Some of their applications and advantages. The success of these innovative teaching and learning methods at a large scale depends on few elements, probably the most important of which is the support of the higher administration and leadership in addition to the availability of “champions” who are committed to lead the change.

Keywords: ARS, classroom, collaborative, interactive, TBL

INTRODUCTION

It is known that during the course of a one hour long lecture, attention is at its peak during the first 10-20 minutes, and that very little is recalled after more than 20 minutes of uninterrupted concentration [1]. It is also well established that adult learners are motivated when learning is participatory and actively involves them in working and reflecting on problems that are perceived relevant [2]. In addition, with the rapid flow of new scientific and medical knowledge and the increase in demands for a lifetime of continuing medical education, adults and future medical doctors want and should take responsibility for their own learning [3]. Because of these facts, there has been a pedagogic shift in higher education from the traditional teacher centered to the student centered approach in teaching, necessitating a change in the role of teachers from suppliers of information to passive receptive students into a more facilitative role.

Active learning activities are based on various learning theories such as self-directed learning, cooperative learning and adult learning. There exist many instructional activities that enhance active and collaborative learning. The aim of this manuscript is to describe two methods of interactive and collaborative learning in the classroom, automated response systems (ARS) and team-based learning (TBL), and to list some of their applications and advantages. The success of these innovative teaching and learning methods at a large scale depends on few elements, probably the most important of which is the support of the higher administration and leadership in addition to the availability of “champions” who are committed to lead the change.

RÉSUMÉ • Il y a eu un changement dans l’enseignement supérieur et dans ses pratiques pédagogiques traditionnelles centrées sur l’enseignant vers une approche où l’étudiant est placé au centre du dispositif d’apprentissage. L’enseignant, autrefois fournisseur d’informations prend aujourd’hui surtout le rôle d’un facilitateur. Les activités d’apprentissage actifs sont basées sur différentes théories d’apprentissage telles que l’apprentissage autonome, l’apprentissage coopératif et l’apprentissage des adultes. Il existe de nombreuses activités pédagogiques qui favorisent l’apprentissage actif et collaboratif. Le but de ce manuscrit est de décrire deux méthodes interactives et collaboratives en classe, l’utilisation de systèmes de réponse automatisés [automated response systems (ARS)] et l’apprentissage en équipe [team-based learning (TBL)], et de lister quelques applications et avantages. Le succès de ces méthodes d’enseignement et d’apprentissage novatrices à grande échelle dépend de certains éléments, dont le plus important est le soutien de la haute administration, en plus de la présence de « champions » qui sont engagés à conduire le changement.

ABSTRACT • There has been a pedagogic shift in higher education from the traditional teacher centered to the student centered approach in teaching, necessitating a change in the role of the teacher from a supplier of information to passive receptive students into a more facilitative role.

Active learning activities are based on various learning theories such as self-directed learning, cooperative learning and adult learning. There exist many instructional activities that enhance active and collaborative learning. The aim of this manuscript is to describe two methods of interactive and collaborative learning in the classroom, automated response systems (ARS) and team-based learning (TBL), and to list some of their applications and advantages. The success of these innovative teaching and learning methods at a large scale depends on few elements, probably the most important of which is the support of the higher administration and leadership in addition to the availability of “champions” who are committed to lead the change.

Keywords: ARS, classroom, collaborative, interactive, TBL
that their mandate is to cover all available material. It is time to address these perceived barriers and modify current traditional teaching. One can gradually experiment with a range of different interactive and collaborative techniques. For example and at reasonable time intervals of about 10-20 minutes, one can take breaks for action and reflection moments such as pausing for questions during a lecture, think-pair-share, role play, group discussions, and case scenarios [1,6]. In addition, the innovative “flipped classroom” approach whereby the traditional class-time and group- or self-study activities are “flipped” or reversed can be applied [9,10]. Such interactive and collaborative activities stimulate learners to assimilate new information or knowledge, which in turn leads to a deeper understanding of content. The use of computer-assisted learning tools also enhances the interactive and collaborative experience [11].

The aim of this manuscript is to describe two methods of interactive and collaborative learning in the classroom, automated response systems (ARS) and team-based learning (TBL), and to list some of their applications and advantages. It is hoped that the information and practical tips be adapted by faculty involved in medical education to more effectively meet the education needs of our medical students.

AUTOMATED RESPONSE SYSTEMS (ARS)

Description
Automated Response Systems (ARS), also known as clickers, are small handheld devices used by students to choose an answer to a posted question prepared as a slide in a power point presentation. Figure 1 describes the process and the set-up. Briefly, a clicker has 10 buttons each corresponding to a letter or number (A to J or 0-9). It communicates with a computer using radio frequencies and a receiver that is plugged into the USB port of a computer. Using specialized software, the responses of students are received, analyzed and can be displayed in several forms – most commonly as a graph (Figure 2). Thus, after a question (e.g. multiple choice or true/false question) is posed, students click their answers then a histogram is displayed showing their responses. The display of the polling results (with or without indicating the correct answer) provides immediate feedback to students and the instructors, and areas of confusion can be immediately addressed with the entire class. Note that the instructor can monitor the number of students that are answering using the “user feedback” box.

