A new strategy for active learning to maximise performance in intensive courses

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SESSION

C1: Integration of theory and practice in the learning and teaching process

CONTEXT

This paper investigates the effect of changing the formative assessment in an intensive introductory Thermodynamics paper offered to students studying towards an Engineering qualification.

PURPOSE

To improve the use of class time of students in an intensive course so that they are better prepared for their exams which occur in close proximity to learning.

APPROACH

A new approach involving a fully rounded experience was implemented to improve use of students' class time. Active learning strategies, and mini-exams were employed. The quantity of formative assessment was increased, and the structure of classes was altered to place the formative assessment immediately after each topic covered.

RESULTS

An improvement to student grades and completion rates was observed compared to the previous instance of the paper. Student feedback towards the new strategy was very favourable.

CONCLUSIONS

The new structure achieved the aim of lifting passing rates, improving participation and preventing procrastination.

KEYWORDS

Intensive courses; active learning; thermodynamics.

INTRODUCTION

This paper describes an innovation in the delivery of an introductory thermodynamics course offered to students studying towards an engineering qualification. The course was delivered in intensive format, across three weeks of study.

Students find it challenging to engage with complex engineering topics in a short period of time, and there is no sizeable study break for pre-exam study. This means that students cannot afford to delay in learning and applying content. Every class must be an opportunity to interact with the content immediately.

The innovation described here involved implementing a new daily structure for the course that attempted to mimic the standard process by which students learn material, apply it, study it and practice it in across a traditional-length semester. The new structure involved integrating the lecture and recitation components to the course to increasing the active learning during material delivery, then allowing students to engage in guided study and open-book formative assessment.

This paper describes the implementation of this innovation. A brief review of the literature on intensive courses is provided, followed by a description of the approach used in this particular class. The results are then presented, and evaluated in the context of the research and the instructor's own critical reflection.

BACKGROUND

Many tertiary institutions around the world follow a teaching format based around the semester. This refers to half a year, from the Latin for six months (Oxford Dictionary, 2017), where typically the course is between 15 and 18 weeks in duration. Courses delivered in a compressed time-frame, generally last less than half this time. Such courses are variously referred to as intensive mode, compressed, accelerated, abbreviated and time-shortened. This paper uses the term intensive courses.

Intensive courses have become increasingly prevalent, as universities become more market driven and responsive to the changing needs of students (Davies, 2006; Daniel, 2000). This would be a concern if intensive delivery entailed a sacrifice of good pedagogy in the interests of revenue-gathering. However there is no compelling evidence that this is the case. Although academics frequently worry about the effect that the shortened time-frame of intensive courses will have on learning quality (Daniel, 2000), most literature finds learner performance comparable between traditional semester-long courses and their shorter intensive counterparts (Kops, 2014; Daniel, 2000; Anastasi, 2007; Hesterman, 2015). Some find an overall positive effect of intensive learning (Kucsera & Zimmaro, 2010; Anastasi, 2007).

The literature identifies that experienced and mature students (outside the 18-22 traditional cohort) tend to prefer intensive courses (Daniel, 2000). In particular, intensive courses work well with those who must balance study with other commitments, such as work or family (Burton and Nesbit, 2008). Students frequently prefer the ability to concentrate exclusively on one subject at a time (Colorado College, 2017; Daniel, 2000); however they can exhibit some resistance initially to the shortened nature of intensive courses, as they feel doubtful about their ability to learn with less time (Burton and Nesbit, 2008; Tatum, 2010). These doubts tend to reduce as their experience with intensive courses increases, particularly for qualitative courses (Tatum, 2010).

