An Innovative Training & Managing Model for High School Practical Projects and Innovative Education

Chao Cong[1,a], XinGang Chen[1,b], Qian Yang[1,c],

[1] Chongqing University of Technology, Chongqing, 400054, China

[a]congchao@cqut.edu.cn, [b]chenxingang@cqut.edu.cn, [c]yangqian@cqut.edu.cn,

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Abstract. A new training and managing model "Training-Scrum", which is based on Scrum agile principle and constructivism education theory, is introduced in this paper for college capstone courses and students' innovative projects in Electrical & Electronics. One of these projects, named "Design of Smart Car for Home Monitor and Control Based on Android", is described. Among the results of this study, it is shown that "Training-Scrum" model can enhance educational effects and student's enthusiasm in capstone projects, especially in innovative and crossing field projects. It is also shown that the appliance of this model can provide a fast and efficient monitoring mechanism for student groups and projects. Therefore, this model is a successful and effective approach of practice teaching and team building in the training of innovative young talents.

Introduction

Innovative project training and practical teaching is always an important part in college education, especially in majors like Electricity & Electronics (EE) and Computer Science (CS). It is commonly known that in these disciplines, capstone projects and related curricula strand are important for knowledge consolidation [1]. Historically, most innovative projects were organized by traditional plan-driven approaches, in which a systematic process is applied and designed with pre-specifiable, deterministic requirements and schedules [3]. However, there are many problems identified when applying these projects:

(i) Technical methods and instrument in some projects became improper;

(ii) There may be problems in communication between students and instructors;

(iii) Student's effort and efficiency became very difficult to evaluate;

In order to minimize these problems, an agile based method "Scrum" has been introduced in the projects.

Background

Agile Principle. The agile principle has been presented for about 15 years, it was officially published as Agile Manifesto in 2001 and with which the Agile Alliance was established. The core idea of agile method is to encourage the develop team to focus on individual capability and collaboration rather than comprehensive documentation and processes in software engineering.

Scrum Method. Scrum is the most popular method regarding as the project management practice and tool in businesses including not only software companies, but also financial service and professional service organizations.

Scrum method defines three different types of roles in a team:

(i) Product Owner (PO), PO is a unique character who is responsible for whole project.

(ii) Scrum Master (SM), SM manages whole process of the development and organizes activities.

(iii) Team Members. Team members have the responsibility to follow the development plan and complete assigned tasks.

In a normal sprint, SM convenes all members every morning for a short standup meeting, named Daily Scrum. SM takes the meeting memos and updates status in Task Board or Kanban, and handles

the proposed problems after the meeting. At the end of a normal sprint, PO summaries and evaluates project status and member efforts in the sprint, and plans new sprint with SM. A classic Scrum framework is shown in following graph.

Fig 1. Scrum Framework

Scrum in Multi-disciplinary Projects and Innovative Education. Scrum has been introduced in college education, especially in software engineering capstone courses, embedded software/hardware design courses and project management in major of CS, EE or mechatronics.

Limitation of Scrum in Education. However, there were identified problems when applying Scrum in courses and student projects:

(a) Managing and self-managing of students could be a fatal problem.

(b) Above-mentioned issue raises another uncomfortable problem, which is described by Mahnic[7], is how to balance between coaching and self-organization.

(c) Self-managing revealed another problem that students lacked the abilities to estimate and plan, moreover, some of them did not fully understand the concept of task or user story being “done”.

(d) Some innovative student projects for science competition or graduation project are becoming increasingly complex and based on multi-disciplinary knowledge and competencies.

In order to handle above problems during applying Scrum in education, we try to combine project management and innovative coaching in traditional process of Scrum via teaching practice, instructional evaluation and process optimizing. Based on traditional Scrum team construction and sprint iteration, we present a new Scrum model - “Training-Scrum”.

