Mind the Gap: Exploring knowledge decay in online sequential mathematics courses

Brian Webby, Diana Quinn, Amie Albrecht, Kevin White

University of South Australia

The Scenario

- Two online foundation level mathematics courses (units).
  - Course 1: algebra and trigonometry.
  - Course 2: introductory calculus.
  - Course 2 relies on a familiarity with the mathematical language and methods developed in Course 1.
- Open Access
  - student chooses what to study and when.
  - student may have no academic experience.

Risks

- over commitment,
- inefficient use of resources,
- personal failure,
- university failure to support,
- timing of enrolment in courses,
- allowing too long a gap between taking sequential courses,
- being unaware of potential knowledge decay.

The Questions

- Do students choose the *gap* between these two courses *wisely*?
- Is there evidence that the size of the gap matters?
- Does the age of the student have an effect?

The Questions and Answers

- Do students choose the *gap* between these two courses *wisely*?

  Maybe.

- Is there evidence that the size of the gap matters?

  Not really.

- Does the age of the student have an effect?

  Seems not.

Knowledge decay

- practical view of learning
  - in languages, mathematics,... knowledge is built across the year(s)
  - sequential courses (Japanese 101, 102,....) build on and extend vocabulary, concepts, techniques
  - a pause in formal learning may lead to loss of knowledge
- neural model
  - an exponential forgetting curve models decay of knowledge, function of time and sparsity of connection
- US schools
  - "summer learning loss" widely studied, contributed to policy change toward year-round schooling

Important reference

Dills, Hernández-Julian & Rotthoff (2015)
Knowledge decay between semesters

- studied knowledge decay at on-campus university
- large, all undergraduate levels, cross-discplinary cohort
- examined summer/fall versus fall/summer regimen
- found overall no evidence for knowledge decay over the longer gap
- but a statistically significant detrimental effect for language courses

Learning mathematics is often likened to learning a language ??

Methodology

- the gap
  - defn: the time between the end of the teaching period of Course 1 and the start of teaching of Course 2
  - multiples of 3 months
- analysis includes engaged students
  - included in the analysis:
    students who pass Course 1,
    score at least 1 mark in Course 2 ($\equiv$ any submission in Course 2).

What gap do students select?

Gap (months)	concurrent	0	3	6	9	12	other
Proportion (%)	3.3	61.6	21.0	7.9	2.6	2.3	1.3

