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How Much Do Students Remember Over Time? Longitudinal Knowledge Retention in Traditional versus Accelerated Learning Environments

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Table of Contents

EXECUTIVE SUMMARY 4
INTRODUCTION 5
1.1 Preamble 5
1.2 Research question 5
LITERATURE REVIEW 5
2.1 Traditional and accelerated learning environments 5
2.2 Controversial shift in higher education 6
2.3 Short-term learning outcomes 6
2.4 Long-term knowledge retention 7
METHODS 8
3.1 Study design 8
3.2 Study population 9
3.3 Statistical analysis 10
3.3.1 Descriptive statistics 10
3.3.2 Knowledge retention of repeat questions – mixed effect modeling 10
3.3.3 Knowledge retention of non-repeat questions – multiple linear regression 10
RESULTS 11
4.1 Participant description 11
4.2 Short-term student learning 12
4.3 Knowledge retention 13
4.3.1 Knowledge retention in Introduction to Health Sciences 13
4.3.2 Knowledge retention in Clinical Epidemiology 16
DISCUSSION 18
5.1 Accelerated teaching and knowledge retention 18
5.2 Limitations 19
5.3 Conclusions 20
REFERENCES 21

List of Tables

Table 3-1: Method of defining repeat question success at each time point 9
Table 4-1: Participant attrition 11
Table 4-2: Participant characteristics (N=270) 12
Table 4-3: Success of retention quizzes at each time point 13
Table 4-4: MEM results of knowledge retention in Introduction to Health Sciences 14
Table 4-5: MLR results of knowledge retention in Introduction to Health Sciences 14
Table 4-6: MEM results of knowledge retention in Clinical Epidemiology 16
Table 4-7: MLR results of knowledge retention in Clinical Epidemiology 17

List of Figures

Figure 4-1a: Knowledge trajectory of repeat questions in Introduction to Health Sciences course 15
Figure 4-1b: Knowledge trajectory of non-repeat questions in Introduction to Health Sciences course 15
Figure 4-2a: Knowledge trajectory of repeat questions in Clinical Epidemiology course 17
Figure 4-2b: Knowledge trajectory of non-repeat questions in Clinical Epidemiology course 18

Executive Summary

Accelerated courses continue to be part of the changing academic landscape at Canadian universities. However, there is limited evidence to support their efficacy in relation to knowledge retention. A greater understanding of knowledge retention associated with accelerated courses (i.e., intensive full-day course for a one- or two-week duration) as compared to traditional courses (i.e., one three-hour lecture once a week for 12 weeks) will provide university stakeholders and administrators with evidence to determine whether quicker courses should be pursued in the postsecondary education environment.

A longitudinal cohort design was developed with the objective of addressing the following research question: Does a difference in knowledge retention over time exist between students enrolled in traditional versus accelerated undergraduate courses?

Knowledge retention quizzes were administered electronically at three time points following the completion of a first-year introductory health science course and a fourth-year clinical epidemiology course, which were delivered in traditional and accelerated formats. A total of 270 students participated in the study. Each quiz included 15 unique retention quiz questions, in addition to five non-repeat questions selected from the final course examination. Descriptive statistics were calculated, including mean and standard deviation for continuous variables and frequency and percentages for categorical variables. The difference in the trajectory of knowledge retention over four points in time (baseline, three, six and 12 months) between students in the traditional and the accelerated courses was determined using mixed effect modeling. Multiple linear regression was utilized to compare the effect of course on knowledge retention at each time point for the repeat questions.

A significant main effect of course format (i.e., traditional vs. accelerated) on the retention of knowledge over time was not found for both the first- and fourth-year courses. The non-significant estimate for course format indicates that students in the first- and fourth-year traditional and accelerated courses had similar knowledge retention levels on the quizzes at three, six and 12 months following the baseline assessment. The positive and significant estimate for time point demonstrated that the success of the retention quizzes decreased over time in both the traditional and accelerated course formats. Not surprisingly, the greatest difference in knowledge retention was observed between baseline and 12 months. For the fourth-year course, the variable time spent on the quiz was significant and included in the final model. The observed significance indicates that the length of time spent completing the quiz impacted success on the retention quizzes.

This study concluded that the accelerated course format does not compromise short- and long-term knowledge retention in first-year or fourth-year undergraduate students. Thus, accelerated courses are a practical and feasible option for students in higher education.

INTRODUCTION

1.1 Preamble

Accelerated teaching and learning is not new to higher education. Marques and Luna (2005) suggest that accelerated teaching is among the most profound educational discoveries of the past century. Wlodkowski (2003) stated that accelerated learning programs have contributed to enhancing higher education and predicted that one-quarter of all students will be engaged in accelerated learning over the next 25 years. Studies have reported student satisfaction following accelerated learning as equal or higher to that of traditional format learning (Stanley, 2006; Wlodkowski, Gonzales & Maudlin, 2002; Wlodkowski, Maudlin & Gahn, 2001; Johnson, Aragon, Shaik & Palma-Rias, 2000). Nevertheless, the utility of accelerated teaching has been contested by educators for years (Hicks, 2014; Feldhaus & Fox, 2004; Daniel, 2000). While not all the factors contributing to some educators' and administrators' skepticism are clear, a constant and largely unfounded criticism is that compressed courses compromise quality of teaching, although there is evidence to the contrary (Hummer, Sims, Wooditch & Salley, 2010; Rudestam & Schoenholtz-Read, 2002). Subsequently, concern exists by faculty that a compacted time period for instruction could lead to compromised reflective learning, as students may require significant time to engage with the course material (Daniel, 2000). Essentially, critics question how well students learn in a short period of time and whether they are disadvantaged in retaining knowledge over time once they have completed a course. However, limited research comparing long-term knowledge retention between accelerated and traditional course formats served as the impetus for the current study, which addresses this gap in the literature. At Brock University, an accelerated course is known as a *supercourse*.

