# Just-in-Time Teaching Visual Instruction for Cohort base Interactive Learning

## For Engineering Course

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*Abstract*—**Active learning tool – Just-in-time Teaching (JiTT) is enhanced with visual instruction and lesson plan in this action research based teaching and learning pedagogy research in engineering course that is Circuits. The JiTT was planed one year ahead to identify and gather the necessary topics for JiTT. The topics were carefully analyzed and visual instruction is found to be a better way for the content delivery during second time the Circuits course was delivered. A JiTT based lesson plan was also proposed and implemented in the Circuits course instead of the structured lesson plan. The observation shows JiTT with visual instruction and JiTT lesson plan has improved the course satisfaction, students' learning experience, and also reduced the teaching resources.**

***Keywords-component; action research, content delivery, just-in-time teaching, lesson plan, visual instruction.***

### I. INTRODUCTION

Most of the lesson time in common practice for engineering teaching is dedicated for the instructor to give lecture for the foundation of mathematic, and physic of that particular engineering course. The lecture session is then followed by hands-on or laboratory session to apply the mathematic and physic for the engineering course. A tutorial session is also required for coaching the student in problem solving and exercise. In this teaching style, the work scope of the instructor and venues (for lecture and laboratory session) are well allocated and the timetable can be well organized as well. However, it is more resources centered rather than student centered. Student-centered teaching style on the other hand, focuses on the student activity and interaction with other student and also the instructor [1]. In our practice, the lecture session and laboratory session are combined and interleaved, while the classroom management and course delivery involves mainly active learning [2]. In active learning, the students need to formulate questions, answer questions, and solve problems by their own with minimum instruction from the instructor. The students also involve in discussion, debate or brainstorming during lesson for cooperative learning. In this inductive teaching and learning methodology for engineering, the students are first introduced with an application and then learn the course material in the context of designing or implementing the application. In this practice, inductive teaching and learning gives the students to focus on problem solving or design challenges. One of the effective tool in inductive teaching and learning is JiTT [3, 4], which will be discussed in the work.

The objective of this work is to carry out an action research to understand and investigate how to implement JiTT in an interactive lesson with the assistant of visual instruction. Understanding the student learning experiment and reference can help in attract the students attention and participation in class [5], especially in engineering course where students are explored to various disciplines of knowledge both in theory and practical. More importantly engineering course should be application and design oriented that required higher hierarchy of learning level, [6]. In order for student to appreciate and master the content towards design phase, an effective teaching tool is required. One possible tool is to provide visual instruction to help the student learning curve besides effective course delivery in class [7]. Visual instruction has been a popular tool for course materials delivery. However, it is always a passive and one-way delivery to the listener. Thus the visual instruction should only be introduced to the students when there are indeed needed and just-in-time in solving their problem. In this case, the visual instruction could be a very power tool in cohort based active learning, especially for pre-lesson active learning, just-in-time interactive learning and post-lesson peer-to-pear group learning, where various visual instruction, question and answer, equipment handling skill, are prepared and delivered just-in-time for interactive learning during cohort base learning. For cohort base learning in one of the engineer course - Circuits & Electronics [8], was benefited by implementing JiTT with visual instruction, which is the subject of study in this work.

The implementation of the JiTT has the following scopes and goals:

- Improve the active and interactive learning effectiveness,
- Enrich the course content delivery in both pre-reading and post-reading, which are major part of active learning but so far were not effectively implemented,
- Accelerate JiTT in cohort based active learning with pre-prepared instruction, description,

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question, for hands on activities, case problem solving, design projects and etc.,

- Exploit effective time-management in classroom management with well-prepared visual instruction in interactive learning, estimate to double up the activities in comparison to traditional instruction.

The action research is carried out with the following approaches and emphasis:

- Action research based methodology,
- Plan the visual instruction that is required based on course syllabus, and feedback from students / instructors,
- Various visual instruction will be prepared based on the course material and design projects,
- Adopt and implement the visual instruction in Circuits & Electronics course delivery,
- Carry out in-time survey from students / instructors for continuous improvement,
- Reflection and continuous improvement of the visual instruction.

