Algebra in Context
or What I Did On My Holidays

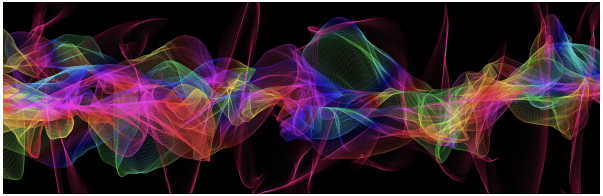
Nicholas Jackson

8 May 2026

Eternal September

It is September 1997/2002/2014/2025 and I am writing a postgraduate dissertation...

Postgraduate Award



- A 30-CATS Postgraduate Award run by Jo Kukuczka from the Academic Development Centre, open to teaching staff at the University of Warwick.
- Taught component: Four seminars (February to July):
  1. Curriculum Design as a Social Practice
  2. Re-Imaging Curriculum
  3. Crafting Curriculum
  4. Critiquing Curriculum
- Project: Critically evaluate these techniques and use them to design a two-module mini-programme, explaining your design choices.

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- Product: Curriculum is a product to be delivered to students, with focus on content and meeting pre-set objectives
- Process: Curriculum as the interaction of teachers, students and knowledge, with focus on enabling learning and experimentation
- Praxis: Curriculum as a vehicle for human emancipation and egalitarian social change, with focus on raising students' awareness of inequality through critical pedagogy

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- Question: How do we do this in maths?

Connected Curriculum Framework

- Dilly Fung, *A Connected Curriculum for Higher Education* (2017)
- Six 'dimensions':
  1. Students connect with researchers and with the institution's research.
  2. A through-line of research activity is built into each programme.
  3. Students make connections across subjects and out to the world.
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UDL (Universal Design for Learning)

- Student-centred, build in support for those at the margins
- What is necessary for some usually benefits everyone
- Reframe barriers from student problems to environmental limitations

My Theory That I Have, Which Is Mine

My project:

- *Algebra in Context*
- Based on *MA267 Groups and Rings*, a 15 CATS, self-contained abstract algebra module for second year joint degree maths students (term 1). This evolved from *MA249 Algebra II*, sister module to *MA268 Algebra 3*
- Two 15-CATS modules:
  1. *MA2xx Algebra in Context 1: Groups* (term 1)
  2. *MA2yy Algebra in Context 2: Rings and Algebras* (term 2)
- Standard treatment of second year algebra topics (groups, rings and fields) interlaced with seminar-style discussions of interdisciplinary applications and the historical context and development of the subject.
- Assessments: traditional problem sets, mini-essays, STACK quizzes, timed final exam

Blooming Taxonomy

Standard framework for classifying learning objectives and activities:

Bloom's Taxonomy

1. Knowledge
2. Comprehension
3. Application
4. Analysis
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Maths-specific variant framework due to Smith et al (1996)

Mathematical Assessment Task Hierarchy (MATH)

Group A Factual knowledge and routine procedures

Group B Using existing mathematical knowledge in new ways

Group C Evaluation, justifying and interpreting

Learning Objectives

Following each module, students will be able to:

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3. Use existing concepts and theorems to construct illustrative examples and counterexamples, and rigorously prove further results about algebraic structures such as groups, rings and algebras. (Bloom 5; MATH C)
4. Critically discuss the historical and wider scientific and social context of algebraic structures such as groups, rings and algebras in mathematics and other disciplines. (Bloom 6; MATH C)

Assessment

- STACK quizzes ($5 \times 2\% = 10\%$): Randomly-generated, automatically marked, retakeable online quizzes with an 80% pass mark. Full (2%) credit for a pass, zero otherwise. (mostly formative)

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ILO	Quizzes	Essays	Problems	Exam
1	**Y**	**N**	**Y**	**Y**
2	**N**	**Y**	**Y**	**Y**
3	**N**	**N**	**Y**	**Y**
4	**N**	**Y**	**N**	**Y**

