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Teaching Accelerated Courses

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ABSTRACT—*Time-shortened accelerated courses are common in many academic programs. In such courses the student, instructor contact hours, which is typically 45 hours, is accomplished in four or six weeks. Working adult students are often drawn to these intense courses since they can continue with their regular daytime jobs and attend classes in the evenings and weekends. Teaching these courses in an accelerated format is a challenge, yet a bigger challenge is to ensure students achieve the learning outcomes in such courses. Past methods and practices do not fully address this mode of teaching and learning. The typical educational paradigms such as behaviorism and constructivism were used to serve industrial growth and expansion by supplying workforce with conformity and standards. With the recent advances in technology and the available learning tools, adequacy of these current paradigms are questioned. Industry and the market are demanding creative problem solvers, where diversity of talents is more useful than conformity of skills. Many institutions now offer short accelerated courses but there seems to be a lack of comprehensive studies on the impact of these short courses on student learning. Best teaching practices in accelerate format, particularly in science and engineering, and ways to enhance student learning haven't been fully investigated. There are several emerging alternatives for learning that need to be evaluated in order to investigate the challenges and opportunities with accelerated programs. This paper examines past practices and evaluates new trends characterizing some of the emerging paradigms in education that can be employed in teaching accelerated courses. Based on some preliminary results and analysis, the paper proposes a teaching approach for accelerated courses that has produced promising results in more technically oriented classes that may be applicable to other disciplines as well.*

Keywords—Active learning, concept mapping, cooperative learning, educational paradigms, experiential learning.

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1. INTRODUCTION

Teaching computer science courses in an accelerated format is a challenge but making permanent learning happen in such a short duration is a bigger challenge.Many questions in the area of accelerated teaching and learning remain unanswered. In particular, which teaching approaches can enhance and maximize student learning and make it more permanent. Suggested learning theories in the literature (Learning-Theories.com) fall into one of several paradigms. Behaviorism perspective founded in the early 20th century by John B. Watson is based on stimulus response [1], and suggests that behavior is caused by external stimuli, and not by the internal mental states or consciousness. Based on this, learning may be reinforced by praises or punishments. This paradigm was effectively replaced by the cognitivist paradigm founded in 1960s by Noam Chomsky [2]. Here, learners are viewed as information processors who are not programmed to merely respond to external stimuli; rather learners are rational beings whose actions are a result of thinking. Another paradigm, the constructivism paradigm, was proposed by John Dewey, Jean Piaget, Jerome Bruner, Lev Vygotsky and others [3] where learners are viewed as information constructors who continuously form their own representations of reality, where new information is connected to and understood based on prior knowledge. The final existing paradigm mentioned here is the humanism paradigm founded

by Abraham Maslow, Carl Rogers and others. This is based on the idea that learning is a personal act to fulfill one's potential. It is student centered and personal, facilitated by teachers, with the goal of developing self-actualized people in a cooperative and supportive environment [4][5].

Available and improving technologies today are introducing new paradigm shifts in learning. It is enabling us to understand the power of learner reflection and critical thinking.It is enabling us to help students become self-learners and encouraging them to take responsibility of their own learning. The traditional classroom-based one way (teacher to student) education is no longer an effective mode of teaching, especially in an accelerated format class. The internet and other technologies are helping us deliver materials and information by alternative methods, and this is reinforcing the concept of self-learners. These benefits hold great potential and new opportunities for accelerated education that can create a more universal approach to teaching and learning. The one-size-fits-all teaching model where all students are expected to learn the same way is no longer necessary. Sir Ken Robinson, in his TED talk "Bring on the Learning Revolution", suggested that a major transformation is required in the way we teach [6]. We have the opportunity and the technology, and now the challenge is to implement this transformation for different delivery modes, including accelerated format computer science courses.

