Challengr, a Classroom Response System for Competency Based Assessment and Real-Time Feedback with Micro-Contests

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***Abstract*—This innovative practice work-in-progress paper presents the *Challengr* tool, a modern Classroom Response System (CRS) used to organise micro-contests in classrooms, especially for higher education. The proposed tool is designed to evaluate students in a fun and challenging way. It also allows instructors to collect feedback about students' performances to adapt and improve their lessons and teaching.**

CRS is an interesting technology to increase students' motivation and introduce interactions in classrooms in a scalable way. Classical CRS like clickers can be used to implement active and cooperative learning, making students engaged actors of their own learning. The tool proposed in this paper is not meant to provide interaction during the lesson or collect real-time statistics with brief questions to the audience. The micro-contests can take place at the beginning of the lesson to check students' backgrounds or memories of the previous ones. At the end of the lesson, it can be used to probe what they understood. Finally, the system supports local challenges and online remote ones and can accept guests. It additionally offers an API to connect it to other tools, like Learning Management System (LMS).

***Challengr* is suitable for computer science engineering courses, in particular when skills to be mastered by students are piecewise and incremental. This work-in-progress tool is planned to be tested for an introductory programming course. It is critical for instructors to follow up how students are assimilating the material from the lessons. It will also undergo a thorough evaluation measuring the impact on students' learning.**

***Index Terms*—Competency based assessment, Evaluation.**

I. Introduction

Classroom Response Systems (CRS) and similar tools such as physical clickers have been designed to bring more interactions into the classrooms, especially for large auditoria. CSR helps instructors to design teaching tactics yielding measurable superior learning outcomes [1] by increasing and improving classroom interactivity [2]. Many audience response systems with different features and usages exist and are used in classrooms [3], [4]. In addition to technical considerations about the used tool, the way it is used in classrooms also impacts the possible effect on students learning.

This paper presents the *Challengr* tool, a modern CRS that is used to run and organise micro-contests in classrooms. This tool has been specifically designed for education, putting the focus on formative assessment and real-time feedback.

A. Related Work

Classroom Response Systems (CRS) have been used from the beginning of the year 2000 [4]–[8]. Initially, they were physical clickers transmitting the user's answer to a received with an RF connection. Later, with the generalisation of smartphones and tablets, the emergence of mobile applications, and the generalisation of Wi-Fi connections in classrooms, CRS evolved from hardware systems to software ones [5].

Many systems have been created and used in educational settings. For example, EduClick is a specific hardware CRS used with software to project questions and manage the interaction [9]. Several types of quizzes can be run, especially competition quizzes. Statistical modes give access to useful information for instructors to improve their teaching. Quick Quiz proposes a gamified approach to teaching based on MCQ supported by a software tool [10].

Recently, Kahoot! [11]–[13] and Poll Everywhere [14], [15], two widespread and popular tools, have been used to organise competitions in classroom settings. These general tools support online polls with MCQ that can be used in classrooms. They both have features similar to the ones desired in this work and implemented in the Challengr tool, to support some kinds of competitions. The main difference, detailed in Section II-E, is the fact that they have not been specifically designed to run micro-contests in an educational setting.

B. Motivations

The main goal of the *Challengr* tool is to bring a new kind of interaction in classrooms to motivate higher education students to learn and improve their learning. It can also be used by instructors to evaluate students' competencies in a fun and challenging way. Real-time feedback about students' performance can be collected and used by instructors to adjust their courses during the semester. Finally, this paper also presents associated instructional use of the developed tool, to foster students' learning. Compared to other existing tools, that may have been used to obtain similar results than those expected with *Challengr*, this latter tool has been designed with educational objectives in mind. The presented tool must be used with the proposed associated instructional use.

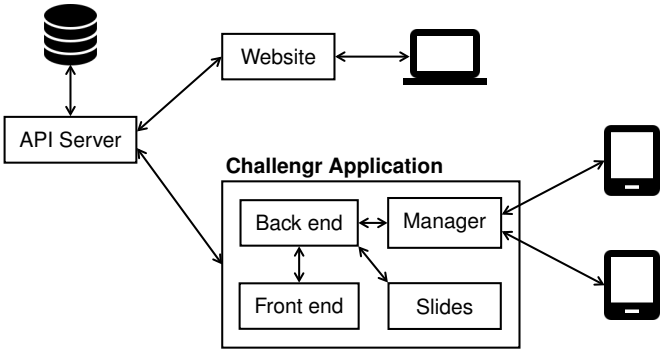

Fig. 1. *Challengr* is a distributed application that can be used to organise micro-contests accepting participants on both a web and a mobile front end.

II. The Challengr Tool

The *Challengr* tool is a distributed application used to organise micro-contests. Fig. 1 shows an overview of its architecture. It consists of three main parts: (a) an API server, (b) a website, (c) and the *Challengr* application. The *API server* proposes services to manage challenges. Some of them are accessible to the other two components while others are open to external applications. The *website* allows instructors to create and manage their challenges and access results and statistics. Finally, the *Challengr application* is used by instructors to run the challenge and allow students to participate.