1.2 Research Question

A longitudinal cohort design was developed with the objective of addressing the following research question: Does a difference in knowledge retention over time exist between students enrolled in a traditional versus an accelerated (supercourse) undergraduate course?

LITERATURE REVIEW

2.1 Traditional and accelerated learning environments

The structure of higher education is rapidly changing in response to government funding, financial restrictions, and altered student demographics and demands (Davies, 2006). Accelerated courses, sometimes also termed "intensive teaching formats," "time shortened courses," "block format," "intensive modes of delivery" or "compressed courses," were developed in response to these changes with the intent of offering courses in a shortened and focused format with no significant loss in content or student contact time (Vreven & McFadden, 2007). Whereas traditional courses are offered during an academic semester with one to three hours of lecture offered per week, accelerated courses are designed to cover the same course material in a shortened period of time, but with the same amount of student contact (Kretovics,

Crowe & Hyun, 2005). While course structure varies by institution, accelerated courses are generally compressed anywhere from one to eight weeks, with individual class sessions lasting four hours or more (Feldhaus & Fox, 2004).

Accelerated courses offer a number of practical benefits when compared to traditional course formats. The ability to offer compressed courses in a college or university's Spring or Summer term is viewed as an attractive academic extension of the typical Fall and Winter term course offerings. This can offer students the opportunity to enrol in courses that did not align with their Fall or Winter term schedules, lighten the course load during the academic year, make up for poor academic performance, or allow for the completion of a university degree in less than four years (Kretovics et al., 2005). Additionally, students are often enrolled in one accelerated course at a time and are not distracted by an abundance of information and responsibilities from a number of courses. Students are able to focus on a single subject area and reduce poor habits such as procrastination due to the short duration of the course. Lastly, the extended length of class sessions can result in lower absentee rates since a significant amount of information is missed with each absence (Feldhaus & Fox, 2004).

2.2 Controversial shift in higher education

Given the potential benefits stated above, accelerated courses are becoming increasingly popular in postsecondary institutions (Feldhaus & Fox, 2004; Daniel, 2000). In the last decade, postsecondary institutions have begun incorporating accelerated courses into their standard Fall and Winter term curricula (Kretovics et al., 2005; Wlodkowski, 2003). Although accelerated course formats have been developed and applied at a number of colleges and universities, the debate surrounding the effectiveness and academic legitimacy of accelerated courses is ongoing (Feldhaus & Fox, 2004; Daniel, 2000). Despite limited evidence on either side of the debate, detractors argue that accelerated courses offer convenience over substance and rigor (Wlodkowski, 2003; Wlodkowski & Westover, 1999). The compressed course's ability to deliver the breadth and depth of information offered in traditional course formats is questioned (Wlodkowski, 2003). A substantial number of comparative studies examining accelerated and traditional courses have been conducted with the objective of identifying the advantages of each course format.

2.3 Short-term learning outcomes

The primary outcomes of interest for analyses comparing traditional and accelerated course formats have been performance and student learning assessed immediately following course completion (Daniel, 2000). Previous research has indicated that the accelerated course format structure is equally if not more effective in terms of the aforementioned outcomes of interest (Feldhaus & Fox, 2004; Seamon, 2004; Wlodkowski, 2003; Daniel, 2000; Scott & Conrad, 1991). A comprehensive review of 100 comparative studies identified that the majority of findings supported both similar and improved learning and performance outcomes in accelerated courses compared with traditional course formats (Scott & Conrad, 1991). A limited number of studies demonstrated improved outcomes in traditional courses. More recent research has confirmed previous findings across a variety of academic disciplines, including fine arts, foreign languages, humanities, natural science and social sciences (Feldhaus & Fox, 2004).

The success of the accelerated format is often attributed to the demographic composition, specifically the age of students, enrolled in the various course formats (Feldhaus & Fox, 2004). Adult learners are more likely than traditional university- or college-aged (18-24 years) students to enrol in accelerated courses. Adult learners have demonstrated superior performance in a variety of learning formats (Woodruff & Mollise, 1995) and it has been suggested that their maturity and life experience has benefited them in accelerated courses (Feldhaus & Fox, 2004). Furthermore, adult students in accelerated courses are thought to possess improved self-direction and motivation compared with younger students (Merriam, 2001; Wlodkowski et al., 2000; Wlodkowski & Westover, 1999). Nevertheless, similar research comparing accelerated and traditional course formats between students of comparable age demonstrated both equal and improved short-term performance outcomes in expedited courses (Feldhaus & Fox, 2004; Seamon, 2004; Van Scyoc & Gleason, 1993).

2.4 Long-term knowledge retention

The effectiveness of accelerated courses is primarily supported by the similarity in short-term performance and student learning with the conventional course format. Despite the observed short-term benefits associated with compressed courses, it is equally important that students retain content over time. Educators might suggest that a traditional course would advantage students in retaining knowledge over time compared to the accelerated format because students would have more time to process the course content. To date, research has yet to demonstrate any long-term differences between accelerated and traditional course formats (Seamon, 2004). Research involving comparative analysis of the long-term impact of course format on learning is limited. A review of literature examining the long-term outcomes of accelerated courses indicated that despite findings on student learning immediately following the completion of traditional and accelerated courses, long-term knowledge retention has not been observed to differ by course format (Daniel, 2000; Seamon, 2004). The most recent comparative analysis of long-term outcomes involved students in accelerated and traditional formats of a psychology course offered at a graduate level (Seamon, 2004). Students in the accelerated course performed significantly better at the conclusion of the course compared with students in the traditional course. Nevertheless, a three-year follow-up with post-tests of course content demonstrated no difference in knowledge retention (Seamon, 2004). Despite the observed similarity between course formats, the study was restricted to a graduate-level course (offered in both three- and 15-week formats) and the sample size at the three-year follow-up involved only nine individuals in the intensive course and six in the traditional course (Seamon, 2004). As a result of the limited number of studies and their associated methodological limitations, additional research comparing long-term outcomes was deemed necessary to ascertain the effects of a variety of accelerated course formats (Seamon, 2004; Scott & Conrad, 1991).

