strategic) decisions that cannot be made at the same time as the traditional scheduling decisions (e.g. the assignment decisions) which are low-level (tactical decisions). The meeting pattern is an input for the schedule. However, its effect is so significant on the schedule that it is supposed to be the output of another study aiming at generating the most suitable pattern for the university. Unfortunately (as will be shown later when reviewing the related literature), the studies on meeting patterns are very scarce in the literature. This study is an attempt to fill the gap.

II. RELATED LITERATURE

In this section, we will first give an outline of the theoretical conceptualization of course scheduling and the technical perspectives prominent in the literature. Next, we will provide a brief outline of the two dominating views with respect to the issue of having short versus long classes. The last part will include an overview of the different studies which aim to present meeting patterns within different education contexts.

Course Scheduling

Course scheduling in an educational institution is a major administrative task (Burke and Petrovic, 2002). It is defined as the determination of which courses are taught at what days and times, in which rooms, and taught by whom (Thompson, 2005). Course scheduling has been the focus of operations research and artificial intelligence for more than 40 years (Alvarez-Valdes et al., 2002). The extant literature primarily focuses on addressing the technical aspects of the scheduling problems and how to employ mathematical methodology, technical software and problem solving techniques to address scheduling related issues.

Dimopoulou and Miliotis (2001), Daskalaki and Birbas (2005) and MirHassani (2006), among many others, applied integer programming techniques. Valouxis and Housous (2003) used constraint programing, Stallaert (1997) and De Causmaecker et al. (2009) applied quadratic optimization

techniques, de Werra et al. (2002) applied edge coloring, and Beynon et al. (2002) applied empirical modelling. Solution method related researches include applying heuristics to scheduling (Abramson, 1991; Alvarez-Valdes et al., 2002; Dowsland, 1990), genetic algorithms (Burke et al., 1994;), neural networks (Foulds and Johnson, 2000; Smith and Ng, 2003), Tabu search algorithms (Hertz, 1991), and simulated annealing (Cangelovic and Schreuder, 1991). Exploring the technical methodologies in details is outside the scope of the present study, but the briefly-presented summary above outlines the earlier research contributions of operations research scholars.

It is worth mentioning that the previous studies have considered meeting patterns as given constant inputs to scheduling; no research (to the best of our knowledge) considers meeting patterns as a research variable.

Length of Time Slots

In this subsection, we briefly present the literature on the length of time slots, which is concerned with the advantages and disadvantages of long and short classes. Even though such a literature does not explicitly refer to class meeting patterns, it is actually an integral part of it.

Advocates of long meeting patterns attribute the benefits of this approach to concentrated teaching and overall in-depth study for students as it allows for more efficient assessment especially with oral skills (Dexter et al., 2006). Additionally, Johannsson and Lorenz (2001) ascertain that long meeting patterns allow students to benefit from enhanced learning experience and higher levels of proficiency since long meetings enable the use of active teaching and allow for greater student involvement. Lee and Genovese (1988) conclude that implementing long meeting sessions in education organizations significantly reduces the number of class assignments and the fragmentation in traditional schedules; fragmentation is an issue for classes requiring extensive practice and laboratory work, such as science, agriculture, and technology courses. Opponents of long meeting patterns, on the other hand, draw on its weaknesses. Rettig and Canady (1996) highlight that the main disadvantage pertains to the extensive need for education facilities, while Dexter et al. (2006) ascertain that students may lose interest and concentration. Bateson (1990) reports no significant difference in students' reported scores of GPA and other direct assessment measures to justify the increased costs and resources.

A parallel stream of research pertains to exploring the strengths of short meeting patterns. This approach involves spreading out learning into periods of shorter duration but increased frequency. It is suggested that the key advantage of this approach entails improving skill acquisition (Lee and Genovese, 1988). In contrast, its weaknesses include significant cost disadvantages and misuse of resources due to frequent meetings (Willingham et al., 2002). In their study, Rettig and Canady (1996) point out that instructors reject the short meetings approach for the simple reason that after undertaking administrative duties, including taking attendance and allowing for few minutes for late comers, the duration of the lecture would not be sufficient to cover the new knowledge that is expected to be delivered by the instructor.