Model Details

Role Definition. In Training-Scrum model, a Scrum team is established with 4-6 members, role definition and responsibility are described as follows:

a. PO role has been replaced by Training Owner (TO), who must be college teachers and instructors with the responsibility of making training and Scrum plan and schedule.

b. Considering about the capability of students, we split the role of SM to be “Managing Master (MM)” and “Technical Master (TM)”, in charge of people management and technical guidance respectively.

c. In principle, MM and TM must be students. However, teachers may also play as MM and TM at the beginning of the project.

d. Other than TO, all team management should follow flat management. MM and TM do not have privileges or priorities for anything. Organization of team member, MM and TM should be voluntary.

Training-Sprint-Accumulation. In Training Scrum, an incremental developing/training iteration lasts 8-12 weeks, which is longer than normal sprint period, depending on the contents included. A typical iteration is composed of 3 phases: training, sprint and accumulation.

Training phase mainly comprises coaching courses, lectures and lessons, all of which are arranged by TO. During training phase, TO refines and generalizes these topics theoretically, and instructs and coaches Scrum members. Training phase normally lasts 1-2 weeks.

Sprint phase is similar to “sprint” in traditional model. In this phase, project objects and requirements are refined as backlogs and tasks, which are assigned to team members. In general, this phase is composed of 3 types of activities: sprint plan meeting, daily scrum and sprint review meeting.

Accumulate phase lasts 5-8 days after sprint phase. In accumulate phase, team members mainly focus on project summary, knowledge sharing and problem discussion. The Scrum team maintains a technical wiki website instead of documentation work.

The whole framework of Training-Scrum model is shown as following graph:

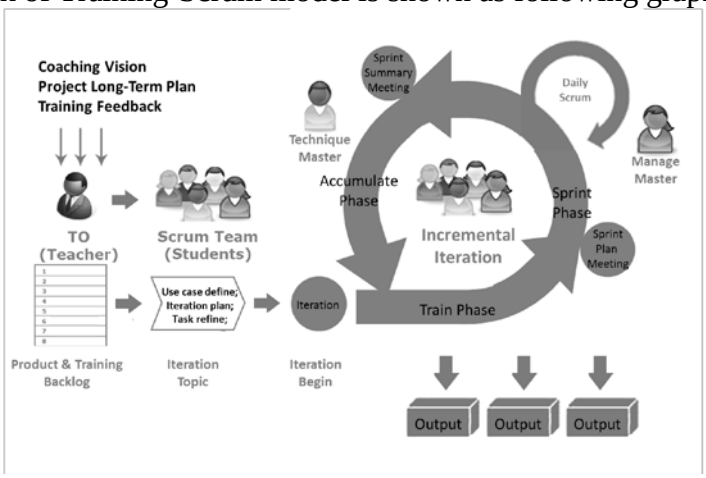

Fig 1. Workflow of "Training-Scrum" Agile Training Model

Backlog Specification. There are 3 types of sprint backlogs (tasks) in Training-Scrum model:

a. Homework task.

b. Project task.

c. Research task.

Definition of tasks should include difficulty, owner and check points. Check point should be specified with corresponding steps, requirements and visualized results to be checked whether the task is finished, or its progress. Some check points should be described with TBD (to be done). Following table shows task properties during a typical iteration:

Table 1. Examples of Task Properties

Task Title	Type	Diff	Owner	Closed	Last Update	Update by	Checkpoint
Dummy task 1	Homework	1	M.Wu	1	2015-08-01	M.Wu	1.Dummy step 1 2.Dummy step 2
Dummy task 2	Investigation	3	J.Hu	1	2015-08-04	J.Hu	TBD: dummy step 1
Dummy task 3	Development	2	C.Zhao	0		C.Cong	1.Dummy step 1

Study Case

Background. We have applied the model in an innovative students' project named "Design of Smart Car for Home Monitor and Control Based on Android", which is an extracurricular activities of scientific and technology for elite bachelor students in majors of Electrical Engineering and Communication Engineering of ChongQing University of Technology (CQUT), China.

The project lasted from September 2014 to August 2015. During the period, 2 Scrum teams were established and 7 iterations were executed. Following table lists the training backlog and defines iteration of one team during the period.