Instructors can have mixed feelings about intensive courses. Some doubt the ability to generate deep learning and engagement in a short timeframe, or feel that intensive courses require significantly greater effort on the part of teaching staff to ensure that sufficient learning is achieved (Anastasi, 2007; Daniel, 2000). Hesterman (2015) notes that teacher attributes are essential to the effective implementation of intensive courses: staff should be experienced and enthusiastic about teaching in intensive mode classes. Kops (2014) identifies that teaching staff appreciate the benefits from intensive courses, including the ability to concentrate teaching into shorter timeframes, freeing up larger blocks of time for research. Teachers may also develop a greater rapport with students, as intensive classes extend the length of time spent with students, and usually entail smaller class sizes (Kops, 2014).

At the institution examined in this article, all courses are taught in modules, lasting between three and seven weeks. Students take one course per module. The students enrolled in courses at the institution represent three distinct groups: level 1 students, who are first years, typically between 18 and 20 years of age; level 2 students, who have completed their first year, and may also be undertaking some industry experience, and level 3 students, enrolled in their final year of study, who will be completing required industry experience. The advantage of this modular teaching is the flexibility it allows students who must fit study in between periods of industry experience.

The course described in this article is a level 1 Thermodynamics paper. Students must complete 12 topics in three weeks, with approximately 25 hours of contact time per week. Students sit two exams, and submit one laboratory assignment for the three-week course. Students must obtain at least 60% in each assessment in order to achieve “competency” (a pass) in the course. Students have an opportunity to “resit” the exam that they failed. The “resit” involves sitting a new exam at a later date.

APPROACH/METHOD

Prior to designing the approach for this course, the research into teaching intensive courses was consulted. Two papers explicitly laid out best practice guidelines. The University of Canterbury (Sampson, Brogt, & Comer, 2011) provides a set of guidelines for teaching in the intensive formats, and Kops (2014) looks at best practice for teaching intensive course as provided by highly rated instructors. Based on the advice of these two papers, and consulting other related literature, the following features were considered important for delivery of the intensive course under investigation in this paper.

1. **Fully prepare courses in advance.**

   Compressed courses offer little flexibility for adjustment, as content cannot be shifted around much in the limited time frame. Accordingly, it is important to prepare courses as much as possible in advance of teaching (Burton & Nesbit, 2002; Kops, 2014). Sampson et al (2011) advise that students’ expectations be managed well from the beginning of the class. Students should know what is covered, when and what is expected of them in terms of assignments, study and workload.

2. **Make learning resources readily available.**

   Students should have timely access to all resources (Sampson et al, 2011), ideally fully-prepared lecture notes that minimise the amount of time students need to spend collating their notes (Kops, 2014). The effective use of the LMS is vital here.

3. Use active learning techniques.

As students' attention suffers decrement as time passes in traditional-length lectures (Bligh, 1998), the longer classes in intensive courses are even less suitable to the typical lecture format. Sampson et al (2011) advise the use of active learning formats, and small group exercises and activities to break up the time in intensive classes.

4. Make effective use of formative assessments.

Formative assessments provide a reflection on learning, and feed forward into future learning. They should be well-designed to enable students to see immediately what they understand and what they need to work on (Irons, 2008).

5. Maximise effective feedback.

Intensive courses do not provide much time for students to catch up on material prior to assessment. Therefore, one of the most serious risks for students in intensive courses is not keeping up with the course. This is also a risk for the instructor, as there is similarly limited time for "catch up" tutorial sessions or the provision of other support for at-risk students. Providing regular feedback on learning is therefore essential for the students and the instructor (Sampson et al, 2011)

The level 1 thermodynamics course described here incorporates these facets above in its redesign. Course materials and quizzes were delivered via Canvas. Students were not required to do pre-reading prior to attending class. Assessment for the course was structured with the three graded summative assessments: Exams A and B which were weighted at 33 and 34% of the coursework grade, respectively; and one practical lab, weighted at 33%. There were six non-graded mini-exams, and three non-graded quizzes.

Each class ran for the set number of hours according to the regular modular delivery for the institution. Classes on Mondays, Tuesdays and Thursdays ran from 8:00am-2:30pm, and Wednesday and Friday classes ran from 8:00am to 11:30am. The schedule for one of the weeks is provided in Table 1 below. Students were provided with each week's schedule in advance; however the overall structure for the three weeks was mapped out prior to the module beginning.