Minimally Invasive Education (MIE) was introduced by Mitra in 2000 [7]. This is a pedagogic method, deriving its name partly from the medical term 'Minimally Invasive Surgery' [8][9]. The concept of MIE was formed over time, based on observations and educational experiments conducted at NIIT, India [7]. The observation was that groups of children learnt to use computers on their own, irrespective of where they were. If computers were made available to them in a safe, public location, then the children were able to teach themselves how to use the computer. This method of acquisition of knowledge does not depend on the presence or the availability of schools or teachers. Also, this is significantly less expensive than traditional methods of computer education. Therefore, in circumstances where schools and teachers are absent, MIE learning stations with tools and learning resources are adequate substitutes. Countries, cities or locations hit by natural disasters or war, or places affected by economic or social problems, are candidates to benefit quickly and reliably through such self-learning method [10][11].

This research focusses on one specific aspect of this new paradigm shift and the opportunity this provides for accelerated classes. This is based on the fact that for accelerated format delivery of course material, students need to be self-learners and teachers need to encourage and promote an environment where the learner has the opportunity to reflect and think critically to understand the concepts at his/her own pace. Furthermore, group discussions promote reflective and critical thinking and with the aid of available technologyremote students can also participate in group discussion. Educators, content providers and facilitators must encourage learnerreflection and try to help students develop skills necessary to think critically, thus enabling and encouraging learners to take responsibility of their own learning.Critical thinking involves a range of thinking and evaluation skills with the objective of reaching some desirable outcomes. Reflective thinkingfocus on the process of making judgments about what has happened. These reflective and critical thinking are important in promoting learning during problem-solving situations as this provides learners with an opportunity to pause and evaluate alternatives and also think about how they actually solve problems and how an alternative is appropriate for achieving their goal. Encouraging learners to think about what and how they are learning can promote understanding. Creating learning opportunities that include self-assessments and self-evaluation are ways to support reflection and critical thinking. This paper describes the main opportunities, some due to advances in technology, that may be used to promote reflection and critical thinking in learners in time-shortened courses.

Availability of technology is playing a major role in creating learning opportunities in accelerated education. In addition to desktops, laptops, internet, tablets, cell phones and other products and services, learners today have access to virtual classrooms, virtual machines, simulators, emulators, cloud, and other software products that are enabling learners to try new concepts, not only in a theoretical form, but also hands-on. Students are able to test their solutions, try different strategies and confirm their theoretical conclusions with immediate feedback in a very non-threatening environment. This encourages creativity and thinking out-of-the-box that promotes reflection and critical thinking. Technology has brought us an unprecedented ability to share resources for learning. Peer reviewed teaching and learning resources are available for free in most disciplines and can be found directly on the internet. An excellent example is the Multimedia Educational Resources for Learning and Online Teaching at http://www.merlot.org. Another popular site is the Khan Academy at www.khanacademy.org, started by Salman Khan, containing thousands of short video lessons on varied topics. Well established Harvard University in Massachusetts, USA has produced a collection of good online academic and learning resources with the goal of making educational content available to a global audience. Although creating and distributing content has become significantly more easier and efficient, the challenge for educators and content providers now is to include the most appropriate and useful material in their courses, thus avoiding information overload. These materials will enable the students to learn the topics in the most effective and learner specific manner. Learners today are increasingly tech savvy and

expect information available on different platforms. The ability to browse and learn on their own has become a growing expectation for many digital natives.

In a study by Orso and Doolittle [12], the authors identified communication, availability, and feedback as the primary characteristics that students felt were important in their learning experience. They needed frequent, timely communication and fast feedback on their assignments, quizzes, and email questions. This kept them engaged and interested.In flipped classes, described by Salman Khan of Khan Academy at www.khanacademy.org, instructors have the ability to handle and work with more students while maintaining learning quality. But even with more students, one important feature that technologies have contributed in the education field is the ability to get back to the learners faster with answers to their email questions, grades, and evaluations. This creates a win-win situation where more topics can be introduced and the student experience is improved. As more technologies become available it is expected that this positive aspect of accelerated education will improve further.