Additionally, there is a lack of evidence outlining which types of accelerated courses and student characteristics influence short- and long-term student learning. Factors such as course level (i.e., year 1-4 undergraduate, graduate) and type (i.e., required vs. elective) are at least a few considerations when determining whether accelerated learning jeopardizes or enhances knowledge retention of course content. A greater understanding of the benefits associated with accelerated courses will provide university

stakeholders and administrators with evidence to determine whether accelerated courses should be pursued to a greater extent in the postsecondary environment.

METHODS

3.1 Study design

A longitudinal cohort study over 21 months (course delivery=9 months and follow-up=12 months) was conducted to compare knowledge retention between students in first- and fourth-year courses. Analysis of knowledge retention over time was stratified by year of study.

Three knowledge retention quizzes were administered electronically at three time points following the completion of the courses. Each quiz included 15 unique retention quiz questions, in addition to five non-repeat questions selected from the final course examination. The selection of retention quiz questions was limited to those answered correctly on the final exam by the entire class within a range of the 10^{th} to 90^{th} percentile, thus eliminating the easiest and most difficult questions on the extremes of the distribution. Accordingly, baseline knowledge included in the analysis is a reflection of 20 questions answered correctly by each student at the completion of the course. Evaluating students on retention of knowledge using the exact same material (i.e., repeat questions) has been demonstrated to be a valid measurement technique (Semb, Ellis & Araujo, 1993). Nevertheless, each set of the repeated 15 follow-up questions was randomly distributed across the three time points to control for memory recall of question order.

Retention quizzes were distributed at three-month, six-month and 12-month time periods for the purpose of examining a knowledge trajectory over time. These are considered to be valid and reasonable timelines for assessing knowledge retention over an appreciable period of time (Bahrick, 1984). At each time point, students were provided with an email directing them to the online quiz. Students were allotted seven days to complete the retention quiz and were asked not to prepare in advance or use course material while completing the quiz.

Knowledge retention was determined separately for the repeat and non-repeat questions. Knowledge retention on the non-repeat questions was evaluated by summing the number of questions that were successfully answered at each time point. The definition of success on the repeat retention quiz question responses at each time point is summarized in Table 3-1. Baseline success was considered to be 100% for each student, since the 15 questions selected for the retention quiz were questions answered correctly during the final examination. Success at three months was evaluated by comparing responses with baseline. That is, a question was considered to be a success if answered correctly at both baseline and three months. Similarly, a successfully answered question at six months was defined by questions answered correctly at baseline, three months and six months. Finally, success at 12 months followed the same definition, with the inclusion of questions answered correctly at baseline, three months, six months and 12 months. The method of defining success (i.e., correctly answered questions at each time point) was implemented to ensure that success accurately represented knowledge retention over time.

Table 3-1: Method of defining repeat question success at each time point

	Baseline	Quiz 1	Quiz 2	Quiz 3	Success
Baseline	✓				✓
3 months	✓	✓			✓
6 months	✓	✓	✓		✓
12 months	✓	✓	✓	✓	✓

In addition to short-term (i.e., three-month follow-up) and long-term (i.e., six- and 12-month follow-up) knowledge retention, we compared the final course grade for students enrolled in the traditional course with those enrolled in the supercourse for both first- and fourth-year courses using the Independent *t* test.

3.2 Study population

The four cohorts of participants in the study included a sample of students who successfully completed one of the following courses: traditional first-year (T1), supercourse first-year (S1), traditional fourth-year (T4) and supercourse fourth-year (S4). More specifically, students included in the final study sample were those who a) successfully passed their course, b) provided informed consent, and c) completed the baseline survey as well as the three-, six- and 12-month follow-up quizzes.

During the 2013-2014 academic year, Introduction to Health Sciences and Clinical Epidemiology were delivered in both traditional and supercourse formats. The first-year Introduction to Health Sciences course was taught in the traditional format between September 2013 and April 2014 (24 weeks) and delivered again as a supercourse during the first two weeks in May 2014. The fourth-year Clinical Epidemiology course was taught in the traditional format between January and April 2014 (12 weeks) and again as a supercourse over one week in May 2014. For both supercourses, one day of instruction was equivalent to two weeks of traditional format instruction. Course content and evaluation criteria remained the same between the traditional and supercourses for both first-year and fourth-year courses. The instructors were the same for Introduction to Health Sciences and Clinical Epidemiology, regardless of the course format.

All students in the four courses were provided with the opportunity to participate in this study. Students were informed of the study on the final day of course delivery and were then provided with an email linked to an online survey with a letter of invitation and consent. Students were notified that successful completion of the baseline survey and all three retention quizzes would result in a 5% increase in their final course grade for their participation in the research project. The 5% incentive to participate in the study was not dependent on their performance on the three follow-up retention quizzes. At this time, the participants were asked to read the letter of consent and select a form fillable box indicating that they had read the letter of invitation and consented to taking part in the study. Consent was inferred by their selecting the box, providing their student name, email and completing the baseline survey. This research project was granted approval through the Brock University Research Ethics Board prior to conducting the study.