Table : Proportion of students with observed study gap

Boxplots

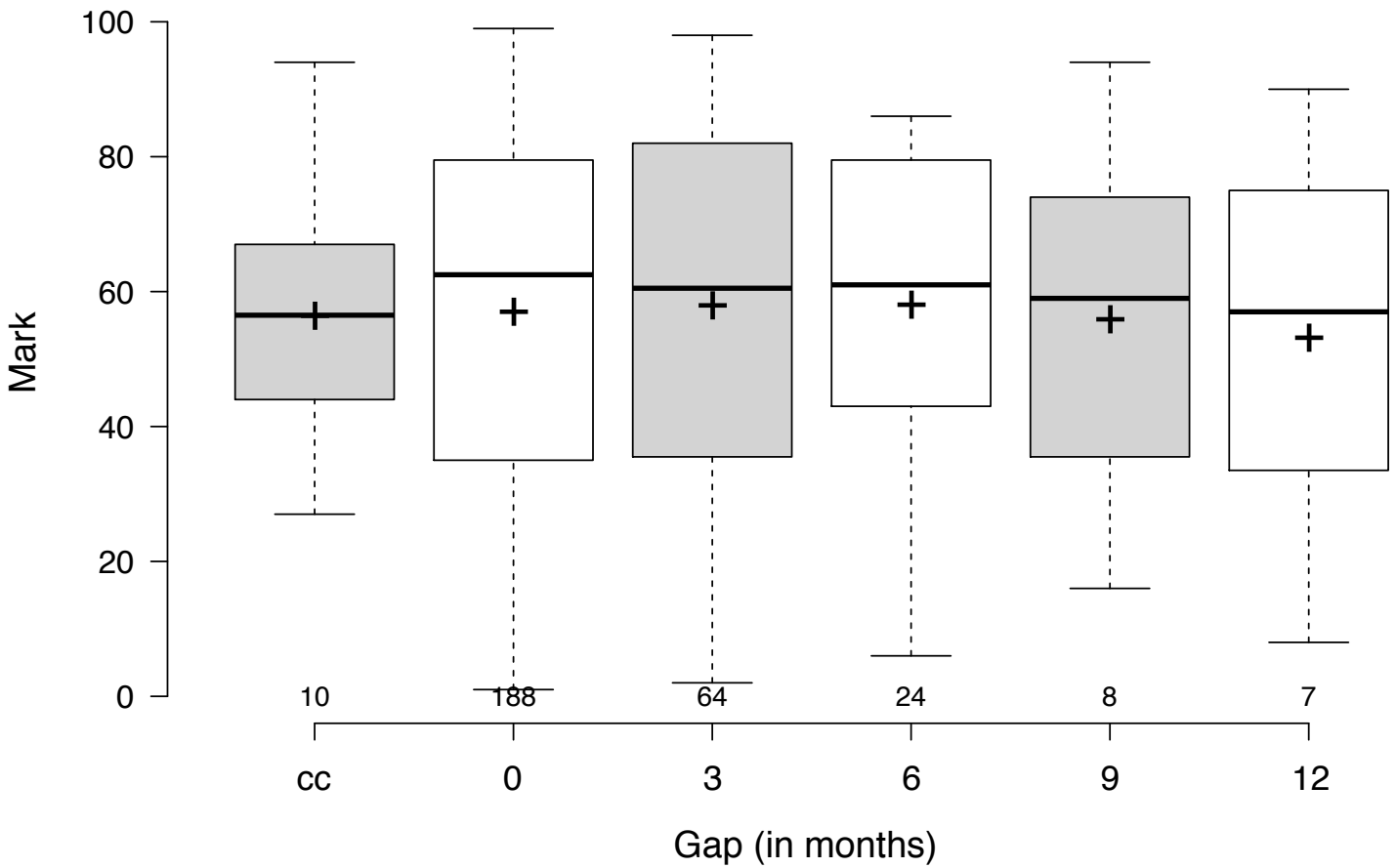
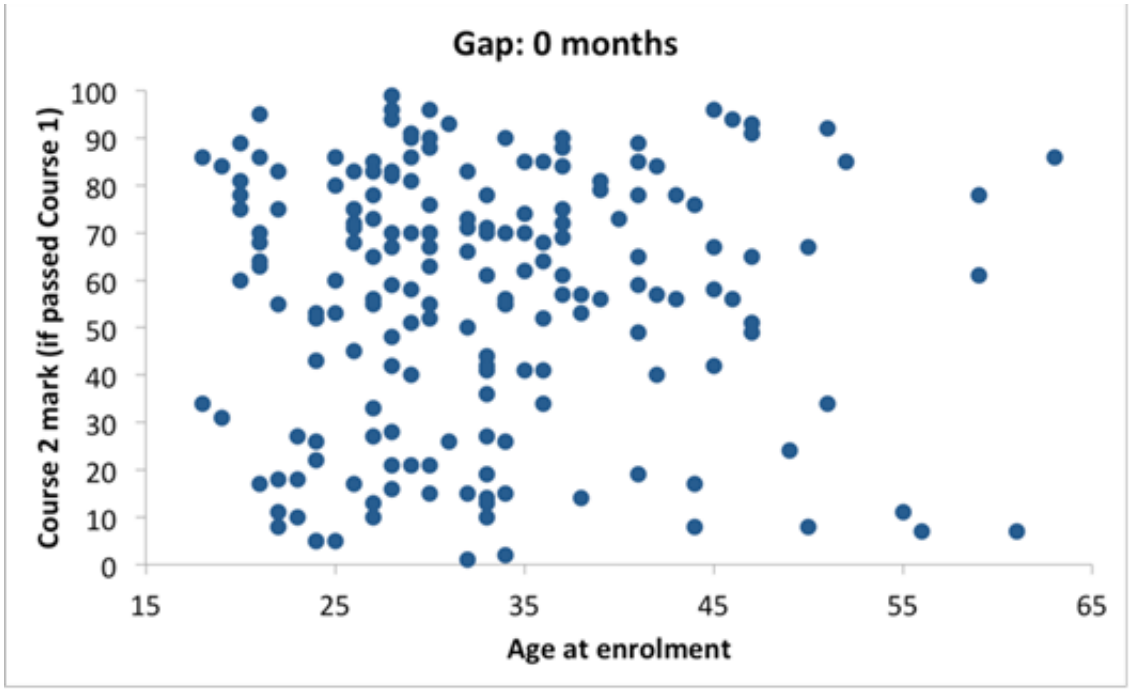


Figure : Course 2 marks against gap between Course 1 and Course 2

A Scatterplot of Course 2 final mark vs age.