2. EMERGING PARADIGMS AND RESEARCH METHODOLOGY

Computer science courses are mostly technical and logical in nature. Contents are based on mathematical concepts, conceptual designs, and detailed implementations. They require analysis and critical thinking. Keeping this in mind, the current research evaluates the emerging paradigm of flipping the classroom that have had reasonable successes and proposes a variation of this approach. There is an opportunity to develop the potential of the individual learner, so that she can concentrate on her interest and develop it to the fullest extent. The use of computers in engineering education introduced a highly self-directed form of learning in technical programs. Computers can be used for simulation of highly complex concepts and systems in engineering and they are becoming a vital component of tools used in new paradigms in computer science.

The flipped-classroom approach with the Khan Academy delivery method shows enormous potential for a viable alternative to old paradigms in education. It has drawn considerable attention among learners, teachers, investors, and philosophers [13]. This new approach in teaching is a pedagogical model in which a lecture, consisting of a presentation in front of the classroom by the instructor, is replaced by short video lectures viewed by students remotely before the class session. This allows in-class time to group problem solving, presentation of projects, and interactive discussion of topics by students. The video lectures are the key ingredient in the new flipped approach. With emerging computer technology such lectures can be created and the most complex concepts in engineering can be explained by animation and simulation, and viewed repeatedly as needed by students both before and after they attend the lecture. Or, in an online modality, they replace the lecture. With emerging, powerful mobile technology the class educational resources and videos can easily be accessible by students at times and places, with miniature mobile devices, that were not previously possible. “According to Inside Higher Ed, a recent study by the Campus Computing Project showed that more than two-thirds of U.S. colleges and universities already are, or willing to start, using lecture-capturing software to make lectures available to students at home. Proponents argue that flipping courses inspires students, gives them more control over their own learning, and frees more class time for meaningful interaction [14]. The flipped classroom changes the role of instructor from delivering lectures to engaging students in problem solving and hands-on exercises during the class-time. The emerging new paradigm of flipped classroom places the responsibility for learning on the students and gives them encouragement, and opportunity while building self-confidence, for experiments and problem solving. However, the flipped classroom model introduces students to an environment of reduced lectures. This will have particular impact upon students who learn best from personal lectures presented in-person by professors.

Robinson’s philosophy of development of diversity of talents for creative problem solving in new learning environments calls for a paradigm shift in education[6][15]. He argues that one needs to find his or her element, and nurture and develop it through education[15]. Often very creative personsdrop out of traditional college because they cannot nurture their primary interest. Those who stay in college in those circumstances endure it and do their best to survive[6]. Steve Jobs, creator of iPhone, states “. . . it was one of the best decisions I ever made. The minute I dropped out I could stop taking the required classes that didn't interest me, and begin dropping in on the ones that looked interesting”[16]. A substantive part of Robinson’s thesis explains how the traditional educational system is structured in an outdated learner process of “one size fits all” without paying enough attention to student’s interests. The system imposes stringent rules on students based on obsolete learning assumptions and conformity. Although critical theorists have raised this issue in the past, Robinson highlights it more emphatically. He points out that the motivation behind the current system is to organize students into arbitrary categories, packing them up like bars of soap, without reference to their individual talents[17]. Robinson’s writings and videos explain about how people learn in different ways. The central problem is that “traditional teaching methods largely ignore the multidimensionality of experience, of the subject, of phenomena and of knowledge itself. As Robinson concludes, the result is often how only a small portion of students find themselves in a position where the information that is rigidly

handed down to them can be grasped, and in a way where they manage to work through the restrictive and highly ideological confines of that information"[17]. Robinson and his followers suggest that rather than sponsoring and encouraging the exploration of phenomena in open and divergent ways, students are subjected to rigid forms of education. Many of the old paradigms promote an authoritarian and controlling theory of education over an organic theory of divergent and free-flourishing education[17].Therefore while the old paradigms are driven toward conformity and standardization, Robinson suggests that we should be going the other way. Robinson is working out the details of identifying one's element or talent and then organically developing it. He states that "Finding your element is a personal quest"[6]. The main advice from Steve Jobs to students reaffirms the same theme[16]. Steve Jobs would also agree with Robinson's[15] views and statements.