3.3 Statistical analysis

All statistical analysis was performed using SPSS (IBM SPSS Statistics for Windows, Version 20.0).

3.3.1 Descriptive statistics

Descriptive statistics were calculated, including mean and standard deviation for continuous variables and frequency and percentages for categorical variables. Comparison of descriptive statistics for students in the traditional and supercourses was stratified by course year. Continuous and categorical variables were compared using the Independent *t*-test and Chi-square/Fisher exact test, respectively, between students in the traditional and supercourses within each of the first- and fourth-year courses.

3.3.2 Knowledge retention of repeat questions – mixed effect modeling

The difference in the trajectory of knowledge retention over four points in time (baseline, three, six and 12 months) between students in the traditional and supercourse was determined using mixed effect modeling. Since same-subject observations of knowledge retention closer in time have a greater correlation than those farther apart, the first-order autoregressive covariance structure was specified (West, 2009; Littell, Pendergast & Natarajan, 2000). In order to test whether trajectories of knowledge retention over the four time points differed between students in the traditional and supercourses, the mixed effect model (MEM) examined the main effects of course format and time point (i.e., time period of retention assessment) on knowledge retention. The interaction between course and period of assessment was also considered. Two separate MEMs for the first- and fourth-year courses were developed. A number of covariates previously outlined in the literature were considered during the modeling process, including gender, age, year of study (i.e., year 1-4 of an undergraduate degree), course type (i.e., required vs. elective) and time spent completing the retention quiz. Covariates significant at $p<0.05$ were included in the final multivariate mixed effects analysis.

Mixed effects modeling is an effective statistical approach to analyze longitudinal data (West, 2009). Unlike repeated measures analysis of covariance, which is limited to continuous covariates that do not change over time, MEMs incorporate time-dependent continuous covariates within the model (West, 2009). Additionally, the lack of independence observed in repeated measures on the same subject is accepted in MEMs without impacting the validity of the results (West, 2009).

3.3.3 Knowledge retention of non-repeat questions – multiple linear regression

Multiple linear regression (MLR) was utilized to compare the effect of course on knowledge retention at each time point for the repeat questions. MLR models were stratified by year of study. The aforementioned covariates were considered during the modeling process. Covariates significant at $p<0.05$ were included in the final MLR analysis.

RESULTS

4.1 Participant description

The complete study sample included 270 participants who met the aforementioned inclusion criteria. Table 4-1 displays participant attrition at each time point due to incomplete quizzes. Both T1 (n=187) and T4 (n=35) had larger samples compared with the S1 (n=20) and S4 (n=28) groups due to greater enrolment during the Fall (September to December 2014) and Winter (January to April 2015) academic terms. T1 had a significantly larger sample size as a result of the first-year course being offered during the Fall/Winter terms as well as the absence of prerequisites.

Table 4-1: Participant attrition

	T1	S1	T4	S4
Baseline (N)	238	28	45	30
3 months	204 (85.71)	25 (89.29)	37 (82.22)	28 (93.33)
6 months	195 (81.93)	22 (78.57)	37 (82.22)	28 (93.33)
12 months	187 (78.57)	20 (71.43)	35 (77.78)	28 (93.33)

Note: Values in brackets indicate the percentage of the baseline sample remaining at each time point.

Table 4-2 depicts the demographic variables of study participants, in addition to self-reported course preference, time spent completing the retention quizzes and short-term knowledge retention. Comparison of demographic variables between the traditional and supercourses revealed a lack of significant difference in age, gender, and the proportion of individuals with a learning disability for both the first- and fourth-year courses. The proportion of individuals with the course listed as part of their degree requirements, in addition to the proportion of individuals in a year of study other than fourth year, was not significantly different between students in the traditional and supercourse formats of the fourth-year course. The aforementioned variables were significantly different between the traditional and supercourse formats for the first-year course. A greater number of individuals in the S1 were completing a degree in which the Introduction to Health Sciences course was not a requirement compared to T1 students. The S1 students also reported more years of study compared to T1 students.

Following the completion of the courses, students were asked whether they preferred the traditional or the supercourse format. Self-reported preference for each cohort showed that they preferred the course in which they were enrolled. However, it should be acknowledged that 26% of T1 students and 17% of T4 students would have preferred to have enrolled in the supercourse. Finally, the amount of time taken to complete the quizzes was evaluated at each of the three time points. A significant difference in the amount of time spent completing the three-month quiz was observed between students in the T1 and S1 courses only.

4.2 Short-term student learning

Short-term student learning was assessed with the objective of evaluating the success of the traditional and supercourse formats at the completion of the courses. Comparison of final grade average in the course between the traditional and supercourses did not reveal a significant difference for both the first- (76.20% vs. 74.65%) and fourth-year (78.57% vs. 78.18%) courses (Table 4-2).

