WIP - A Modification to the Case Study Method to Teach Students to Read Academic Papers

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***Abstract*—Most learners are introduced to academic papers in their graduate work. Typically, most of us learn to read and understand these papers by reading many of them and listening to more senior colleagues and teachers describe and interpret these papers in the class or reading groups. As our experience grows we become better at this skill. There is a need to read papers in a particular research area to provide an understanding of what has been done in the area, and what questions remain unanswered.**

We describe a work-in-progress to help teach students to read academic papers and build a base understanding of a field under the broad framework of case studies adopted and developed by business educators. This approach requires students to prepare for a discussion on a particular case in a class, mostly, independent of the instructor. We have applied a number of these best practices from case study teaching and applied a modified approach to a sequence of papers a research area during a course. We applied our modified technique in 2015 with 10 students, and students commented on how the approach helped them, significantly, in being able to read and understand academic papers.

I. Introduction

A common skill needed by many professionals and academics is the ability to both read and write academic papers. In a student career path, the first time these journal and conference papers are introduced to be reader is in graduate school if not as a senior in undergraduate. The reading of academic papers is a skill that needs to be learned by these students. Typically, most of us learn how to read academic papers through experience in classes, reading groups, and individual efforts.

Reading academic papers can be challenging, but even more challenging is finding, reading, and synthesizing a number of papers within a research area. For one, selecting seminal papers in a research area is not easy, but contextually placing these papers is a skill and effort that takes significant time. Many of us rely on a reading groups dedicated to a broad research areas that will read enough papers and to help us develop this knowledge. Another common approach is to take a senior or graduate level course that provides some of us the context and ordering to start our understanding of an area.

In this work, we propose a framework to give students experience with reading a number of papers in a specific research area using the case method approach created and used in a number of areas, originating in business [1], [2]. The approach forces students to prepare by reading the paper and then entering a safe learner space in which all the students discuss the case/paper. The instructor picks the cases/papers to discuss, and during lecture, the instructor documents the discussion, records participation, and guides discussion to help the learners when needed.

We used this approach in a cross-listed fourth year undergraduate and graduate course in FPGA CAD. This approach was used in lectures so that a number of papers in the related research area were read and discussed. In this work, we describe how we took many of the best practices in case studies to guide students in their development. As this is a work-in-progress all we have is anecdotal comments from students on how they felt that this approach helped them significantly in their ability to read and understand academic papers in FPGA CAD. Our future goal is to take this approach and record and disseminate students skill development in this area.

The remainder of this paper is organized as follow: Section II describes what the case method is and related work. Section III describes our framework in our class and provides details on our approach to guiding students in a case study of a paper. Section IV briefly discusses our view of the approach based on anecdotal views from students. Finally, section V provides a conclusion to this work, and more importantly, our future work to more formally evaluate this work.

II. Background - Case Method for Teaching

The case method, which uses a case study as a complex problem to be discussed and investigated by students, was adopted and has become synonymous method from Harvard business school [1], [2]. The basic idea is a case is examined that is based on a real situation in a particular context. This presents a situation of some complexity, and case participants need to discuss and come to some solution(s) or plan(s) for the case. Shapiro's book [3] lists the basic process as:

1) Case learners prepare for the case by reading and analyzing it
2) Optionally - students can perform a deeper preparation by having a priori small group discussions
3) An in-class discussion is done for the case
4) An end-of-class summary is provided by the facilitator

This approach is used in many higher educational settings such as business, law, and medicine, and the method has been

adopted in other fields such as science [4]. The case method employs an active learning principal that focuses on student-centered learning [5]. The majority of the work requirements is on the student, and some research evidence in law has shown that the students who are taught using the method are not necessarily better lawyers as might be hypothesized [6].

As there are many books on the case method, our approach used ideas from Rosenthal and Brown's book for examples of pedagogically strong cases [7], and Barnes, Christensen, and Hansen's book [8] on how to teach cases (readers should note that this book is not only good for learning about the case method, but is also an excellent resource for learning about teaching). Additionally, we attended a discussion with Rosenthal on "How to use case method" in 2014 at Miami University.