The ultimate research on the two streams outlined previously has given rise to studies investigating the *spacing* effect in education. This approach, which attempts to align, relate, or integrate new knowledge to prior knowledge, has been advocated as an effective technique in promoting long-term memory storage. It occurs when learning and practice sessions are spaced out or distributed over a period of time. Gallo and Odu (2009) stipulate that the spacing technique is more advantageous than compressed sessions. Toppino and Bloom (2002) reconfirmed that the spacing effect "enhances memory performance".

Meeting Patterns

To the best of our knowledge, there is scarce research literature pertaining to meeting patterns. Scheduling related studies do not attempt to design a meeting pattern to be used in developing a course schedule. In general, research on designing meeting patterns is lacking in the literature. Limited research has opted to present pattern solutions or practical recommendation. The only research studies that we were able to identify are presented in this subsection.

There is no clear distinction in the literature between investigating meeting patterns and class scheduling. Most existing studies typically address the effect of class scheduling on students' performance. However, some of these studies are actually tackling the meeting pattern while referring to it as class scheduling; in particular, Dills and Hernandez-Jullian (2008) explored whether students' learning depend on class scheduling and if it is more efficient to have classes in the morning than later in the day, while Dexter et al. (2006) study investigates whether students learn more when classes meet more often.

The study of Boronico (2000) on undergraduate and post graduate students at the three departments in the Business Administration School at Monmouth University presented a model that relied on hierarchical programming and developed a pattern excluding classes on Fridays and Wednesdays. The benefits identified from the proposed scheduling are flexibility in staffing and minimum slack in University's operational resources. This study advocates that the proposed pattern comprehensively addresses students' demand and conflicts and achieves higher levels of uniformity across departments.

Foulds and Johnson (2000) implemented a slot manager modelling written in Microsoft Access to develop a course scheduling solution at New Zealand University (Waikato Management School). Their study designed a slot manager to aid course schedulers in allocating courses to feasible slots and rooms. Although, they do not provide details in their research about the applied slot pattern, they stipulate that it has been implemented for more than 3 years and has significantly reduced the efficiency of record-keeping and the generation of conflict-free schedules.

The study conducted by Dimopoulou and Miliotis (2004) at Athens University outlined a pattern for compulsory and optional courses where student schedules are patterned to take place on three days and half every week with sessions' timings organized as block slots of two. The identified pattern was implemented on Mondays, Wednesday and Thursdays (9:00 am – 3:00 pm) and on Tuesdays and Fridays (3:00 pm – 9:00 pm). The University's premises were divided in two zones (A and B) with timings alternating between the two zones to avoid conflicts and congestion. The study concludes that the concentrated scheduling system offers flexibility and facilitates the construction of schedules according to pre-determined criteria that are specified by the users. The study reports that the designed system increases reliability as well as the efficient and effective sharing of data by users in different departments.

Dills and Hernandez-Julian (2008) implement a block schedule pattern to change the earliest class times at Duke University. Students were given the choice between: 1) afternoon classes on Tuesdays and Thursdays and morning classes on Mondays, Wednesdays and Fridays and 2) afternoon classes on Mondays, Wednesdays and Fridays and morning classes on Tuesdays and Thursdays. The results indicates that late afternoon classes are better for 2-day- a-week classes while morning classes are more suitable for 3-day- a- week classes. It is worth indicating here that colleges are scheduling classes on the last working day of the week to increase the utilization of their resources.

The study conducted by Pongcharoen et al. (2008) at the Faculty of Science and Technology in Thailand designs a slot pattern to enable four teaching days considering a set of hard and soft constraints. For scheduling purposes, each day, students are required to attend 12 sessions, 50 minutes each. A meeting pattern was designed and implemented where no classes are taking place on Thursdays and allowing Wednesday afternoons for College's activities. The new pattern was reported to increase the attendance to scheduled meetings and activities.