Table 2. Training-Scrum Iteration List

Sprint Title	Start Date	End Date	MM	TM	Finished Tasks
S1-Android Practise I	2014-9-1	2014-09-30	C.Cong	Q.Yang	14 tasks
S2-Android Practise II	2014-10-08	2014-10-31	C.Cong	Q.Yang	11 tasks
S3- Smart Car Application I	2014-11-10	2014-12-12	Q.Yang	C.Cong	12 tasks
S4- Smart Car Application II	2014-12-15	2015-01-23	M.Wu	C.Cong	12 tasks
S5-Android Practice III	2015-02-16	2015-03-27	M.Wu	J.Hu	14 tasks
S6-Smart Car Application III	2015-04-06	2015-06-03	C.Zhao	J.Hu	23 tasks
S7-SmartHouse Car & Android App Project	2015-06-29	2015-08-29	M.Wu	J.Hu	31 tasks

In our study cases, "S7-SmartHouse Car & Android App Project" is a typical iteration lasting 8 weeks and including key functions and user stories in the whole project "Design of Smart Car for Home Monitor and Control Based on Android". Therefore, we give an overview of this iteration as an example of the application of Training-Scrum model in project.

Definition of User Stories. Based on training backlog, the user scenario of "S7-SmartHouse Car & Android App Project" was: user wants to control the smart car to get access to monitoring network, status network and security network in user's house via smart phone and internet. User stories and function list could be created as following table:

Table 3. User Story and Product Function List in "S7-SmartHouse Android App Project"

User Story	Function Description	Diff
User wants to have an extensible Arduino-based smart mini-car	1. Establish basic structure for mini-car	2
	2. Establish power system and driving system for mini-car	2
	3. Design control logic on smart mini-car	3
User wants to remotely control and monitor the mini-car	1. Design camera and wifi module on the MCU on smart mini-car;	2
	2. Design driving and controlling program for camera and wifi module;	3
	3. Deploy a PC server as message controller and video stream receiver;	3
User wants to design android app to remotely control and monitor the mini-car	1. Design android app control UI.	2
	2. App can connect mini-car via wifi;	3
	3. App can decode and decompress video stream from camera;	3
	4. App can control the speed and direction of mini-car;	2
User wants to add temperature and moisture capturing function in car	1. Deploy temperature sensor in mini-car.	2
	2. Deploy moisture sensor in mini-car.	2
User wants to monitor temperature and moisture via app	1. Design temperature and moisture monitoring UI in app.	2
	2. Implement monitoring and display function in app.	2
	3. Implement acquire data by command function in app.	2
User wants to add gas monitoring function in car	1. Deploy gas sensor in mini-car.	2
	2. Implement data uploading function in Arduino;	3

Training Course Design. According to iteration backlog and user stories, training lectures, experiment and technical seminar could be refined and tailored. In training phase, these activities were applied to all members in Scrum team, and homework tasks were assigned.

Sprint Phase. At the beginning of sprint phase, TO created sprint backlog based on user stories and MM held sprint plan meeting with all team members. In meeting, TM refined the user stories as different types of tasks and estimated difficulties of them. All of team members were discussing the distribution of each task and its effort. Responsibilities and deadlines should be clarified and recorded after the meeting. In our study, Worktile was used as an online managing "kanban" tool, which provided a task assigning and managing page in "kanban" style, as shown in following graph.