One may argue that creating one's own life is not easy for many people who do not have adequate resources and opportunities. Robinson's philosophy of an autonomous, divergent and free-flourishing education wherein a student finds his or her element, nurtures it, and designs an educational experience based on their primary interest may very well work for the highly motivated, exceptionally talented and well prepared students who have had pre-college access to advanced educational experiences and exposure to a variety of career options through their parents, relatives, family friends, teachers, school counselors, college recruiters, older siblings, etc. For the vast majority of students, however, this ideal situation is far from reality. College educational experience is very challenging, and without the appropriate background, preparation, exposure, experience and support, designing their own educational experiences that would lead to success would be nearly impossible. As a result, adopting an educational system that is based on Robinson's philosophy could lead to an engineering profession that is even more exclusive and inaccessible than it already is.

In this research, the authors'objective was to experiment with one particular teaching strategy in an accelerated computer science programming class. The class met 10 times over a one month period andeach class session was 4.5 hours long. Students were primarily adults and had no prior programming background. Although flipping classroom was a promising option for this class, however the authors felt this approach might not work well with adult students whooften carry a heavy load of family and employment responsibilities. It was felt that although the course was accelerated, the long class sessions can provide a unique opportunity and enough time for the instructor to introduce and develop entirely new concepts to students. In fact, the extended block of class time enables the instructor to utilize a mix of teaching strategies to ensure students are engaged in discussions, critical thinking and reflection.

All class sessions under study were held in a computer equipped classroom with the necessary programming tools. The lectures consisted of presentation of new programming concept by going over a short code segment using PowerPoint slides or on the whitebeard and sometimes both. The lecture was followed by live coding. Instructor led the programming examples and students followed writing the same code on their own computer. The instructor led programming presented opportunities for additional classroom discussion of the concepts and "what if" sort of analysis that was possible since the output of the program could be examined instantly. This approach also allowed students to interact with the programming environment and related tools that exposed them to compiler messages and syntax errors.

At the end of each class students were given one or more programming assignment as a project to work on in teams of two or three students. The programming project was graded to encourage and ensure full participation. To promote students teaching and further discussions among team members the project required that teams must ensure that all members have a good grasp of the concepts. To better understand the effects of this approach, a questionnaire, shown in Table1, was administered to students during the last class session.

3. DATA ANALYSIS AND GUIDELINES FOR BEST PRACTICES

Table 2 shows the student responses to the questionnaire. There were 26-27 responses. Analysis of these responses did not show dependencies on questions 1, 2, and 3. Factors that improved student learning did not depend on whether the student was employed, or whether the student was a graduate or an undergraduate student, or if they had any previous programming experience related to computer science. Responses in Table 2 to question 4 are the number of rankings between one and three for each mode of class work. High scores were for PowerPoint presentation, group work, discussions, and lab work. Question 5 responses indicated about 10-15 hours of self or group study time outside class per week. This number was expected, based on the content and the amount of work assigned for self-study weekly. Question 6 responses clearly indicates that in-class group projects helped student learn the concepts. Responses to question 7, once again, confirmed that group work, class discussions, and lab work in class were important to the students and these items helped them in in the learning process.

Table 1: Questionaire 1

Questions	
1	Are you employed? (Yes/No)
2	Are you a graduate or undergraduate student?
3	Did you have any programmiing experience before taking this class? List programming classes and languages and where/how you were exposed to them.
4	Which teaching style works best for you, select as many as you want but rank with (1, 2,…) where (1) designates best approach. a. Power Point Presentations b. Video Lectures c. Group Work d. Discussions e. Labs f. Others (specify …….)
5	On average, how many hours can you study outside classes weekly?
6	Do in-class group projects help you learn the concepts?
7	What would have helped you do better in this class?

Based on the survey results and the class experiences of the authors with time-shortened courses with long class periods, the following best practices for teaching computer science accelerated courses are suggested that may be applicable to other disciplines as well. These practices in the content and delivery design may be used to promote reflective and critical thinking in learners.