Oran (2009) research explores course scheduling in Jordanian Universities and advocates the benefits of adopting 90-minute-lecture scheme by alternating implementation of courses' scheduling on even and odd days of the months. The proposed scheme has the advantages of reducing academic years by approximately 40 working days and better utilization of limited resources available to the thinly resourced universities in Jordan. The pattern which the study advocates avails one day for faculty members to schedule non-teaching activities. The study reports large economic benefits as a result of saving on transportation and energy costs.

Hammad (2014) conducted a study on redesigning the class meeting pattern at Qatar University to improve performance. Her work is based on the results of an online survey that aimed to ascertain whether students and faculty members prefer four teaching days instead of five and whether they opt for one-hour rather than one-hour-and-half lectures. The responses collected from 687 students and 119 faculty members show that 83.2% of the students prefer the one-hour lectures over the one-and-half-hour long sessions, while 71.3% of the faculty members prefer the one-and-half-hour lectures to the one-hour sessions. Both students and faculty seem to favor the idea of a full non-teaching day; 82.1% of the students and 93% of the faculty approve of it. Based on the results of the survey, Hammad proposed a class meeting pattern featuring one-hour-and-half lectures, no teaching on Thursdays and no teaching between 12:30 and 2:00.

Although the work of Hammad marked a significant departure, it has some major limitations. The first one is that her questionnaire did not explain to students that they cannot opt for "four instructional days" and "one-hour lectures" simultaneously; as a result the students selected what they judged convenient choices to them without taking into consideration the feasibility of their choices. The second limitation is that the pattern she proposed may not meet the Qatari specificities (as will be shown later in this paper) and may not be realistic (as it decreases the number of slots by more than 26%). A third limitation is the non-robustness of the brief capacity analysis she conducted. Indeed, she did not distinguish in her analysis between pre-5:00pm and post-5:00pm slots (highly varying in their utilization rates) nor did she specify the methodology she used to obtain her projections for the number of students for the years 2014 to 2018. Hammad also failed to show how she obtained the data related to the (actual and projected) capacity that she referred to as the number of seats, and she based her analysis on the years 2010 to 2013, which represent an exceptional growth in the number of students. The current paper, which is concerned with the same problem, aims at dealing with all these limitations.

III. ANALYZING THE EXISTING MEETING PATTERN

The existing meeting pattern of Qatar University is described and analyzed below. As discussed earlier, the meeting pattern has a significant impact on both students and faculty members.

Description of the Pattern

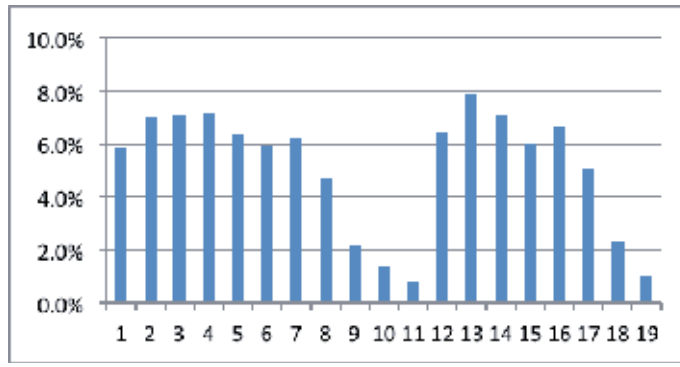
In the fall of 2007, Qatar University established a standardized meeting pattern that has been in effect since then. As per the Class Scheduling