Scatterplots

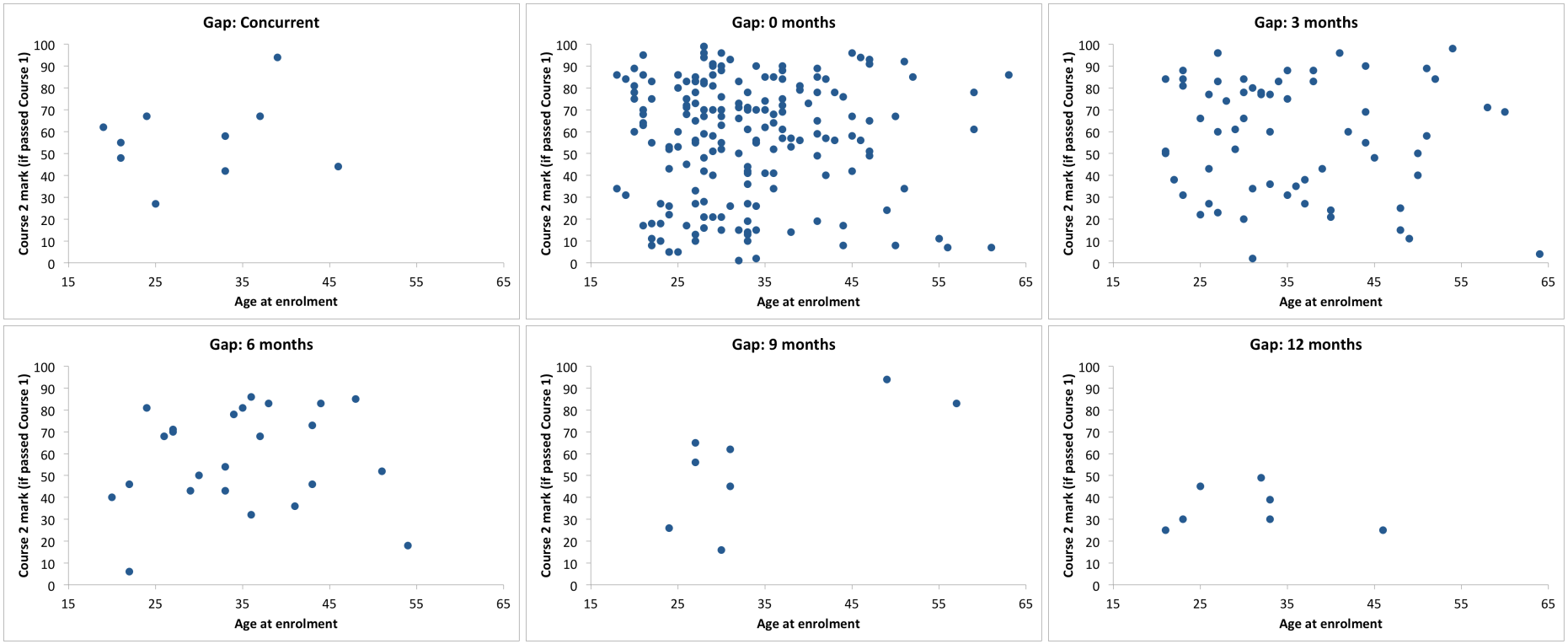


Figure : Relationship between Course 2 final mark and age for various gaps between Course 1 and Course 2.

Discussion 1.

- no definite evidence for knowledge decay in our study
  - the highest median mark is with 0 months gap, but no statistically significant difference.
  - is the tertiary environment different to high school?
  - is the online environment different?
- age profile of online cohort is older, online students self-directed
  - academically wise? able to foresee potential effect of an extended gap? do they preferentially choose shorter gaps?
  - no relationship age with gap selected, no relationship age with outcome

Discussion 2.

- potential confounding?
  - cohort largely new to university, after success in one course knowledge decay may be countered by more effective learning in the second
- courses presented online can support knowledge retention in ways not easily available in face-to-face environments
  - resources available for self-study
  - capacity to review, relearn, refresh, recall, rebuild knowledge

Conclusion

- a university has an obligation to provide best advice on enrolment
  - including gap between sequential courses
- analysis of online sequential course outcomes showed
  - knowledge decay possibly less of an issue
  - students select minimal gaps
- However, to support students' success
  self-assessment tools and resources for revision (at appropriate level and discipline topic) may be important components of the online learning environment