Partially Flipped Classes: The flipped-classroom approach has shown potential as a possible alternative to old paradigms in education. This changes the role of instructor from delivering lectures to engaging students in problem solving, experiments, and hands-on exercises during the class-time. Although flipping classes has worked well, but it is based on the assumption that students do their study outside class. In our case, with busy adult students this may not work as well. What we have that works to our advantage is the long blocks of class time. The extended block of class time provides a great opportunity and the required time to properly treat a topic, engage student, and be creative in classroom in terms of mixing teaching strategies. Due to longer class time, it is quite possible to allocated classtime for student self-study, and discovery. In a way the outside studying (in flipping) is still done in class perhaps in teams and possibly guided and facilitated by the instructor.

Each class is planned to consist of four parts:

1. Guided student self-study – students are asked to review existing video lectures and lessons in class for a short time. A class discussion should follow this initial self-study step. This step can also be used to informally introduce the problems students would be working on for class project. There can be variations of this step, for example, class may starts with a quiz with questions from the topics that were assigned in the previous class. The quiz should be designed to help student assess their understanding of the night's lecture.
2. Short lecture/discussions – in this step instructor provides additional lectures filling in gaps in student knowledge. Lectures based on descriptive examples and hands-on examples are encouraged whenever possible. The presentation by the instructor covers topics students have studied on their own, ending with reviewing and going over the quiz, if any, taken by students in the first part.
3. Group project – students work in groups of two or three to solve problems related to night's lectures and perhaps previous lectures. This part consists of group activities, critical thinking, and problem solving. Students collaborate and work in groups to solve relevant and practical problems assigned by the instructor. Reflection and critical thinking by the individual students and the groups are promoted and encouraged. This part is graded. The role of the instructor here is to encourage students and groups to evaluate different approaches to solving the problem

4. Closing the class by goingover the in-class group project. This part includes a discussion and solution to the problems in project. This part can also include introducing the next topics with reading assignments for the next class. The authors have termed this paradigm as the partially flipped class as there is the traditional presentation by the instructor in the second part.

Class Projects: In-classprojects for each class are designed to incorporate all aspects of the current and past topics covered so far in the course. This helps learners to use the learned concepts, try out new and different solutions and evaluate the pros and cons of each approach. Instructor facilitates the discussions and encourages students to think critically and logically.This is where teamwork, collaboration, discussion and student teaching come into picture.

Table 2: Responses to Questionnaire of Table 1

Questions from Table 1	Number of Responses	Response Category					
1	27	No	Yes				
		19	8				
2	26	Undergraduate	Graduate				
		16	10				
3	27	No	Yes				
		19	8				
4	26	Ranking Between 1-3					
		PowerPoint	Video	Group Work	Discussions	Labs	Others
		12	2	17	17	12	7
5	27	0-10	11-20	>20			
		17	7	3			
6	27	No	Yes				
		4	23				
7	26	One of Top 3 Choices					
		PowerPoint	Video	Group Work	Discussions	Labs	Others
		1	0	12	10	9	6

Collaboration in Class: Encourage and promote group activities and discussions. Discussion in class that encourages critical thinking is important for making the learning more permanent. This could be in the form of a project or a question-answer session that covers most of the topics to which the learners have been introduced. This encourages the student to reflect upon the relations between the different concepts that the students have learnt and helps make learning relevant. By connecting the theoretical and the practical elements of a course through a well-constructed discussion, the students begin to think critically of activities that may seem purely theoretical but are actually preparing the student for the real world scenarios they should expect in the marketplace [18]. Scholarly research for online students also promotes this reflection about the practice and the pragmatic demonstration of real world skills.

More Classwork to PracticeduringClass Time: Practice in class working with instructor collaboration and with other class members is an effective instrument to make learning happen. Classwork should be created to keep students engaged with the course material at multiple times and over multiple sessions creating a stop and start affect that needs to be addressed in the content design. Course creators should be aware of this and design accordingly so that students experience the ability to interact with smaller pieces or sequences of material so they can continue to make effective use of the asynchronous learning experience [19][20]. By packaging data in small sequential lessons or learning activities, course designers provide a vehicle for the occasionally connected student to engage and reflect in small steps, thus proceeding to the next step only after the previous step is reflected upon. Additionally, there is the opportunity for non-linear content where Course Learning Outcomes (CLOs) are demonstrated in non-sequential activities that can be utilized by students in no particular order [21]. This non-linear approach increases engagement by allowing the learner the freedom to choose content in their own order of interest. This also encourages the learner to reflect and take responsibility of the learning process.