This work is a continuous process of improving the teaching and learning experience for both faculties and students in the following aspects:

- This work could significantly improve the student learning effectiveness, and enrich the content delivery bases on the visual instruction that fully complies with the syllabus and learning objective,
- At the same time, this work could improve the work efficiency of the instructors and laboratory assistants where various visual instructions could be reused and improved continuously.

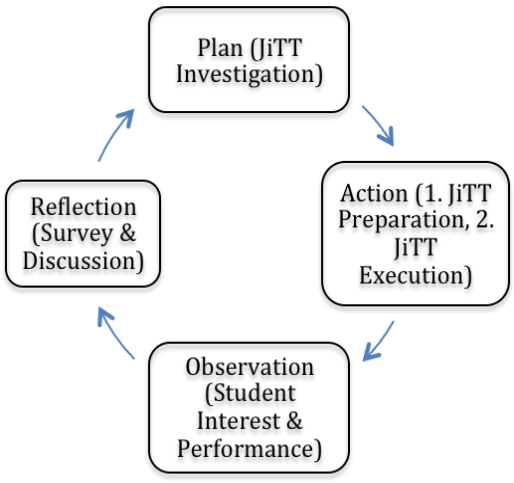


Figure 1. Action research for JiTT video

## II. Methodology

Action research methodology was adopted in the pedagogy research. The action research flow is illustrated in Fig. 1. The course under study is Circuits & Electronics. The pedagogy research was initialed and planed in 2013 when the course was first launched. In this planning phase, the teaching and learning process was recorded and analyzed to figure out what is learning topic that can be better delivered in the subsequent time the course is repeated. Basically, reflection and experimental teaching and learning pedagogy are the ground of this work [9]. The main focus is on the topic that can be covered and explained during lesson. It was found that one of the critical topic is the hands-on session where the student need to know how to use the equipment and software for testing and design. It is also found that conducting lesson to cover know how of the equipment and software is very resource intensive, where a few teaching staffs is required to guide the students. Merely supplying manuals could not improve the student learning curve, and not effective. This planning phase identified this important topic to be covered in the second time the course is offered, and bring us to the JiTT video preparation in the action phase. The details are shown in Fig. 2.

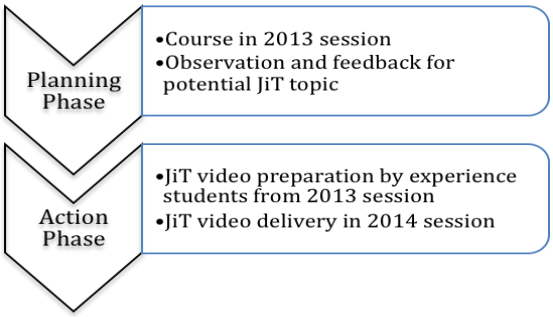


Figure 2. JiTT video preparation and delivery phases

The action phase in fact was divided into two parts: Part-1 JiTT video preparation; Part-2 JiTT video delivery. Part-1 was carried out right after the course was completed first time. Part-2 was executed during the second time running of the course in 2014. It is worth mentioned that Part-1 JiTT video preparation was by the students that has taken the course. They understand the requirement of the JiTT. They also proposed the exact detail execution of the video preparation, which is important as the video was prepared specifically for our course and students with similar background. The video was taken in the same laboratory setup using high resolution Fujifilm mirror-less camera. Miror-less camera was used instead of digital single-lens reflex (DSLR) camera to avoid heating problem in DSLR camera for long video taking. High-resolution video is required for better editing and processing. High-resolution screen capture is also required from the video for written instruction preparation. The video was then processed and edited with iMovie in MAC. Various effects were added to the video for a better video instruction, eg. narration, subtitle, annotation, soundtrack and etc. For a video for fifteen minutes, the average preparation time was approximately six hours with two persons effort. The video preparation involves no special setup in a common laboratory. To avoid interference and disturbance, longer preparation time is taken than expected. The preparation time can be reduced in a dedicated video taking room and proper setup room.