Table 1: Week 1 structure.

Week 1					
Times	Monday	Tuesday	Wednesday	Thursday	Friday
	31-Jul	1-Aug	2-Aug	3-Aug	4-Aug
0800-0830	Temperature	Specific Heat and Steam	Specific Heat and Steam cont.	1st Law of Thermodynamics cont.	Expansion and Contraction
0830-0900					
0900-0930					
0930-1000	Tea Break	Tea Break	Tea Break	Tea Break	Tea Break
1000-1030	Pressure	Specific Heat and Steam cont.	1st Law of Thermodynamics	Catch-up Tutorial	Study Break
1030-1100					
1100-1130					Quiz 1
1130-1200	Lunch	Lunch	Lunch	Lunch	
1200-1230					
1230-1300	Tutorial	Tutorial		Tutorial	
1300-1330					
1330-1400	Study Break	Study Break		Study Break	
1400-1430	Mini-exam	Mini-exam		Mini-exam	

Each full day contains a study-break and mini-exam, as in Table 1 above. The aim of this structure was to replicate the standard study structure employed by students in traditional semester-long courses: attend class, apply concepts in recitation-format class (tutorial), engage in private study, and then sit practice tests or exams to prepare for assessments. In a traditional semester, this takes place over the many weeks of a semester, as shown in Figure 1 (a) below.

Hora and Oleson (2017) identify that, in a traditional-length semester, students' study, as a distinct activity from attending class, or completing assignments, typically takes place a few days prior to a test or examination. As intensive courses do not allow for this, it was necessary to compensate for the limited time-frame that students have to reflect on their material in a way that takes advantage of the longer contact hours that the intensive format provides.

Figure 1 (b) above illustrates how each full day of class replicated the learning/applying then study/practice structure. This approach actually reflects an improvement on the structure shown in Figure 1 (a), as study and practice takes place in a guided environment, with instructor input. This enables accurate feedback on students' learning and more effective use of students' time.

As figure 1 (b) shows, the class combined lecture/recitation methods of delivery. This involved interspersing material with problems that students and the instructor solved in an interactive tutorial-type framework. As each sub-topic was covered, one or more relevant questions were asked of the class. Students had an opportunity to solve these themselves, or work in small groups, with the instructor's guidance. This increased the level of active learning in the transmittal portion of the class. Students were then presented with half an hour or so to study their materials, before sitting a "mini-exam", which tested content from the current day via exam-type questions.

Active learning techniques were embedded in this structure. Prince (2004) finds that introducing active leaning technique into lectures enables students to refocus attention and improves retention and recall. The environment for active learning was fully-guided, which is particularly important for level 1 students, whose learning may be compromised in minimally-guided active learning frameworks (Kirschner, Sweller, & Clark, 2006).