Applications
ARS have been frequently utilized in many formats to increase interaction and assess preparedness or understanding of students. In addition, the capability of assigning a unique identifiable clicker for each participant, the ability to time response, and the option to generate reports for grading, allow their use for delivering tests and recording performance [12]. At the American University of Beirut (AUBFM), we have been applying this technology since 2012 in a variety of settings that involved medical students, medical residents, graduate biomedical students, and nursing students, both individually and in teams. We have used clickers intermittently in lectures every 10-20 minutes and towards the end of lectures or presentations.

![Figure 1. How to set up & run a session with Audio Response System (ARS)](www.turningtechnologies.co.uk)
to identify knowledge lacunae to be promptly addressed in class, and restore students’ concentration and interest. We have also used clickers in reviews and case discussion sessions in the classroom.

Advantages
ARS have been shown to improve student centered active learning, allow for cognitive engagement, and enhance students’ interaction [13, 14]. Although ARS are associated with positive engagement of students in lectures, the value of ARS in improving learning outcomes and grades has not been well established. Yet, many learning theories such as peer instruction, game based learning, active learning, and agile teaching support the use of clickers in education [15]. Feedback from our students clearly indicates that the method was appreciated by the majority of students, and that using clickers helped students apply their knowledge as one student wrote: “the clicker questions were very helpful in allowing the students to think critically and keeping them focused during the lecture” and “[clickers made] sure that we are keeping up with the material.”

TEAM-BASED LEARNING (TBL)

Description
Team-based learning (TBL) is a problem-based, student-centered, “flipped classroom” teaching approach that stimulates interactive and collaborative learning while maintaining individual accountability. As the name implies, TBL requires students to work in teams (6-8 students per team) formed at the beginning of the course, and lasting throughout the course. As shown in Figure 3A, a typical TBL exercise consists of 3 phases. Phase 1 is the individual pre-class preparation of the contents to be covered in the session proper. This is the knowledge that students have to attain, which in traditional curricula would usually be given as a lecture. Phase 2 is the readiness assurance process (RAP) that ensures that students prepared and grasped the content from Phase 1. In Phase 2, students initially take a test individually (individual readiness assurance test-iRAT) to assess their understanding of the reading or pre-class preparation, and their readiness to use that knowledge in problem solving. After this, the students take the same test but as teams (the group RAT-gRAT). During this process, the teams commit to an answer and are given special forms called Immediate Feedback Assessment Technique (IFAT) forms. These are self-scoring answer sheets that provide immediate feedback about the correct answer, allow for partial grading, and markedly foster team interactions [16]. Phase 3, the last phase, involves a higher level of learning that entails applying the knowledge and concepts gained in solving problems and making decisions, using a team approach. These exercises must present a significant problem, require the team to select a specific answer from the same choices, and have all teams report their answers simultaneously (using lettered cards or other forms such as a gallery walk); hence the 4S’s of TBL. In order to assure peer accountability, a peer evaluation is filled periodically.

Instructors who elect to apply TBL in their courses should be faithful to the described methodology. This is because each of the proposed steps is based on years of testing and pedagogical evidence, and accordingly, a modified TBL process may fail to produce the desired targets (see Advantages). Potential physical and logistic constraints should also be taken into consideration. Although TBL can be run “anywhere” including a classic lecture hall, it is preferable to have a dedicated large room that is equipped with movable chairs and tables that allow for exam like seating, as well as small group clustering. Moreover, class management and discussions highly depend on the presence of a reliable sound system and microphones.

Figure 2. Print screen of a question slide before (A) and after (B) polling using automated response systems.
In designing a TBL session, instructors should use the so-called “backward” method. This method differs from traditional approaches of teaching in that, after deciding on the learning objectives, rather than selecting the reading that will achieve these objectives, the instructor develops a problem-solving application exercise which will allow the students to apply the knowledge in solving relevant and significant problems. Successful application of knowledge is considered the ultimate test of mastery and deep understanding of the study topic. Once this part of the exercise is constructed, the instructor then writes questions that test whether the students have the necessary knowledge required for the application exercise; the last step is to decide on the reading material or other form of assignment (e.g. previously given lectures) that students must prepare to successfully answer both the questions and the cases [17] (Figure 3B). Table I provides an example showing how a learning objective, readiness assurance test question, and application question are aligned. For more information on TBL, one can visit the [www.teambasedlearning.org](http://www.teambasedlearning.org) site. One can also check the portal hosted by the Association of American Medical Colleges (AAMC): [www.mededportal.org](http://www.mededportal.org) for examples of TBL modules.