In terms of how to read scientific papers, we are not aware of any formal research on this topic. Reading comprehension is a popular topic in K-12 education and higher-education research, but this does not focus on the topic we are interested in. As for information on how to read scientific papers, there are some online articles such as "How to (seriously) read a scientific paper" (Accessed January 31st, 2017 - http://www.sciencemag.org/careers/2016/03/how-seriously-read-scientific-paper).

III. Case method as applied to in-class paper discussions

The goal of this work is to create a framework to help learners understand how to read academic papers as related to a research area. The framework we propose for this is a modification of the case method used in a number of areas. In this section, we describe our framework as applied in a class on FPGA CAD taught in 2015 to five undergraduate students in their 4th year and five graduate students.

TABLE I. Papers covered and the areas covered

Number	Paper	Area
1	[9]	Architecture Survey
2	[10]	CAD Survey
3	[11]	Architecture - Homogeneous FPGAs
4	[12]	Architecture - Heterogeneous FPGAs
5	[13]	Architecture - Routing Architecture
6	[14]	CAD - HDL Synthesis
7	[15]	CAD - Techmapping
8	[16]	CAD - Packing
9	[17]	CAD - Placement Optimality
10	[18]	CAD - Placement
11	[19]	CAD - Placement and Routing
12	[20]	Creating FPGAs
13	[21]	Power Measurement
14	[22]	FPGA quality to ASICs

Within this course, the goal is to learn about CAD for FPGAs, which includes an understanding of both FPGA architecture (which is a specific type of integrated chip that has reprogrammable properties) and the algorithms that map a design to these architectures. Table I shows the papers covered in this course and the topics that they cover.

Before class discussions begin, the first lecture is used to make a contract as to behavior during each discussion. Each student is required to read the respective paper before class and make notes on the paper. One (or more) student is selected before the class as the discussion leader for the paper, and as the leader, the student is required to make additional notes and questions to guide the discussion for three-quarters of class time, where class is 75 minutes. Each student makes a name-tag that is displayed in front of them so that other students can identify each other and use their names in discussion. Each student is expected to participate in the discussion as described in the contract, and this is recorded by the facilitator.

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Base Notes
- Facts early - 70% routing, Gap in area
- Question is area efficiency of hetero with and without shadow clusters
- 2 types of hard circuits - Carry chains vs. Multipliers
- Economics supply and demand ratio
- Shadow Cluster
    - Pin Demand
- Experiment
    - Real benchmarks
    - Synthetic benchmarks

Board Plan
- Structure of this paper (accross top or left side)
- Experiment heavy
- Methodology and tools

Student question...
- Everyone can add a anonymous question or misunderstanding

My Questions...
- What is the key reason this idea is a benefit?
- How was W picked?
- Booth encoding?
- How were the synthetic benchmarks created?
- How would you build the tools to do this?
- Do modern FPGAs have shadow clusters?

Paper Structure and Ideas
- Terminology used versus invented
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Fig. 1. Facilitators notes in preparation for the class discussion

The facilitator is required to do a number of tasks withing this framework:

1) Prepare for the discussion by reading the paper, making notes, preparing some questions to stimulate discussion (if needed), and planning out a general flow for the board - Figure 1 shows the prepared notes for paper 4
2) Record if each student has sufficiently participated in the discussion
3) Write on the board notes from the discussion to frame what the students are doing
4) Refrain from talking in the discussion as much as possible unless the discussion goes off topic
5) At the end of class the facilitator reviews the discussion using the board to identify poignant and missing points during the discussion

Figure 2 shows the discussion as captured on the board from paper 4 (in Table I). Note that there are a number of red question marks included on the board; these notes are used by the instructor to highlight additional questions as related to the discussion. These questions or notes are remarked on in the instructors final review.