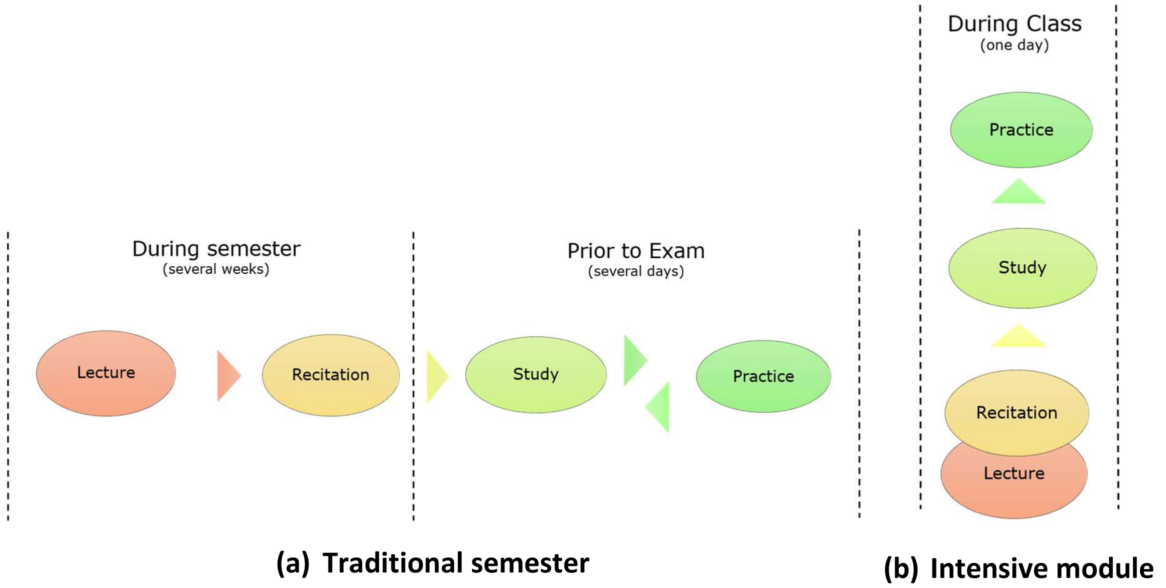

Figure 1: Typical learning and study process for traditional-length semester (a) and in the intensive class (b).

Mini-exams occurred three times per week. This is to gain the advantage of multiple testing effects on retention of material (Crooks, 1988; Tatum, 2010). The shorter time frame for the course increases the risk that procrastination results in a fail. By having multiple formative mini-exams, with moderate stakes, students were not able to delay in familiarising themselves with the material. Although no marks were attached to the mini-exams, the instructor was aware of students' performance and followed up with those who were underperforming. Therefore students had a reason to try harder during the mini-exam, and the instructor was able to monitor performance during the course and address at risk students early.

Tatum (2010) notes the importance of distributed practice and its impact on memory retention. He cites Rohrer and Pashler's (2007) work on optimal spacing between study sessions and testing. The ideal interval between study sessions is between 10% and 30% of the interval between study sessions and the exam. In this course, the exams were spaced between 10 and 12 days apart. The study sessions were spaced between 24 and 48 hours apart, which corresponds to a gap between study sessions of approximately 8-16% of the retention interval for the first exam, and 10 and 20% of the retention interval for the second exam, which is in keeping with the recommendation from Rohrer and Pashler (2007, as cited in Tatum, 2010).

Hesterman (2015) notes that incubation of ideas takes time for students, and suggests that this may be compromised in time-shortened teaching formats. When a problem is set aside for a period, the solution may become apparent during this incubation process (Tatum, 2010). As the time could not be increased, the mini-exams and quizzes attempted to compensate for this. They encouraged students to retain and develop their understanding of the material, including that taught earlier, in order to foster the kind of idea development that is not usually not able to occur in compressed courses.

The continued reinforcement of concepts across the paper calls to mind the spiral curriculum (Bruner, 1960). Although this is typically applied across programs of study (Bruner, 1960; Harden, 1999), single classes can teach their topics in a cohesive "micro"-spiral. As each successive topic is covered, it revisits concepts and skills from earlier topics, builds on them, and demands ever higher processes of thought and problem solving. Developing a cohesive micro-spiral is especially important in intensive courses. Students' mental load increases the more disparate they view the topics (Sampson, Brogt, & Comer, 2011). Continued reinforcement of earlier topics helps students see the interrelationships between topics, and shows them that their knowledge is deepening, as well as broadening.

OUTCOMES

To gain insight into the effectiveness of the new course method, the 2017 passing and completion rates will be compared to the 2016 instance of the course. As a new program, no earlier data exist to make further comparison. Student perceptions will be summarised from the formal feedback, gathered at the course level, as well as inform commentary received during the course. The instructor will also reflect on the experience of modifying the course delivery.

Student performance

Table 2 below compares student performance between 2016 and 2017 for the same paper. The 2016 offering had a similar class size and make-up as the 2017 paper.