Policy and Procedures Manual (p. 6) issued by Qatar University (2011), the current pattern aims at: i) ensuring the maximum use of instructional week, ii) providing students with a wide range of registration options, and iii) facilitating the utilization of instructional facilities. The pattern, as shown in Figure 1, is composed of 19 possible time slots and entails the same start and end times for each lecture while alternating the occurrence of the lectures every other day. The slots 1 to 6 and 9 to 11 allow one-hour lectures on Sundays, Tuesdays and Thursdays, while the other slots allow one-and-half-hour classes on Mondays and Wednesdays (for slots 12 to 19), or Sundays and Tuesdays (for slots 7 and 8). The break between classes is ten minutes for the one-hour meetings and fifteen minutes for the one-and-half-hour classes, which makes the actual length of the lectures either fifty minutes or seventy-five minutes. Non-teaching slots occur on Thursdays from 2:00 to 5:00 pm.

Figure 1: Existing Meeting Pattern at Qatar University

	8:00	8:30	9:00	9:30	10:00	10:30	11:00	11:30	12:00	12:30	13:00	13:30	14:00	14:30	15:00	15:30	16:00	16:30	17:00	17:30	18:00	18:30	19:00	19:30	20:00
Sunday	1		2		3		4		5		6		7		8		9		10		11				
Monday	12			13			14			15			16		17		18			19					
Tuesday	1		2		3		4		5		6		7		8		9		10		11				
Wednesday	12			13			14			15			16		17		18			19					
Thursday	1		2		3		4		5		6		Non-Teaching Time				9		10		11				

Figure 2: Distribution of the Classes among the Slots



The analysis of the existing pattern is based on the schedules of the last eleven semesters from Fall 2010 to Fall 2016 (excluding summer sessions) provided by Qatar University, Registration Department, Schedules Section (2015). These schedules show that 89.43% of the classes are scheduled in the 14 slots 1-8 and 12-17, while 7.23% are scheduled in the five slots 9-11 and 18-19; the remaining 3.34% are scheduled outside the 19 slots (basically in the non-teaching-time slot). Figure 2 depicts the distribution of the classes among the 19 slots. The figure confirms that the five slots 9-11 and 18-19 are under-utilized; indeed, the classes scheduled in these five slots combined are fewer than those scheduled in slot 13. This perfectly reflects the reluctance on the part of most students to attend classes starting after 5:00pm.

Alignment with the Strategic Direction of the University

Qatar University is the national education institution for the State of Qatar; its mission statement aims to deliver high quality undergraduate and postgraduate programs towards preparing competent graduates who are destined to shape the future of the State. The academic community of the University includes committed academic scholars who teach the offered courses and conduct academic research that contributes to the aspirations and needs of the external community locally and regionally.

As per the University's strategic plan, the key performance indicators of the University are assessed on several anchors including: preparing competent graduates, offering quality education programs, conducting quality research to address knowledge gaps and engaging with the external society to address key community challenges. Assessing the proposed meeting patterns should reflect the same dimensions of the University's key performance indicators. The arguments below highlight some limitations of the existing meeting pattern and indicate that the ensuing outcomes may not be aligned with University's strategic direction.

The faculty members' dissatisfaction with the short one-hour lectures (Hammad 2014) is justified. A one-hour lecture is actually only fifty minutes of instructional time as the students are given a break of ten minutes for each scheduled hour. Typically, ten to fifteen minutes are lost at the beginning of each lecture in such unproductive activities as dealing with late students, taking attendance and reviewing the material covered in the previous lecture (as students are often not up to date). The remaining time from the fifty minutes is too short to cover new knowledge, which may affect students' learning outcomes and inhibit preparing competent graduates as sought by Qatar University.

Another dimension pertains to students' engagement in non-instructional activities such as sports, social and cultural events that aim at engaging students with the external and academic communities. Students' engagement in non-instructional activities is integral to the formation of competent graduates and it contributes to the formation of students' personalities and enhances learning experiences (Hughes et al., 2008; Ream and Rumberger, 2008). However, the non-teaching time slot on Thursday from 2:00 to 5:00, at Qatar University, is too short and too inconvenient to encourage students' participation in non-instructional activities. Actually, common exams, make-up lectures and other instructional activities are usually booked during this non-teaching time slot.