Applications

TBL was first attempted in a medical school in 2001 [18, 19]. Since then, TBL was used and proven effective in several medical courses and disciplines including pharmacy and veterinary medicine at more than 50 universities in the USA and outside the USA.

The TBL method has been applied to cover both basic and clinical material. In some instances, a whole course was designed as a series of TBL exercises, in others only few sessions were as such. The duration of phases 2 and 3 varied depending on course design, the learning objectives, and the material to be covered [20-26].

In 2007 at AUBFM, TBL was introduced into the teaching of pharmacology to medical students and it has evolved over time [27-29]. Currently, bimonthly clinical pharmacology TBL sessions are delivered to third year medical students rotating in the internal medicine, surgery and anesthesiology clerkships. In addition and more recently, TBL has been applied on a very large scale at AUBFM whereby more than 80 TBL sessions have been delivered during the first two years of the new integrated curriculum. Recently, we have experimented with the use of clickers in the readiness assurance process of TBL [30].

Advantages

In contrast to classical lectures that focus on “covering content,” the TBL instructional method aims at “applying knowledge” in a highly interactive setting, in which students are accountable towards each other. Thus students shift from passive to active learning, and the responsibility for learning shifts from the instructor to the students. TBL fosters teamwork, improves communication skills among...
students, teaches them to respect each other’s opinions and contributions, and eventually leads to high performance teams, essential for the practice of modern medicine soon to come during the clinical years. There is plenty of evidence in the medical literature showing that TBL improves medical students’ satisfaction and performance on high-stakes exams [31, 32]. TBL also has the advantage of “ensuring the effectiveness of small groups with high student faculty ratios (e.g. up to 200:1) without losing the benefit of faculty-led small group discussions with lower ratios (e.g. 7:1)” [33, 34].

Our experience with TBL in both clinical pharmacology and the new curriculum has been very positive. In the overwhelming majority of TBL sessions, students have indicated that the exercise deepened their understanding of the material and promoted their critical thinking and allowed them to apply the knowledge they learned. For the clinical pharmacology, students were highly satisfied with the course and the teaching approach, and their performance on prescription writing and formulary development had significantly improved [28, 29]. The course continues to be delivered for medicine 3 students who consistently appreciate the learning experience.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning objective</td>
<td>- Establish goals for the treatment of hypertension.</td>
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<tr>
<td></td>
<td>- Choose appropriate antihypertensive regimens based on patient-specific characteristics and concurrent disease states.</td>
</tr>
<tr>
<td></td>
<td>- Modify pharmacologic regimens for patients who experience adverse events or do not have adequate blood pressure control on initial regimen.</td>
</tr>
<tr>
<td>Reading assignment</td>
<td>Treatment guidelines from the <em>Medical Letter: Drugs for hypertension</em>. Issue 141. May 2014.</td>
</tr>
<tr>
<td>Readiness assurance test question</td>
<td>Angiotensin receptor blockers are especially likely to cause:</td>
</tr>
<tr>
<td></td>
<td>A. Postural hypotension</td>
</tr>
<tr>
<td></td>
<td>B. Cough</td>
</tr>
<tr>
<td></td>
<td>C. Hyperglycemia</td>
</tr>
<tr>
<td></td>
<td>D. Hyperkalem</td>
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</tbody>
</table>
| Application exercise         | A 50-year-old Caucasian woman with hypertension has been maintained on hydrochlorothiazide 50 mg daily and felodipine 5 mg daily for 6 years. She was on captopril several years ago, but it was stopped because of dry cough. Two weeks ago, her blood pressure was 150/97 with a heart rate of 98 beats per minute. Her urine showed microalbuminuria; her serum creatinine was 1.5 mg/dL and her potassium was 4.1 mEq/dL. So her physician stopped felodipine and started losartan 25 mg daily.

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What is the best next step?

A. Stop losartan and start ramipril
B. Increase losartan to 50 mg/day
C. Increase hydrochlorothiazide to 100 mg/day
D. Add eplerenone 25 mg/day
E. Continue her present regimen unchanged

CONCLUSIONS

In this manuscript, we described and listed examples of applications and advantages of automated response systems (ARS or clickers) and team-based learning (TBL). The success of these initiatives on a large scale depends on at least three elements. First, commitment and support of the higher administration and leadership are of paramount importance. Second, technical and personnel support are essential should TBL and/or ARS be used on a large scale. This is because creating TBL modules for the first time is a tedious process, and faculty may need coaching and guidance to develop their first module. As for ARS, it involves the use of technology which could be challenging for some faculty. Third and last but not least, there should be dedicated faculty experts who support and develop fellow faculty who are just starting.

At least one “champion,” preferably more, should be available and committed to lead the change. One major challenge for leading this change has been the need to “con-
than other methods such as mass training sessions, penalties and/or incentives. This is in line with Gawande et al. who concluded that “people follow the lead of others they know and trust” [35].

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