A. Question

The heart of micro-contests is the question. Instructors can create them and manage their own private library of questions through the website. The proposed tool supports several kinds of questions including simple MCQ, open text, drag and drop, image hotspot, etc. A tag feature allows instructors to organise their questions library and to efficiently search through them.

B. Challenge

Instructors can create and configure new challenges through the website. Just by selecting a list of questions and a list of participants, they are done with the micro-contest setup. The tool makes it possible to either run local challenges or remote ones. In both cases, a challenge can be configured to accept public guests that have not to be on the participants' list.

Local challenges are meant to be run on a private Wi-Fi not connected to the internet. In addition to minimise cheating risk, it is useful to prevent an unstable internet connection disturbing the contest. Such challenges are handled by the *Challengr* application run by the instructor on a computer connected to the same network as the students. Remote challenges require an internet connection since they are completely managed by the *Challengr* servers. The main advantage is that instructors do not have to install nor run anything on their computer except a web browser. The main disadvantage is the dependence on a good internet connection.

In both cases, instructors can control the flow of the micro-contest. For each question, one slide with its statement and answer propositions is generated. Depending on their device, students will either see the projected slide or only the answer input component. Students have a limited amount of time to answer the question, which is configurable for each question. The score for a correct answer, a wrong one, and an abstention can also be configured for each question. When creating the challenge, it is possible to organise the questions by groups, each being configured with the maximum time and scoring scheme for its questions. Typically, difficulty levels are used to define these groups (easy, medium, and hard questions).

C. Statistics and Feedback

After the completion of the challenge, both students and instructors have access to several statistics and feedback information. Students can review all the questions with their answers, the correct one, and an optional feedback explanation if the instructor has set it up for the question. They can also see their own total score and position in the classroom ranking.

Instructors have access to more detailed statistics about each student, each question, and about the whole classroom. For challenges only consisting of MCQ, instructors have access to psychometric indicators from Classical Theory Test (CTT) and Item Response Theory (IRT). It can help them to identify difficult questions and not well-asked ones. For all questions, they also can access basic statistics about students' answers (histograms, average, standard deviation, etc. Finally, for questions that have been used several times in different challenges, they can perform diff analyses.

Finally, instructors can add a feedback survey with questions asked to students after the completion of the challenge, just before the results and ranking are made available. It is a convenient way to collect simple information about their experience. Examples of questions to ask are whether they found the challenge fun, whether its level was too difficult for them or what is the score they expect to have. Several predefined questions are available for instructors to include them when designing their challenge.

D. API

The proposed tool comes with an API server providing internal services to support the website and the *Challengr* application. External services are also available and used to ease the connection with other tools, in particular Learning Management Systems (LMS). This latter access can be used to retrieve data from the Challengr tool into other tools. For example, the detailed score of a student obtained during a challenge can be used to support a certification assessment.

E. Advantages

Compared to Kahoot! or Poll Everywhere, the Challengr tool is more specific and only targeted to competitions. While the two aforementioned tools can also support some kinds of competitions, they are way more general. In particular, as far as we know, they only support online remote competitions with MCQ with at most four answer options. Also, only Poll Everywhere has some integrations with LMS, which is absent from Kahoot!. Finally, neither offers instructional

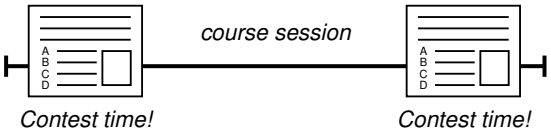

Fig. 2. A challenge should be run either at the beginning or at the end of the course session, depending on what information the instructor wants to collect.

use or specific tools targeted to instructors and dedicated to improving their teaching. The Challengr solution comes as a bundle with technical infrastructure and tool and with educational features aiming at improving teaching and learning for instructors and their students.

III. Instructional Use

The challenges supported by the proposed platform can be used in different settings. Several scenarios have been thought of, to use the *Challengr* tool in a classroom to evaluate students' competencies and collect information for the instructor. Fig. 2 illustrates two proposed moments in time when to run a challenge, namely at the beginning or at the end of a course session. In each of these scenarios, information about the current competencies of students is collected and made available to both the instructors and themselves.

A. Running Challenge

Proposing challenges to students at the beginning of the course may serve two purposes. Running a challenge that emphasises the previous course session encourages students to revise their notes [16]. Additionally, immediate feedback guides students about their own learning status and progress. Having students better prepared ahead of a course session is more pleasant for the instructor. It also provides a signal to students who are maybe a bit late in the course material. Another reason is to check any background or prior knowledge. It may help instructors to better know their classrooms before starting a new course. Another possibility is to end the course session with a challenge. The instructor will then be able to check what students remembered or understood about the course session they just heard, depending on the questions used. The collected feedback allows the instructor to better prepare the next course session to possibly provide reminders to students.