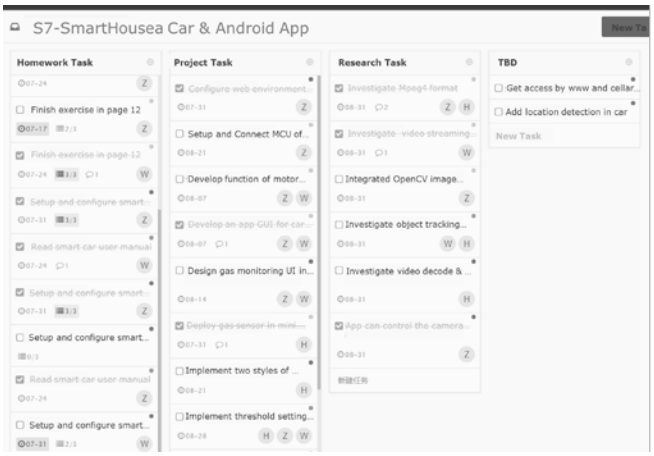

Fig 2. Task Definition & Assignment with Worktile Tool

After sprint plan meeting, all members who had been assigned with tasks started their daily development work. Considering about collegial situation and activities, daily scrum meeting was replaced by half-weekly standing meeting, which was organized by MM every Monday and Friday afternoon.

With Worktile tool, project progress in different types (in individual type, in task type, in difficulty) would be recorded and monitored.

Sprint Summary and Evaluation. At the end of sprint phase, MM and TO discussed about the status of project and judged if the sprint should be closed. Then MM informed all team members and held the sprint summary meeting.

According to Scrum principle, member effort should be evaluated by achievement and difficulty of his/her task or user story. In Training Scrum model, there were scores from 0~3 representing the completeness -“degree” or “stage” of task accomplishment, on the basis of inter-/intro-team comparison. Moreover, the responsibility of MM and TM should be considered as “role weight” in evaluation. At last, personal effort could be quantified as the product of difficulty, completeness and role weight. As shown in following table.

Table 4. Personal Evaluation in Sprint Review Meeting

Member	Tasks	Diff	Completeness	Role Weight	Total Score	Ranking
M.Wu	5	2	2.2	125%	27.5	2
J.Hu	5	2.2	2.2	125%	30.25	1
C.Zhao	5	2	1.8	100%	18	4
J.Zhao	4	2.5	2	100%	20	3

Following graph demonstrated sprint result and product for S7-SmartHouse Android App Project

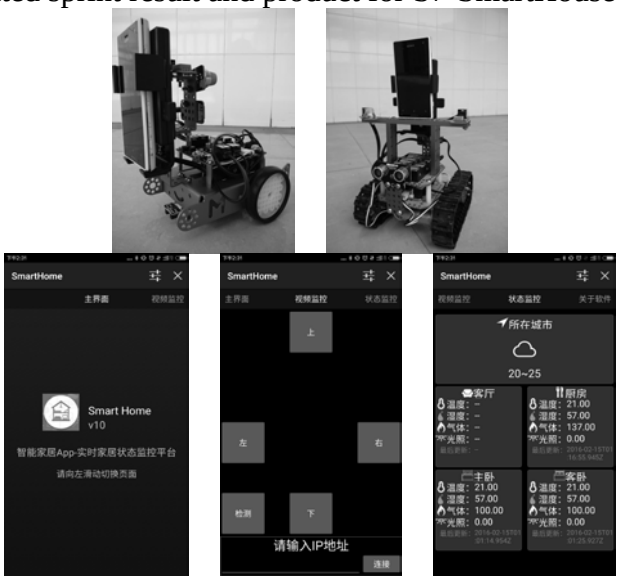

Fig 5. Demonstrated Product Output for S7-SmartHouse Android App Project

Summary

The purpose of this paper is to introduce Training-Scrum agile model in coaching and practical projects for undergraduate students majored in Communication Engineering and Electronic Information. Project result showed the "Training-Scrum" model had advantages in student's innovative and crossing field projects.

1. Training Scrum model combines agile principle and constructivism education theory in managing activities in student and research team project process, in which short-term training and practicing iteration had significant advantage in students' practical education;

2. Definition of "Training-Sprint-Accumulate" phases made the purpose of project more clear and impressive for students, who would benefit from the combination of lecturing and developing in new technique or area excluding from traditional class teaching.

3. In Training Scrum model, definition of Scrum role provided students with more chance and free space to exercise and perform themselves. As a result, students learned and competed from each other, reviewed their defects, and became more positive active participation to the project.

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