Moreover, with the existing meeting pattern, most faculty members have to teach three, four or even five days a week. Multi-day teaching makes it difficult for faculty to allocate sufficient time to conduct academic research which may conflict with the University's strategic orientation to promote academic research. Multi-day-teaching schedules may also minimize faculty participation in the University's engagement initiatives with the external community and professional organizations.

Finally, a recurring complaint from administrators at the University, College and Department levels is referred to their struggle to find a convenient mutual slot to schedule student meetings, common exams and make-up lectures. The same problem arises when scheduling events (including senate assembly, committees and executive meetings) for faculty members at the University, College, and even Department levels as the identified slots may be inconvenient to some faculty members and may conflict with their pre-teaching commitments.

IV. PROPOSING A NEW MEETING PATTERN

The existing meeting pattern was designed to have the key advantage of utilizing the University's current and planned capacities as well as providing students with greater registration options to ensure flexibility. However, as shown in the previous section, this pattern has developed some drawbacks that affected its operational efficiency and its alignment with the University's strategic plan.

Features of the Proposed Pattern

The limitations of the existing pattern include in particular: i) the negative effect of its one-hour teaching sessions on teaching productivity and educational attainment, ii) the negative effect of its short non-teaching time on students' engagement in non-instructional activities, iii) the negative effect of its multi-day teaching schedules on faculty's productivity in research, and iv) the difficulties it introduces when scheduling faculty and/or student meetings, common exams and make-up lectures.

A straightforward solution to cope with the limitations above would be to replace the three one-hour lectures (of the slots 1-6 and 9-11) by two one-and-half-hour lectures and consequently substitute the three teaching days, Sunday, Tuesday and Thursday, by only two. Such a solution would increase the non-teaching time from three hours to a full day (twelve hours) in addition to eliminating the one-hour lectures (See Figures 5 and 6).

However, extending the non-teaching time from three to twelve hours theoretically means a decrease in capacity from 57 hours per week (the total number of hours covered by the 19 slots in the current pattern) to only 48 hours (57 minus 9), which corresponds to a decrease of 15.8%. A plausible question to raise would then be the effect of such a change on the capacity of Qatar University; that is, would the University be able to decrease its capacity by almost 16%?

Capacity Analysis

Although the expansion of the non-teaching time to a full day will theoretically decrease the capacity of Qatar University by almost 16%, the actual decrease is much less than that. To illustrate the difference between the theoretical decrease and the actual decrease, let us consider the slots 9, 10 and 11; reducing these three slots to only two (i.e. replacing nine hours by only six) will theoretically decrease the capacity by 5% (obtained after dividing 54 minus 57 by 57). However, in reality these three slots are utilized only around 4.27% (i.e. 2.17% plus 1.35% plus 0.75%, as shown in Figure 2), which makes the actual decrease in capacity around only 1.4% (4.27% divided by 3).

Qatar University wouldn't be able to make uneven utilization of the slots if the rooms were fully utilized. Figure 3 shows the average number of hours per week during which each room is utilized for each of the eleven semesters (from Fall 2010 until Fall 2015) while taking into account both the case where all 19 slots are considered and the one where only 14 slots (excluding the five under-utilized slots) are considered. For instance, during Semester 1 (Fall 2010), the rooms were used on average 21.25 hours during the 19 slots and 19.29 hours during the 14 slots; these numbers jump to 32.83 and 25.66, respectively, in Semester 11 (Fall 2015). The chart indeed shows that the utilization of the rooms displays an overall upward pattern during the last seven semesters; the trend is more noticeable when considering all 19 slots, which means that Qatar University started increasing its use for the under-utilized slots.