Table 4-2: Participant characteristics (N=270)

	T1 (N=187)	S1 (N=20)	T4 (N=35)	S4 (N=28)
Mean age in years (SD)	19.10 (2.08)	20.50 (3.20)	22.51 (1.98)	21.96 (1.95)
Gender (%)				
Male	43 (23.00)	8 (40.00)	15 (42.90)	12 (42.90)
Female	144 (77.00)	12 (60.00)	20 (57.10)	16 (57.10)
Concentration (%)	†	†		
Major	160 (85.60)	9 (45.00)	33 (94.30)	26 (92.90)
Non-major	27 (14.40)	11 (55.00)	2 (5.70)	2 (7.10)
Year of study (%)	†	†		
1	155 (82.90)	11 (55.00)	-	-
2	25 (13.40)	3 (15.00)	-	-
3	5 (2.70)	5 (25.00)	1 (2.90)	6 (22.20)
4	2 (1.10)	1 (5.00)	31 (88.60)	20 (74.10)
5	-	-	2 (5.70)	1 (3.70)
7	-	-	1 (2.90)	-
Learning disability (%)				
Yes	4 (2.10)	1 (5.00)	1 (2.90)	3 (10.70)
No	178 (95.20)	19 (95.00)	32 (91.40)	25 (89.30)
Unknown	3 (1.60)	3 (1.60)	2 (5.70)	-
Undisclosed	2 (1.10)	2 (1.10)	-	-
Preference (%)	†	†	^	^
Traditional	139 (74.30)	1 (5.00)	29 (82.90)	1 (3.60)
Supercourse	48 (25.70)	19 (95.00)	6 (17.10)	27 (96.40)
Mean time to complete quiz in minutes (SD)				
3 months	12.60 (9.00) †	9.00 (3.96) †	24.60 (15.00)	21.60 (12.00)
6 months	9.6 (56.40)	10.80 (9.60)	19.20 (19.80)	23.40 (14.40)
12 months	9.6 (6.60)	9.60 (6.00)	18.60 (12.60)	17.40 (14.40)
Final course average (SD)	76.20 (6.63)	74.65 (7.23)	78.57 (6.92)	78.18 (5.58)

†p<0.05 when comparing T1 with S1

^p<0.05 when comparing T4 with S4

4.3 Knowledge retention

The success of the retention quizzes at each time point is displayed in Table 4-3.

Table 4-3: Success of retention quizzes at each time point

	Baseline	3 months	6 months	12 months
T1				
Repeat	15 (100)	9.25 (61.6)	7.12 (47.5)	5.86 (39.1)
Non-repeat	5 (100)	3.07 (61.4)	2.61 (52.2)	2.39 (47.8)
S1				
Repeat	15 (100)	8.90 (59.3)	6.60 (44.0)	5.25 (35.0)
Non-repeat	5 (100)	2.55 (51.0)	2.40 (48.0)	2.55 (51.0)
T4				
Repeat	15 (100)	8.94 (59.6)	6.29 (41.93)	4.89 (32.6)
Non-repeat	5 (100)	3.09 (61.80)	2.86 (57.2)	2.29 (45.8)
S4				
Repeat	15 (100)	8.32 (55.46)	5.64 (37.6)	4.36 (29.1)
Non-repeat	5 (100)	2.54 (50.8)	2.71 (54.2)	2.36 (47.2)

Note: Values in brackets indicate the success of retention quizzes expressed as a percentage

4.3.1 Knowledge retention in Introduction to Health Sciences

4.3.1.1 Repeat questions

A significant main effect of course format (i.e., traditional vs. supercourse) on the retention of knowledge over time (β=-0.369, p=0.343) for the repeat questions was not found (Table 4-4). The non-significant estimate for course format indicates that students in the first-year traditional and supercourse had similar knowledge retention levels on the quizzes at three, six and 12 months following the baseline assessment. However, a significant main effect of time (i.e., the time point of the knowledge retention assessment) was observed. The reference for the time point variable was the final assessment that took place at 12 months. The positive and significant estimate for time point at baseline, three months and six months demonstrated that the success of the retention quizzes decreased over time. Not surprisingly, the greatest difference in knowledge retention was observed between baseline and 12 months (β=9.202, p<0.0001), followed by three months (β=3.412, p<0.0001) and six months (β=1.253, p <0.0001). The interaction between time and course (p=0.632), in addition to a number of covariates including gender (p=0.195), age (p=0.809), course type (p=0.558), year of study (p>0.05) and time spent completing the quiz (p=0.953), were considered during the modeling process. The covariates were not significant and therefore not included in the final model. Figure 4-1a represents the trajectory of knowledge retention of repeat questions for the traditional and supercourse formats of the first-year courses.

4.3.1.2 Non-repeat questions

Similarly, a non-significant association between course format and success at three months (p=0.152), six months (p=0.386) and 12 months (p=0.187) was observed for the non-repeat questions (Table 4-5). A number of covariates, including gender (p>0.05), age (p>0.05), course type (p<0.05), year of study (p>0.05) and time spent completing the quiz (p>0.05) were considered during the modeling process at each time point. With the exception of course type, the covariates were not significant and therefore not included in the final models. Figure 4-1b represents the trajectory of knowledge retention of non-repeat questions for the traditional and supercourse formats of the first-year courses.