Promote Learner Reflection and Critical Thinking: The course content must encourage learner reflection and critical thinking at each learner's level of understanding. Students today are tech savvy and are capable of getting information they need. The ability to browse and learn on their own has become a growing expectation for many digital natives. Courses should be designed with content and questions that guide the learners in the right direction and make them reflect and think. Create open-ended questions that learners can explore, reflect and think critically by applying the concepts that they are learning. This makes the learning process more interesting and the learning more permanent. This section describes the best practices in the content and delivery design that may be used to promote reflective and critical thinking in learners.

Closing Activity to Promote Critical Thinking: A good closing activity for the class and/or the course is important for making the learning more permanent. This could be in the form of a project or a discussion that covers most of the topics the learners have been introduced to. This encourages the student to reflect upon the relations between the different concepts that the students have learnt and helps make learning relevant. The course designer should be explicit in the relationship between course materials and the CLOs for the course [22]. Additionally, course content should map activities in the course to the Program Learning Outcomes (PLOs) giving the student the opportunity to think of how each course activity relates to the goals of the degree and the practice of the profession [23]. By connecting the theoretical and the practical elements of a course through a well-constructed closing activity, students begin to think critically of activities that may seem purely theoretical but are actually preparing the student for the real world scenarios they should expect in the marketplace [18]. Scholarly research for students also promotes this reflection about the practice and the pragmatic demonstration of real world skills. As students are commissioned to uncover converging and divergent discourses in the scholarly literature, they are forced to examine the gaps between their own workplace experiences and the theoretical possibilities for improvement outlined by these publications [24]. Therefore, closing activities should include a mix of real world or simulated real world practical application with effective use of scholarly research in which to develop the practical demonstrations of CLOs and PLOs.

4. CONCLUSIONS

This study proposes some guidelines and best practices in teaching accelerated courses in a Computer Science program.Although many obstacles and opportunities still exist for transforming learning in this environment into its full potential, these suggested best practices provide a foundation for encouraging the learner to become a self-guided student. This, in turn, increases student engagement and learning effectiveness. The ability for learners to take responsibility of their own learning by improving their reflective and critical thinking skills will not only improve their learning of the content but will become a significant skill that will stay with them throughout their professional career.

5. CONTINUING RESEARCH

Technology has opened up many opportunities for possible improvements in teaching and learning but there is still much to understand about how learning happens and ways to enhance learning and make it more permanent. This research, in the field of teaching accelerated courses in a technical program,needs to continue. Preliminary guidelines presented in this paper are based on limited data from one accelerated course in the computer science program. This work needs to be validated by taking this research to the next step with multiple courses in both the undergraduate and graduate programs and with different student cohorts to get a proper cross section of the students, courses and classes. This work can be further extended by including other programs in the areas of Engineering, Information Technology, and Information Systems.

The survey results clearly reveal that Active Learning strategies such as in-class group work and discussions that keep students engaged indeed help students learn. Further research is needed to understand the effect of Discovery Learning in the context of Active Learning. The main challenge is to know how much and what kind of guidance should be provided to the learners. The same also applies to Problem Based Learning. Another area of research in the context of Active Learning is in the area of Cooperative Learning where the key is to determine the optimum group size that allow students to work together to improve their own learning and that of their peers. The first phase of these researches has taken place where survey results have been collected. The next step is to analyze the survey results for insights. The second phase plan is to design the appropriate Discovery, Cooperative, and Problem Based Learning activities and then measure their dynamics and effectiveness.

Other possible research areas include evaluating available and emerging technologies for more efficient content creation and distribution that promotes reflection, and thus making learning more permanent in these accelerated courses. In addition to these reflective and critical thinking skills, are there other skills that the learner can gain that will further enhance student learning in an accelerated learning environment? This area needs further research. Plans are in place for case analysis to

understand ways to improve learner engagement in accelerated programs.

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