Table 2: Changes in pass, fail and did not sit rates from 2016 to 2017

	Pass	Fail (%)	Did Not Sit (%)
Change (2017 compared to 2016)	+ 18.7%	- 7.4%	- 11.3%
Improved / worsened in 2017	Improved	Improved	Improved

As shown above, 2017 saw a marked improvement to all metrics. The number of students passing, rose by 18.7%. The number of students sitting assessments and failing fell by 7.4%. The number of students who chose not to turn up to the exam at all, the Did Not Sit (DNS) outcome, fell by 11.3%.

It should be noted that a DNS has the same effect as a fail for the student. They must undergo another examination at a later date, as they would have done had they sat the exam and failed. Therefore a significant reduction in the effective fail rate (sitting and failing plus DNS) is an improvement between the two instances of the course.

Student feedback.

Students reported that they appreciated the mini-exams and quizzes. Both informal and formal feedback reflected favourably on the continued testing conducted during the course.

Instructor perceptions.

The motivation for this approach arose out of the experience from a similar paper, for a different group of students. When given problems as part of workshops, which followed traditional type lectures, at first students solved the problems by reverse-engineering answers, and performed poorly in free-format problems. This was concerning in an intensive course, as the short time frame limited the amount of time they could spend on the learning curve.

In addition, students always wanted more quizzes and opportunities to practice exams. As the class time was relatively long, the time for private study in the evenings is limited, and there is no reasonable study break between classes and each exam. Some students could be guaranteed to study at home, whereas others may not. Therefore, providing opportunities to practice during class time, in a guided environment, maximised the formative value of each quiz and mini-exam.

Performance during the formative assessments in this course revealed some students to be “at risk” at the beginning of the module. Those who regularly participated in the formative assessments lifted their performance markedly during the module and had a successful outcome at the end. As the theory-application-study-practice structure was employed, students began to perform better in solving more varied problems. As this is the skill required in the graduate profile (solving complex and unexpected problems), an improvement to such skills demonstrated by students is an achievement in the paper.

However, there are some improvements required going forward. There was a small group of students who did not regularly attend classes. Most of these students failed the course, whereas only one of the students who regularly attended class failed the course. Some students noted that they had other commitments, such as work, that prevented their attending class. In future, students should be better informed from the beginning of the module that they should attend all classes. To that end, some online quiz work should be graded. This would encourage students to attend class, and also to attempt more of the formative quizzes as practice for the graded quizzes.

DISCUSSION

The new structure was received favourably by students. The idea of doing exam-type questions as the capstone activity for each full day was very appealing to students. This is unsurprising, as the exams counted for 67% of students’ final grade. Given the position of the mini-exams, and the importance students place on exam preparation, it is worth talking about the potential for instrumental approaches to learning, or “surface learning”, on the part of students. Surface learning refers to the situation where students aim to reproduce knowledge, so as to meet the requirements of a task with minimal effort (Biggs, 1987). Students do not distinguish between new ideas and existing knowledge and focus on material likely to appear in examinations; therefore they may give the impression of extensive learning, but such learning is superficial and soon forgotten (Fry, Ketteridge, & Marshall, 2003; Kember & Gow, 1994). An approach that focuses on the deliverable as the exam may seem to encourage surface learning, as students can be tempted to view learning as valuable only if it has the potential to be reproduced in the exam.

One way to minimise this, and foster deeper learning is to avoid repetition of questions, and make use of a variety of practice problems, so that students do not focus on identifying patterns and formulating study plans based on expectations of what will be tested. As students who have taken the instrumental, surface approach to learning may actually perform well on examinations, it is difficult to tell if the class was focused on surface or deep learning. However, the fact that students moved away from a reverse-engineering approach to answering questions, and began to perform better on a variety of free-format questions, is taken as evidence of better deep-learning.