Table 4-4: MEM results of knowledge retention in Introduction to Health Sciences

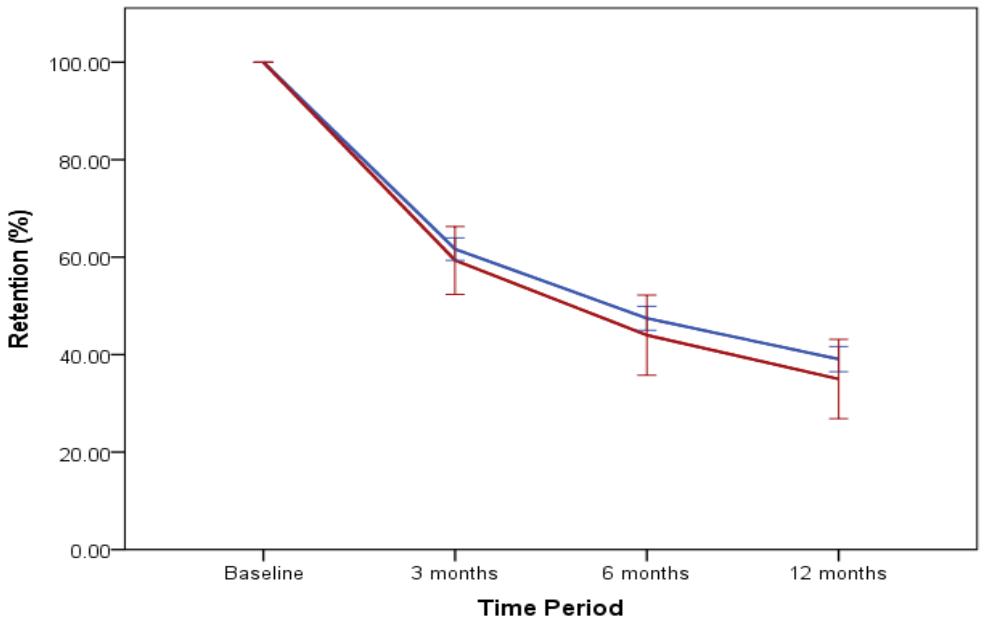
	Estimate	Standard Error	T-value	*p*-value
Intercept	5.464	0.382	14.312	<0.0001
Course format (supercourse)	-0.369	0.389	-0.950	0.343
Time point				
Baseline	9.202	0.176	52.305	<0.0001
3 months	3.412	0.157	21.612	<0.0001
6 months	1.253	0.124	10.121	<0.0001
12 months	-	-	-	-

Note: The reference for the variable *time point* is the final assessment, which took place at 12 months.

Table 4-5: MLR results of knowledge retention in Introduction to Health Sciences

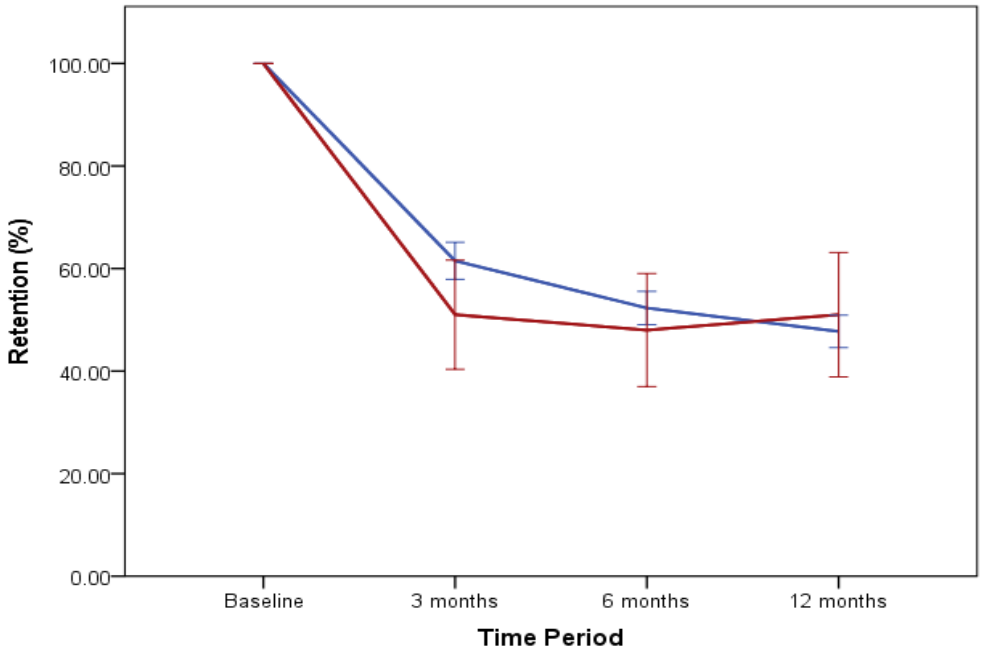
	Estimate	Standard error	T-value	*p*-value
3 months				
Intercept	3.634	0.329	11.057	<0.001
Course format (supercourse)	-0.424	0.295	-1.437	0.152
Type of course	-0.033	0.19	-1.712	0.088
6 months				
Intercept	2.824	0.300	9.400	<0.001
Course format (supercourse)	-0.234	0.269	-0.868	0.386
Type of course	0.006	0.017	0.350	0.726
12 months				
Intercept	2.581	0.330	7.824	<0.001
Course format (supercourse)	0.358	0.270	1.323	0.187
Type of course	-0.482	0.206	-2.333	0.021

Figure 4-1a: Knowledge trajectory of repeat questions in Introduction to Health Sciences course



Note: Knowledge trajectory of the T1 (red) and S1 (blue) courses

Figure 4-1b: Knowledge trajectory of non-repeat questions in Introduction to Health Sciences course



Note: Knowledge trajectory of the T1 (red) and S1 (blue) courses

4.3.2 Knowledge retention in Clinical Epidemiology

4.3.2.1 Repeat questions

Similar to the outcomes of the first-year model, a significant main effect of course format on knowledge retention (β=-0.341, p=0.410) was not observed, while the time point of assessment was significant (Table 4-6). As observed with the first-year course, the greatest difference in knowledge retention was observed between baseline and 12 months (β=10.595, p<0.0001), followed by three months (β=3.864, p<0.0001) and six months (β=1.180, p<0.0001). The interaction between time and course (p=0.780), in addition to a number of covariates including gender (p=0.479), age (p>0.05), concentration (p=0.562), year of study (p=0.835) and time spent completing the quiz (p=0.024), were also considered during the modeling process. The non-significant covariates were excluded from the final model. The variable time spent completing the quiz was significant and included in the final model. The observed significance indicates that the length of time spent completing the quiz impacted success on the retention quizzes. Figure 4-2a displays the trajectory of knowledge retention of the repeat questions for the fourth-year traditional and supercourses.