This framework is the same as the case method approach, The main difference between using this approach for papers instead of cases is that the discussion focus is less about a cases discussion of "what to do" and is instead a discussion of "what was learned". The main challenge for an instructor is how to pick the set of papers that will be included in the class. The good thing, however, is an instructor is, usually, an

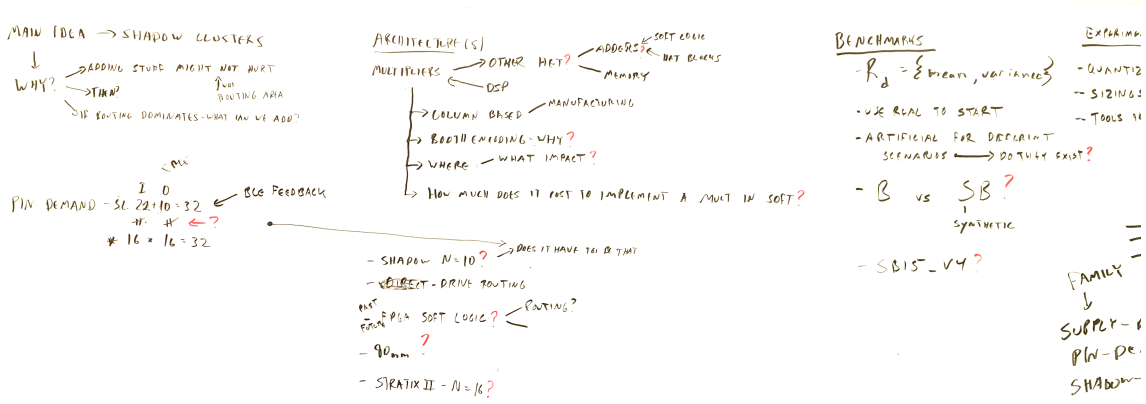

Fig. 2. A sample board from class created by the facilitator. Note the red questions marks if viewing in black and white.

expert in the topic area, and if survey papers exist for the topic area then they also provide a good starting point for students.

Since a number of papers is presented over time, ideas on how to read academic papers can be included in the final discussions. Some of these ideas include:

- Is the new terminology in this paper invented by this work, existing within this research community, or academic vocabulary?
- Is there a common structure to papers?
- How do you compare similar papers to one another, and is one paper better than the other?
- Could you replicate the experiment and do you think your results would be similar?
- How does an industrial produced academic paper differ from one generated strictly from academia?
- What can be learned from looking at the citations other than where the information came from?
- How does an abstract differ from the introduction and the conclusion?

IV. Discussion of What We Learned

We believe the above described approach is as good as or better than the traditional experiential random walk that most learners experience when developing their academic paper reading and contextualizing skills. While both methods for reviewing individual papers are learner centered, the case methodology approach provides hands off guidance with structure. The method is applicable in the classroom and could even be adopted in a seminar or reading group. The focus on a research area and using more than one paper allows students to get a good introduction to the area.

The course participants felt this was the best aspect of the course, and a number of students in the following year requested to audit the course just to experience the paper reading aspect of the course. We do not have a formal assessment of this work as this is a work-in-progress. One of our plans is to provide a pre and post assessment where students are asked to summarize a few sections of existing papers. One trick we may use is to include excerpts from an automatically generated paper using the work by SCIgen project (https://pdos.csail.mit.edu/archive/scigen/). The hope is that students will be able to identify poor/fake work once they've completed the course.

This approach, however, does not compare our framework to existing traditional approaches. We have not come up with a research plan to answer this question.

V. Conclusion and Future Plans

In this work-in-progress, we described our modification to the case method approach to teaching for introducing students to reading and discussing academic papers in a research area. In this case, we implemented our approach as part of a senior/graduate course on CAD for FPGAs. The key aspects to this approach are the way in which discussions are facilitated. This includes both the facilitating of individual papers and the overall organization of multiple topics as related to the research area. Finally, we discussed how we think the approach was successful and how we plan to more formally assess our approach.

In future, we plan to assess our framework more formally as described in the discussion. There are two other ideas we would like to implement in the future: one, including a fake paper in the sequence to determine if students are doing their work, and two, having students do a paper review of either one of the existing papers or another paper similar to what academics do for conferences and journals.

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