This is further confirmed by Figure 4 that converts the numbers of Figure 3 into percentage; the utilization hours for the 19 slots are divided by the total hours of these slots, namely 57 hours (19 times 3) and those of the 14 slots are divided by 42 hours (14 times 3). The increase of the utilization rates for the 19

Figure 3: Average Weekly Utilization of the Rooms in Hours for the Eleven Semesters

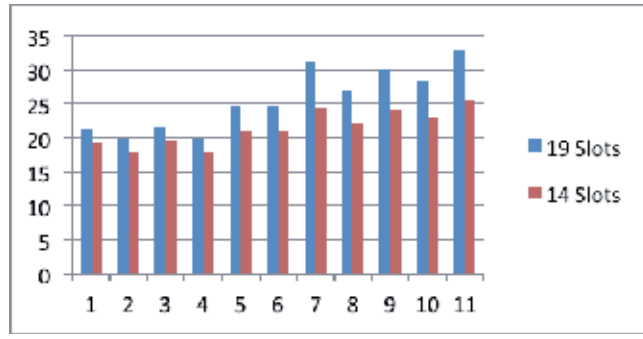
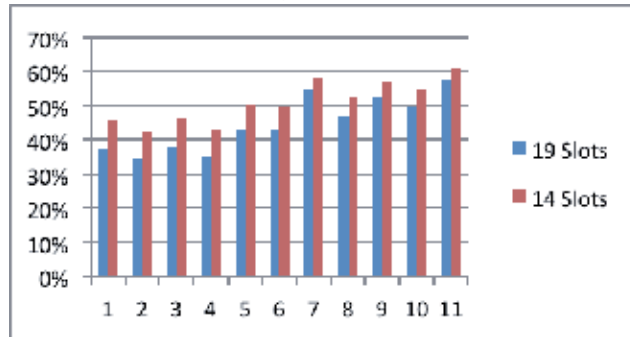


Figure 4: Average Weekly Utilization of the Rooms in Percentage for the Eleven Semesters



slots is faster than that of the 14 slots. However, in spite of this remarkable increase the rates remain significantly low (below 60%). This suggests that Qatar University would be able to decrease its teaching time (and the number of teaching slots) by more than 20% if it acquired a more efficient scheduling system (it is worth mentioning that Qatar University is still relying on a manual system in developing its schedules).

However, one may argue that the current capacity cushion should be used to absorb the increasing number of students enrolled at Qatar University rather than using it to expand the non-teaching time to a full-day. Table 1 provides the evolution of the number of students during the last six years; the table is limited to the Fall semesters because most the new enrollments occur during that semester (very few new enrollments take place during the Spring). The table shows that although the number of students continues to go up, the growth rate is going down over the last four years.

Table 2 compares different trend projections by providing the corresponding correlation factor and mean absolute deviation. It can be seen from the table that the best forecast (highest correlation factor and lowest mean absolute deviation) is provided by the trend projection of the last three years, which shows that the increase in the next year is as low as 1,000 students or so.

Obviously, the number of students is not the only factor that determines the capacity needs. Other factors may include the capacity of the sections, the capacity of the rooms, the number of programs offered, and the number of specialty courses. A multi-regression analysis

Table 1: Number of Students Enrolled at Qatar University during the Last Six Years

Semester	*Fall 2010*	*Fall 2011*	*Fall 2012*	*Fall 2013*	*Fall 2014*	*Fall 2015*
Number	8,171	9,070	12,243	14,879	16,132	16,771
Absolute Increase	-	899	3173	2636	1253	639
Relative Increase	-	11%	35%	22%	8%	4%

Table 2: Comparing Different Trend Projections

		Correlation Coefficient	*Mean Absolute Deviation*	*Fall 2016 Forecast*
Projection of Last	*6 years*	97.7%	608	19,560
	5 years	96.2%	719	19,606
	4 years	95.6%	500	18,716
	3 years	98.3%	136	17,819

would certainly provide better results than the simple regression we used. However, the added value of the multi-regression may not justify the complexity it introduces. Since the forecast of the capacity need is not the main object of the paper we opted for a simple model that associates the capacity need with the number of students. Our choice is justified by the fact that all the mentioned factors vary more or less proportionally in accordance with the number of students.