True evidence of deep learning is retention over time. Students who have actually grown their body of knowledge and skills will be able to recall and employ them at a later date. Therefore one change that must be added to this program is implementation of a follow-up test. This can be a diagnostic test taken in the higher-level Thermodynamics paper to assess the degree to which students have successfully retained the skills taught in the current paper.

The improvement to the passing rate was considered a success; however it is difficult to say whether it is attributable to this change in approach only. The previous year's paper was taught by a different instructor. It is hard to judge whether approach alone was the reason for the improved passing rate. In addition, as this programme has only been running for the past two years, there are no other years' papers for comparison, so it is difficult to know precisely the reason for the improvement.

One factor that is a little more obvious is the significant improvement in the completion rate. As DNS (did not sit) results are essentially fails, the reasons for a student electing not to sit the exam are likely similar to their reasons for failing an exam. However there is one key difference: a DNS involves the student not bothering even to turn up for the exam. It is arguable that such an outcome reflects another variable: a profound lack of confidence that sitting the exam will result in a pass. Of course, there may be other reasons, such as illness, that prevent a student from turning up to the exam, but in the presence of automatic rights to "resits", it is likely that students elect to skip an exam if they feel there is little point in sitting it, due to the likelihood of a fail.

This makes intuitive sense, but little research exists on the true reasons for students not sitting exams. This is because skipped exams often count for zero, and students are aware that lack of preparation is not an adequate excuse for skipping an exam, so tend to proffer other excuses which may be fraudulent (Abernathy & Padgett, 2010; Caron, Whitbourne, & Halgin, 1992; Ferarri & Beck, 1998). Abernathy and Padgett (2010) find that a peak in illnesses and bereavements among students prior to skipping a test can only be attributed to a desire to delay taking that test. Adams' (1990) slightly tongue-in-cheek assessment of students' reasons for missing final exams finds a surprisingly strong link between a student's grade in the course prior to the exam and the reported mortality rate of their grandmothers. Students who are failing a class are 24 times more likely to have a family member die prior to the exam than students who are sitting on an A for the class. The relationship between academic success and excuse fabrication has been found to be significant by Caron, Whitbourne and Halgin (1992), and Roig and Caso (2005). Both studies find that students with higher GPAs report being less likely to fabricate an excuse for missing an assessment.

In the current institution, the availability of a resit makes it easier to miss a final exam and students are not required to come up with an excuse for this. This makes it more likely that ill-prepared students will skip the regular sitting of the exam. The mini-exams worked to address this problem: students received continued preparation for the final exam. Students were informed very early of the areas where they needed improvement, and the consistent use of mini-exams meant they could also track their progress. It is possible that mini-exams could *increase* the DNS rate:

students who receive information that they are not doing well in the course may be more likely to skip the exam than students who did not have this awareness. In the end, only one student did not sit the final examination. Therefore we can infer a link between this kind of course structure and students' sense of preparedness going into the exam. We can also interpret as much from student feedback on the course, where students reported that the mini-exams helped them to prepare for the final exam.

This program also offers a unique opportunity to investigate the reasons for students not sitting exams that other programs do not have. Do to the availability of "resits", students can elect not to turn up to exams without needing to provide a reason. It may be useful to conduct a quick survey of students who are choosing to miss the exam to find out their reason for doing so, as these students will not feel the need to proffer alternative excuses.

CONCLUSION

This paper described the implementation of a new, research-informed, active learning strategy involving replication of the typical learning and studying structure that students tend to follow in a traditional-length semester on a daily basis in an intensive format course.

Students responded well to the altered structure, and were particularly satisfied with the quantity of formative assessment and the level of active learning in the class. Achievement by students in this class showed an improvement for all measures, including passing and completion rates, compared to the previous offering of the course.

The lack of further instances of the course, however, makes it difficult to assess if this change was due to the innovation employed, or other factors. Other factors require further investigation, such as the level of deep learning that has taken place, and the reasons for students choosing not to sit exams. Consequently two follow-up areas for investigation have been proposed.