## III. Just-in-time Teaching in Action

JiTT also requires re-structure of the lesson plan to ensure a good transition of the lesson delivery during a formal lesson. The structured lesson plan is depicted in Fig. 3. Instead of topic by topic lesson delivery and followed by an application design as shown in Fig. 3, the lesson was started with a selected application that is a system design approach. The lesson delivery then focuses on the application analysis, design, and implementation. The lesson plan is illustrated as in Fig. 4, which is kind of active learning using JiTT and enhance with visualization, which is JiTT video in this case. In the JiTT lesson plan, we start with a digital electronic application design requirement, eg. adder, and end with the same topic. In order for the students to design the adder, a loop back is required to the first lesson of the adder introduction. In this lesson plan and execution, the linkage between the topics is stronger and the students can follow the lesson better. A simple survey for lesson satisfaction for digital electronic for 2014 session that applied JiTT lesson plan is approximately 90% in comparison to merely 60% in 2013 session that applied a structured lesson plan. This is a remarkable result in the view that logic gate and Boolean algebra are in fact not an easy topic to many students who are not familiar with logic.

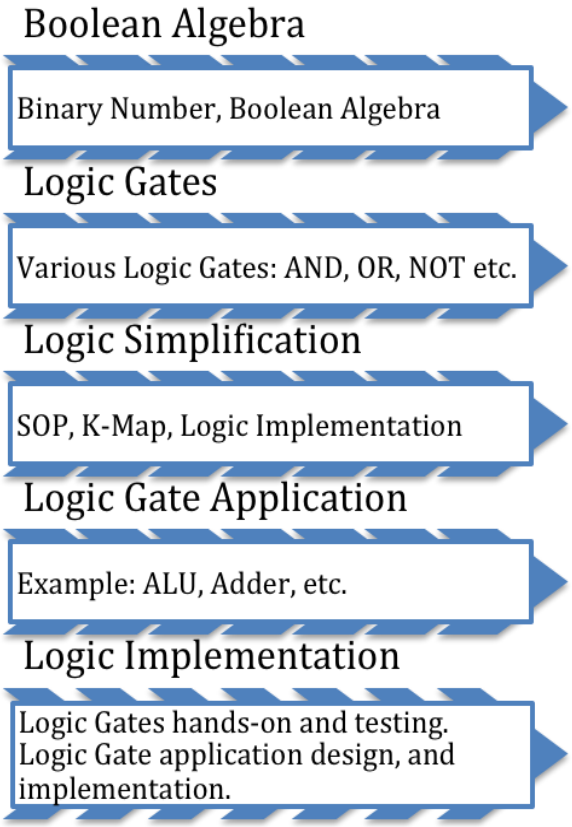


Figure 3. Structured lesson plan for introduction of digital electronics

The advantages of the JiTT lesson plan are obvious in our action research. In comparison to the structured teaching and lesson plan, students' participation in JiTT lesson is very encouraging. This can be observed in the following activities:

- hands-on activities of the adder design,
- using equipment for test and measurement,
- electronics assembly on the strip board, that involves soldering, wiring, and verification,
- electronics selection for user interface for the adder design.

All the students successfully designed and implemented an application using logic gates from analysis, design, implementation and prototyping within one week after the lesson. Worth to mentioned that 92% of the students has this course as their very first experience in circuits and electronics.