4.3.2.2 Non-repeat questions

A non-significant association between course format and success at three months (p=0.279), six months (p=0.386) and 12 months (p=0.526) was observed for the non-repeat questions (Table 4-7). A number of covariates, including gender (p>0.05), age (p>0.05), type of course (p>0.05), year of study (p<0.05) and time spent completing the quiz (p>0.05), were considered during the modeling process at each time point. With the exception of year of study, the covariates were not significant and therefore not included in the final model. Figure 4-2b represents the trajectory of knowledge retention of non-repeat questions for the traditional and supercourse formats of the first-year courses.

Table 4-6: MEM results of knowledge retention in Clinical Epidemiology

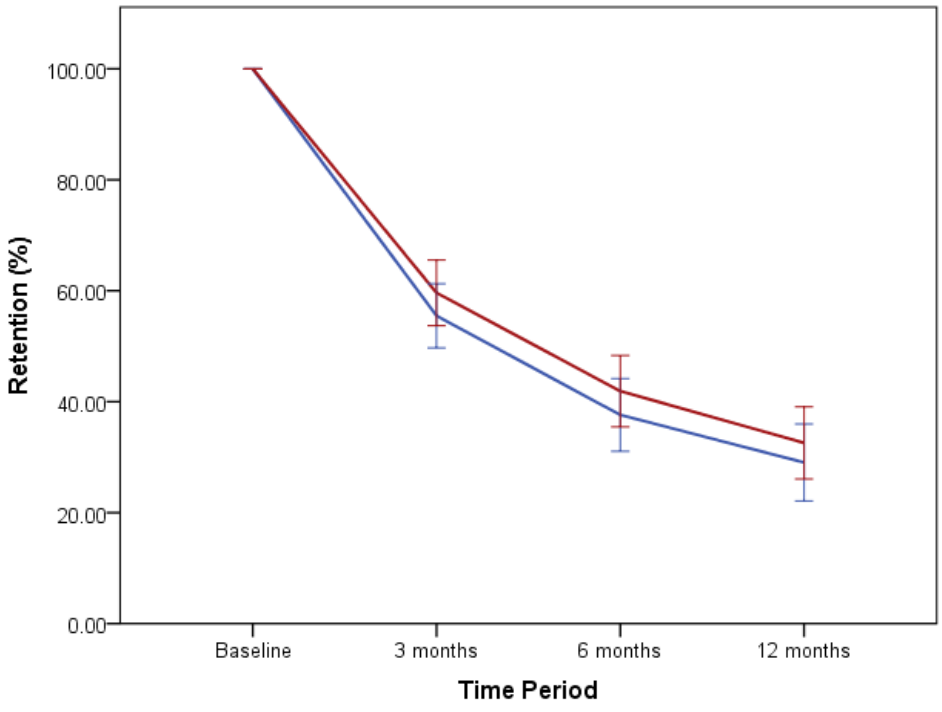
	Estimate	Standard error	T-value	*p*-value
Intercept	4.363	0.329	13.284	<0.0001
Course format (supercourse)	-0.341	0.412	-0.828	0.410
Time point				
Baseline	10.595	0.318	33.283	<0.0001
3 months	3.864	0.304	12.690	<0.0001
6 months	1.180	0.249	4.736	<0.0001
12 months	-	-	-	-
Time spent (hrs)	11.048	4.963	-	0.026

Note: The reference for the variable time point is the final assessment, which took place at 12 months.

Table 4-7: MLR results of knowledge retention in Clinical Epidemiology

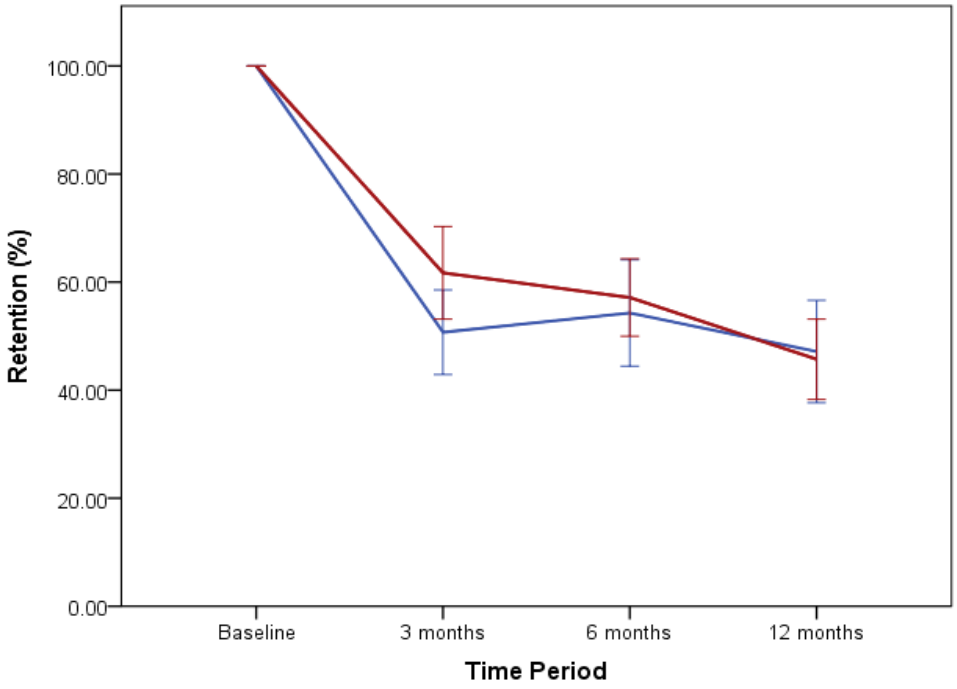
	Estimate	Standard error	T-value	*p*-value
3 months				
Intercept	-0.479	1.310	-0.366	0.716
Course format (supercourse)	0.330	0.302	1.092	0.279
Year of study	0.546	0.270	2.018	0.048
6 months				
Intercept	3.387	1.354	2.501	0.015
Course (supercourse)	0.271	0.312	0.868	0.389
Year of study	-0.392	0.280	-1.403	0.166
12 months				
Intercept	1.514	1.352	1.120	0.267
Course format (supercourse)	-0.199	0.311	-0.638	0.526
Year of study	0.381	0.279	1.365	0.177