REFERENCES

Abernathy, A. M., & Padgett, D. (2010). Grandma never dies during finals: A study of makeup exams. *Marketing Education Review, 20*(2), 103-114.

Adams, M. (1990). The dead grandmother/exam syndrome and the potential downfall of American society. *The Connecticut Review*.

Anastasi, J. S. (2007). Full-semester and abbreviated summer courses: an evaluation of student performance. *Teaching of Psychology, 34*(1), 19-22.

Austin, A. M., & Gustafson, L. (2006). Impact of course length on student learning. *Journal of Economics and Finance Education, 5*(1), 26-37.

Biggs, J. B. (1987). *Student Approaches to Learning and Studying.* Melbourne: Australian Council for Educational Research.

Bligh, D. A. (1998). *What's the Use of Lectures?* San Francisco: Jossey-Bass.

Bruner, J. S. (1960). *The Process of Education.* Cambridge: Harvard University Press.

Burton, S., & Nesbit, P. (2002). An analysis of student and faculty attitudes to intensive teaching. *Celebrating teaching at Macquarie.* North Ryde: Macquarie University.

Caron, M. D., Whitbourne, S. K., & Halgin, R. P. (1992). Fraudulent excuse making among college students. *Teaching of Psychology, 19*(2), 90-93.

Colorado College. (2017). *The Colorado College plan: building on the block*. Retrieved from The Colorado College web site: https://www.coloradocollege.edu/other/strategicplan/progress/implementing.html

Crooks, T. J. (1988). The impact of classroom evaluation practices on students. *Review of Educational Research, 58*(4), 438-481.

Daniel, E. L. (2000). A review of time-shortened courses across disciplines. *College Student Journal, 34*(2).

Davies, W. M. (2006). Intensive teaching formats: a review. *Issues in Educational Research, 16*(1), 1-20.

Ferarri, J. R., & Beck, B. L. (1998). Affective responses before and after fraudulent excuses by academic procrastinators. *Education, 118*(4), 529-538.

Fry, H., Ketteridge, S., & Marshall, S. (2003). *A Handbook for Teaching and Learning in Higher Education.* London: Routledge.

Harden, R. (1999). What is a spiral curriculum. *Medical Teacher, 21*(2), 141-143.

Hesterman, D. (2015). *Intensive mode delivery of courses in engineering, computer science and mathematics.* Perth: University of Western Australia.

Hora, M. T., & Oleson, A. K. (2017). Examining study habits in undergraduate STEM courses from a situative perspective. *International Journal of STEM Education, 4*(1), 1-19.

Irons, A. (2008). *Enhancing Learning through Formative Assessment and Feedback.* New York: Routledge.

Kember, D., & Gow, L. (1994). Orientations to teaching and their effect on the quality of student learning. *Jounral of Higher Education, 65*(1), 58-74.

Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist, 41*(2), 75-86.

Kops, W. J. (2014). Teaching compressed-format courses: teacher-based best practices. *Canadian Journal of University Continuing Education, 40*(1), 1-18.

Kucsera, J. V., & Zimmaro, D. M. (2010). Comparing the effectiveness of intensive and traditional courses. *College Teaching, 58*, 62-68.

Oxford Dictionary. (2017, August 2). *Semester*. Retrieved from Oxford Dictionaries: https://en.oxforddictionaries.com/definition/semester

Prince, M. (2004). Does active learning work? A review of the research. *Journal of Engineering Education*, 1-9.

Roig, M., & Caso, M. (2005). Lying and cheating: fraudulent excuse making, cheating and plagiarism. *The Journal of Psychology, 139*(6), 485-494.

Sampson, K., Brogt, E., & Comer, K. (2011). *Guidelines for Teaching in Time-Shortened, Intensive, or Summer School Settings.* Christchurch: University of Canterbury.

Tatum, B. C. (2010). Accelerated education: learning on the fast track. *Journal of Research in Innovative Teaching, 3*(1), 35-51.