In term of the teaching resources, JiTT video has reduced the manpower requirement and also the consultation hours in 2014 session in comparison to 2013 session. Manpower for handling the electronics design activity has been reduced from 4 to 2, which is 50% reduction. This helps the laboratory managers to focus in other design activities. The greatest advantage comes from the reduction of the consultation time spend for coaching

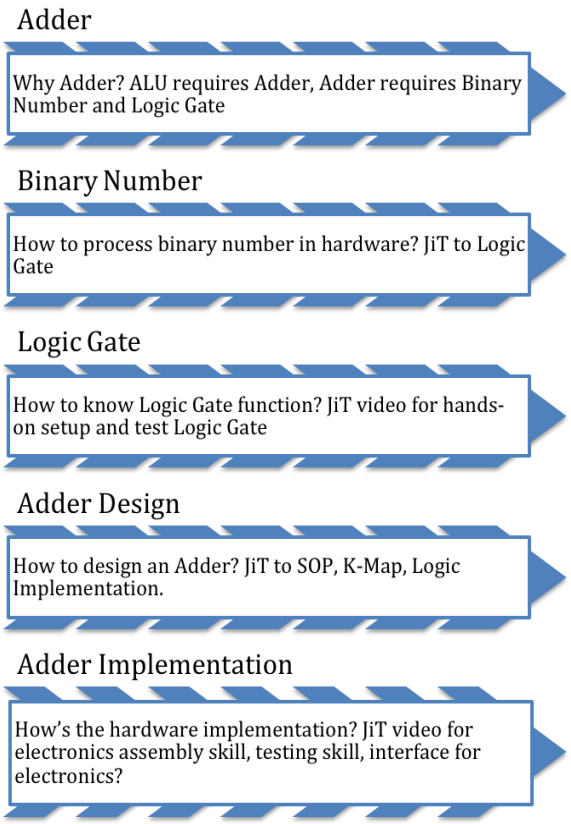


Figure 4. JiTT lesson plan for introduction of digital electronics

the
students in using equipment to handle test and measurement, merely 10% time spent in 2014 session in comparison to 2013 session. Students can easily pick up

these skills through the JiTT video. JiTT video can be viewed several times by the students to clear their doubt in handling those first time seeing complicated equipment and electronics handling skill. JiTT provides a closely related and interlink learning activities for the students, where they know what to do, and how to do.

In the reflection phase, students' interest in JiTT video was investigated. The summary of the observation is listed in TABLE I. We have 98 students in this lesson that was divided equally in two cohorts. This is very clear that JiTT video is a preferred teaching tool for the students. The students request more JiTT videos also. These results should encourage the teaching staff and the school to support the production of the JiTT videos and also the JiTT lesson plan.

TABLE I. SUMMARY OF THE OBSERVATION.

| S/N | Observation | Note |
|---|---|---|
| 1 | 91.8% (90 students) have not used NI Elvis-II before attending Circuits & Electronics lesson. | NI Elvis-II is one of the equipment for test and measurement. |
| 2 | 90.8% (89 students) think the videos are useful for hands-on and design activities. | Video was also prepared for other design activities besides JiTT. |
| 3 | 91.8% (90 students) would like to have more video in helping the hands-on and design activities. | Video was also prepared for other design activities besides JiTT. |

## IV. CONCLUSION AND FUTURE WORK

In this action research project that took almost one and half years, JiTT video in course material delivery was instigated and implemented. The project shows how video can be integrated into JiTT lesson plan, and improve significantly the student learning experience, while reducing the teaching resources requirement. The JiTT visual instruction can be extended in interdisciplinary learning [10], which involves various design activities. At the same time, it is also possible to reuse the visual instruction for massive open online learning (MOOC) to benefit more students [11], with proper setup and course management that should be student centric in our desired implementation, [12].

In order to produce high quality JiTT video the below facilities are required for JiTT video preparation:

- video / audio capture devices,
- a sound proof filming room,
- a dedicated laboratory with filming facilities and also the laboratory equipment,
- a dedicated iMAC (Apple desktop) with dedicated microphone for video / audio processing for the video.

The students helper who supported the JiTT video has to prepare the video and video processing during night time or weekend where that's no disturbance from other activities in the laboratory. It is proposed to have dedicated resources for the JiTT video implementation.

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