B. Collected Feedback

Both approaches can be used for either formative or certification assessments. In any case, the collected information informs students about their own situation and progress and instructors about how their classrooms are performing. Checking the audience understand the concepts presented during the course is important for instructors. This is the case for some computer science courses where concepts are brought in a piecewise and incremental way. For example, in an introductory programming course, variable and boolean expression concepts should be well understood before moving to the loop concept. Using Challengr with the proposed settings and relevant questions can help instructors to better understand their classroom and adapt their teaching.

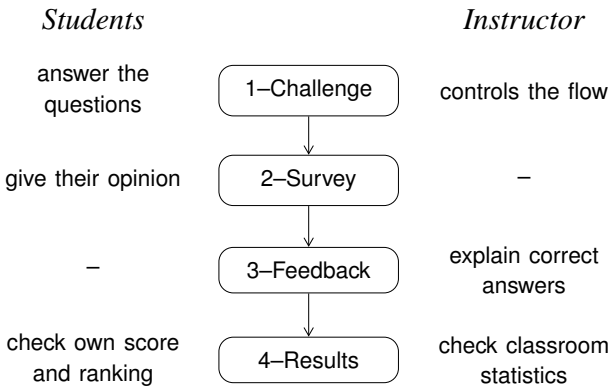

Fig. 3. A possible timeline starts with the challenge, followed by a survey, then a feedback session showing correct answers, and finally the results.

IV. Student Assessment

The *Challengr* tool has not only been designed to bring interactivity for students in the classroom nor to provide an information collection mean for instructors. Following the principles of *Technology-Enhanced Formative Assessment* (TEFA) [3], the proposed tool can be used to assess students and capture real-time information about their learning progress. First, students can follow their progress in micro-contests' rankings during the semester, to note an evolution or a stable position at the top.

With these formative assessments, instructors can keep track of the progress of their students and classrooms. They can also provide students with feedback by adding comments explaining the correct answers for each question or by going through them with students after the end of the competition. Fig. 3 shows a timeline example of what can be done with the *Challengr* tool. The first step is the execution of the challenge controlled by the instructor. Students are discovering and answering the questions at the rhythm defined by the instructor. At the end of the competition, students get some time to fill in the feedback survey. After that, the instructor can go through all the questions again, while showing the correct answer and explaining why it is the correct one. Finally, individual scores are made available to students, along with the ranking. At that time, the instructor could access general statistics about the classroom.

Using such formative assessments during the semester has proven to have a positive impact on students' learning [17], [18]. The results of the challenge both help students and instructors to have information about their knowledge and progress with time. The survey may help instructors to better characterise and profile students, which can be useful to personalise their learning. For example, a student always overestimating his/her score may need some advice from the instructor. Finally, the feedback time is important for students to learn from their errors and to gain self-confidence for the questions they mastered. The Challengr tool can also be used for certification assessment, especially when run locally without internet access. The provided API can be used to

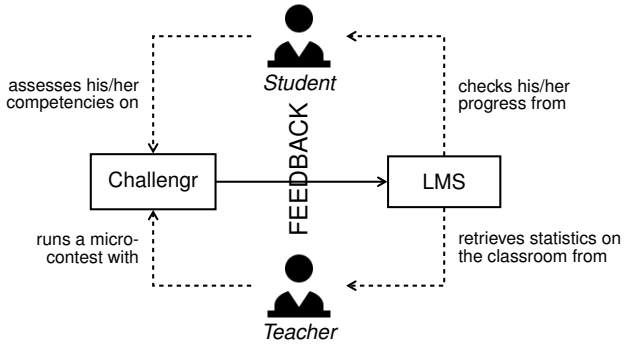

Fig. 4. The Challengr tool has been designed to support real-time feedback between instructors and their students by proposing fun and challenging micro-contests to assess students' competencies.

retrieve the scores into an external application such as an LMS, for example. The large variety of question types makes it possible to create rich challenge enough so that to be able to assess differently several competencies. It may also help to remove any bias or random answers possible with MCQ-only quizzes. For this latter case, the generated statistics may help instructors to neutralise some questions after having analysed the psychometric indicators.

V. Conclusion and Future Work

As summarised by Fig. 4, the Challengr tool has been designed to be a real-time feedback tool between instructors and their students. The proposed tool can be used to create and run challenges in classrooms. They are meant to bring a fun and interactive way for students to assess their competencies and for instructors to collect students' performance information.

The Challengr solution is planned to be tested with students following an introductory programming course, following existing evaluation approaches [19], [20]. Gamified approaches used for higher education have proven efficient [21], in particular, to learn to program [22]. This upcoming experiment will have as main objective to measure how well the Challengr tool improved several aspects of teaching and learning. Two surveys will be conducted on this occasion, to measure the motivation and user experience of students with the tool, the evolution of students' performance on the assessed competencies. A survey will also be conducted among teachers to measure the relevance of the statistics and feedback generated by the tool. Future work also includes improving the platform itself, by adding new question types, testing new statistics information, and by implementing integrations with popular LMS, by using the Learning Tools Interoperability (LTI) specification. Finally, the Challengr solution will also be used with the *"stars system"*, a tool supporting competency based assessment, to provide certification assessments [23].

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