Figure 4-2a: Knowledge trajectory of repeat questions in Clinical Epidemiology course



Note: Knowledge trajectory of the T4 (red) and S4 (blue) courses

Figure 4-2b: Knowledge trajectory of non-repeat questions in Clinical Epidemiology course



Note: Knowledge trajectory of the T4 (red) and S4 (blue) courses

DISCUSSION

5.1 Accelerated teaching and knowledge retention

Regardless of course level, students enrolled in our supercourses overwhelmingly preferred (>95%) to have completed their course in an accelerated format. While not statistically significant, it is noteworthy that preference for accelerated courses was expressed by a relatively large number of students enrolled in the traditional first-year (17%) and fourth-year (25%) courses. Students prefer accelerated courses because they allow them to learn subject material in a quicker and more convenient format (Hicks, 2014). Accelerated courses allow students to be immersed in the subject content of one course, without having to manage the demands of multiple courses (Feldhaus & Fox, 2004). As a result, students tend to be more self-motivated and actively engaged in their education (Arrey, 2009). Furthermore, students tend to enrol in accelerated courses as a strategy to balance work and education, since compressed courses often lead to less absence

from employment (Hicks, 2014). This would be especially relevant to students enrolled in Spring courses, which was the case in our study. Finally, Rood (2011) found that employers are equally accepting of their employees enrolling in accelerated degree programs and that employers that were more knowledgeable of accelerated programs demonstrated a stronger preference for these programs compared to employers with less knowledge for accelerated programs.

Our study followed the definition of accelerated teaching and learning outlined by Kretovics and colleagues (2005), whereby the supercourses were scheduled with the same number of contact hours as traditional courses, but the duration period was shortened to one-twelfth the time. Our study found that students enrolled in an accelerated course were not disadvantaged with respect to knowledge attained upon completion of the course, such that no significant difference existed in the final course average, regardless of course year. Other studies also demonstrated no discernable difference in learning, as determined by final course average between accelerated and traditional courses (Wlodkowski & Westover, 1999, Hicks, 2014). Changes in course content or student evaluations can alter a final course average. Furthermore, it is common for faculty members to adjust their assignments and methods of assessment in compressed courses (Kretovics et al., 2005). However, we implemented identical course content and student evaluations by the same instructors for both modes of delivery and in both courses. Although not measured, the lack of significant difference in final course average could be attributed to greater student engagement, time management, and ability to focus on one subject in our supercourses, which would counteract the challenges of a compressed course duration. Kasworm (2003) reported that students enrolled in an accelerated degree indicated that they benefited from learning one subject at a time rather than experiencing the 'focus overload' that is characteristic of being enrolled in multiple courses simultaneously.

Student knowledge retention during our longitudinal study diminished progressively at follow-up time points of three, six and 12 months regardless of course format, course level, age, gender, degree concentration and year of study. Previous studies have shown that long-term knowledge retention is not mediated by the number of course contact hours (Seamon, 2004; Van Scyoc & Gleason, 1993), age, gender (Hicks, 2014) or year of study (Logan & Geltner, 2000). Similarly, the decreased knowledge retention trajectory in our study was comparable for repeated and non-repeated questions. Both types of questions were evaluated in our study to determine the influence of familiarity of question content as a result of repeated questions. Our results indicate that the repeated questions over 12 months did not advantage a student's knowledge retention over time, such that a similar decreased knowledge retention over time was found for repeated and non-repeated questions.

5.2 Limitations

A limitation in our study was the inability to control for the environment with respect to follow-up quizzes. Follow-up quizzes were completed online by all students. While instructions were provided prior to each follow-up quiz to complete each question without assistance from course material or another person, it was not possible to authenticate whether the subjects did so. Nevertheless, the average time taken to complete the follow-up quizzes was considered reasonable for both courses. Furthermore, except for the three-month

follow-up quiz in the first-year course, the average time to complete the quizzes was similar between the groups for both courses.

5.3 Conclusions

Accelerated courses continue to gain popularity because of the convenience they afford students, administrators and faculty members. It is important that accelerated courses be crafted and organized so that the same material that would be covered in a traditional course is properly conveyed to students. If an accelerated course is structured to reflect its traditional course, it is expected that knowledge attained in the course and knowledge retention over time following the course should be the same for both formats. Knowing that accelerated courses do not compromise learning adds another motivation for students in higher education to enroll in such courses and programs. University and college administration and academic faculty should continue to endorse accelerated learning opportunities. A properly designed accelerated course can facilitate the academic requirements of a traditional course, but can also enable students to schedule their curricular pursuits more efficiently within their non-academic commitments (Davies, 2006). Accelerated courses could be offered during fall or spring reading weeks or scheduled in a block sequence over any term in order to facilitate the preference of students to focus on one course at a time. Regardless of the approach, our study concluded that the accelerated course format does not compromise short- and long-term knowledge retention in first-year or fourth-year undergraduate students. Thus, accelerated courses are a practical and feasible option for students in higher education.

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