As far as the capacity supply is concerned, although the university was very cautious providing data about future capacity (as such data was treated as confidential) it is well known that a new college of Engineering is under construction, which is supposed to absorb the increase in the number of students for at least the next five years. It can be concluded that Qatar University will continue to enjoy an excess of capacity for at least another five years. Moreover, taking into account the economic booming in Qatar it is expected to see more construction and more capacity expansion in the forthcoming years. Therefore, the University can afford, with no risk, a full non-teaching day.

The Proposed Pattern

A first possible alternative pattern would make Thursday the non-teaching day (Figure 5); this is the proposal of Hammad (2014). This pattern has the advantage of creating a clear cut between teaching and non-teaching days. The faculty members would have three consecutive days (including the weekend) to focus on research; and the students would be ready to engage in non-instructional activities after having completed four days of learning. However, the main disadvantage of this pattern relates to the risk of perceiving Thursdays' non-teaching day as an extension to the usual weekend (Friday-Saturday), which may result in low presence of students on campus on Thursdays and even on Wednesday afternoons.

A second possible alternative pattern would make Tuesday the non-teaching day (Figure 6). This would solve the problem of extended weekend created by the previous pattern. However, the main disadvantage of this pattern is that lectures would be scheduled on Thursday afternoon which is not a preferred option for both students and faculty members.

Figure 5: First Alternative Meeting Pattern: Thursday as Non-Teaching Day

	8:00	8:30	9:00	9:30	10:00	10:30	11:00	11:30	12:00	12:30	13:00	13:30	14:00	14:30	15:00	15:30	16:00	16:30	17:00	17:30	18:00	18:30	19:00	19:30	20:00
Sunday	1				2			3			4			5			6			7			8		
Monday	9				10			11			12			13			14			15			16		
Tuesday	1				2			3			4			5			6			7			8		
Wednesday	9				10			11			12			13			14			15			16		
Thursday	Non-Teaching Time																								

Figure 6: Second Alternative Meeting Pattern: Tuesday as Non-Teaching Day

	8:00	8:30	9:00	9:30	10:00	10:30	11:00	11:30	12:00	12:30	13:00	13:30	14:00	14:30	15:00	15:30	16:00	16:30	17:00	17:30	18:00	18:30	19:00	19:30	20:00
Sunday	1				2			3			4			5			6			7			8		
Monday	9				10			11			12			13			14			15			16		
Tuesday	Non-Teaching Time																								
Wednesday	1				2			3			4			5			6			7			8		
Thursday	9				10			11			12			13			14			15			16		

The proposed pattern builds on the disadvantages of the previous two by splitting the non-teaching day into two half-days, namely Tuesday morning and Thursday afternoon (upper part of Figure 7). Although it does not offer a continuous non-teaching day, this pattern has most of the advantages of the previous two patterns but not their disadvantages. Its most important advantage is probably its flexible capacity; as shown in the lower part of Figure 7, the cushion capacity slots on early Tuesday mornings and early Thursday afternoons can be utilized to increase capacity whenever deemed necessary.

Linking the proposed patterns to the University's strategic direction is a key element in our discussion. It is postulated that the new revised pattern contributes to preparing competent graduates and enhancing student

Figure 7: Proposed Meeting Pattern: Split Non-Teaching Day

	8:00	8:30	9:00	9:30	10:00	10:30	11:00	11:30	12:00	12:30	13:00	13:30	14:00	14:30	15:00	15:30	16:00	16:30	17:00	17:30	18:00	18:30	19:00	19:30	20:00
Sunday	1				2			3			4			5			6			7			8		
Monday	9				10			11			12			13			14			15			16		
Tuesday	Non-Teaching Half-Day													5			6			7			8		
Wednesday	9				10			11			12			13			14			15			16		
Thursday	1				2			3			4			Non-Teaching Half-Day											

	8:00	8:30	9:00	9:30	10:00	10:30	11:00	11:30	12:00	12:30	13:00	13:30	14:00	14:30	15:00	15:30	16:00	16:30	17:00	17:30	18:00	18:30	19:00	19:30	20:00
Sunday	1				2			3			4			5			6			7			8		
Monday	9				10			11			12			13			14			15			16		
Tuesday	17?				18?			Non-Teaching						5			6			7			8		
Wednesday	9				10			11			12			13			14			15			16		
Thursday	1				2			3			4			17?			18?			Non-Teaching					

learning and productivity, ensures providing higher quality education to students, and enables faculty members to dedicate more time to conduct research and to be more involved in various community related initiatives. These anchors are quite relevant constructs of the University's strategic direction.

The proposed pattern, despite all its advantages, does have some shortcomings. However, they are not serious enough to inhibit its implementation. The first limitation of the design is that it does not respond to the wish of 83.2% of the students who prefer the one-hour lectures over the one-and-half-hour longer sessions. However, it seems that Hammad (2014) failed to explain to the students in her questionnaire that they cannot opt for "four instructional days" and "fifty-minute lectures" simultaneously. It is clear that the students are selecting the least tiring choices without caring much about feasibility or academic attainment. For this reason, it was not possible to take their opinion into consideration in this particular aspect. The faculty members (71.3% of whom prefer the one-and-half-hour lectures to the one-hour sessions) seem to have a more valid point as they believe that the longer sessions result in higher teaching productivity.

The second shortcoming of the proposed design is that it generated three instructional days for those having lectures on Sunday before and after 14:00. The three teaching days are actually one full day and two half-days. However, they could be just two half days if we could generate efficient schedules where the teaching is limited to either the morning (before 14:00) or the afternoon (after 14:00).

The third shortcoming is the timing of the first four slots. Having a first lecture on Sunday and a second one on Thursday for the same course may not be appropriate as this could negatively affect the continuity of the course. Actually, this is true only for the very first and the very last weeks of the semester; in all other weeks the continuity is guaranteed as the lecture of Sunday comes two days after the lecture of Thursday.

V. CONCLUSIONS

This paper discussed the design of class meeting patterns, a topic rarely addressed in the literature. It analyzed the existing pattern at Qatar University and identified a number of limitations pertaining to some aspects of this design, namely the one-hour teaching sessions, the short non-teaching time and the multi-day teaching schedules and how they negatively impact teaching productivity and educational attainment, students' engagement in non-instructional activities and faculty's productivity in research, respectively, in addition to the difficulties such design poses when scheduling faculty and/or student meetings, common exams and make-up lectures.

An alternative pattern, which expands the non-teaching time from three hours to twelve hours, was designed to cope with these limitations. It was shown through an analysis of the capacity utilization and the forecasting of the future demand that the proposed pattern will not result in any capacity deficit. The capacity analysis revealed that the average weekly utilization of the rooms at Qatar University is less than 35 hours, while the meeting pattern it adopts provides an availability of 57 hours per week for each room. This excess of capacity cushion is mainly utilized to cope with the inefficiency of the scheduling system in place, which represents a major area for improvement; automation is probably the most urgent step to be undertaken by the University.

The research also shows that the class meeting pattern is specific to each university as it has to be aligned with its respective strategic direction, culture and behavior. The pattern should satisfy the preferences of the users (students and faculty) as long as it does not conflict

with the strategic orientation of the university. Short lectures, which have the advantage of enhancing interest and concentration, may turn out to be quite inefficient if the lecture undergoes any unproductive time; this makes them convenient to some colleges, but not others.

Further extension of this research would purport to conduct more targeted surveys in order to achieve a better understanding of why students prefer one-hour lectures and to make them aware of the fact that one-hour lectures cannot be combined with four-teaching days. Focus groups could also be conducted in order to have students and faculty compare the existing pattern with the proposed one, and also come up with their own design of new meeting patterns.

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