Module delivery

- Contact hours:
  - Two 1-hour lectures, covering mathematical content
  - One 1-hour seminar-style discussion, covering history and interdisciplinary applications
  - Optional support classes/office hours
- Semi-flipped model with supplementary reading on both mathematical content and class discussion topics

Syllabus: Algebra in Context 1: Groups

Week	Topic	Theory	Context	Assessment
1	Groups	Definitions, basic properties	Early/mediæval history	
2	Symmetry	Isomorphism, cyclic, dihedral and matrix groups	Symmetry in chemistry	Quiz 1
3	Permutations	Permutations, subgroups, Cayley's Theorem	Abstract group concept, the 19th century, bell-ringing	Problems 1
4	Subgroups	Cosets, Lagrange's Theorem Cauchy's Theorem	Number Theory	Essay 1, Quiz 2
5	Quotients	Normal subgroups, quotients, direct products	Conjugation in linear algebra, Rubik's Cube	Problems 2

Syllabus: Algebra in Context 1: Groups

Week	Topic	Theory	Context	Assessment
6	Homomorphisms	Kernels and images, Noether's Isomorphism Theorems	Women in maths, Germany, Noether's Theorem in physics	Quiz 3
7	Classification	Presentations, small finite groups, abelian groups	Classification of Finite Simple Groups	Problems 3
8	Actions	Groups acting on sets, orbits and stabilisers, conjugacy	Symmetry in music and art	Essay 3, Quiz 4
9	Finite groups	Conjugacy in S_n and A_n, Sylow's Theorems, classification up to order 31	Combinatorics and counting (Not) Burnside's Lemma, Polya's Enumeration Theorem	Problems 4
10	Representations	Linear representations, characters	Particle physics	Essay 4, Quiz 5

Syllabus: Algebra in Context 2: Rings and Algebras

Week	Topic	Theory	Context	Assessment
1	Rings	Definitions, examples, Sun Tzu's Remainder Theorem	History: China and India	
2	Integral Domains	Zero divisors, units, division rings, fields	Cryptography	Quiz 1
3	Quotients	Homomorphisms, ideals, quotients, Isomorphism Theorems	Error-correcting codes, information theory	Problems 1
4	Divisibility	Prime and irreducible elements	CRC checksums	Essay 1, Quiz 2
5	Domains	Euclidean domains, PIDs and UFDs	Algebraic Number Theory, quaternions and octonions	Problems 2

Syllabus: Algebra in Context 2: Rings and Algebras

Week	Topic	Theory	Context	Assessment
6	Polynomials	Irreducible polynomials, roots of unity	History of solving equations, Sumeria to the Renaissance	Quiz 3
7	Field Extensions	Tower Law, splitting fields, the Galois group	Finite fields	Problems 3
8	Galois Theory	The Galois Correspondence, solving equations by radicals	Geometric constructions: circle-squaring, angle trisection, cube doubling	Essay 3, Quiz 4
9	Algebras	Vector spaces, algebras, modules	Lie algebras in particle physics	Problems 4
10	Categories	Categories, objects, morphisms and functors	Algebraic topology, computer science	Essay 4, Quiz 5

Some historical topics in algebra:

- Sumeria (cunieform tablets c.1500–2000 BCE, eg Plimpton 322)
- Egypt (Rhind papyrus c.1500 BCE)
- Greece (c.600–200 BCE)
- China (c.300 BCE onwards, eg *Nine Chapters on the Mathematical Art*, Sun Zi's Remainder Theorem)
- India (c.400 CE onwards, eg Aryabhata, Brahmagupta, Bhaskara II)
- Arabia (c.800–1200 CE, eg Al-Khwarizmi, Omar Khayyam)
- Women in mathematics (eg Noether's Isomorphism Theorems)

Design Manifesto

- Nothing is apolitical: the status quo is a choice, and in some cases this status quo dates back centuries
- Adopt a "praxis" style approach to curriculum: "[to help] these young fellas be the best versions of themselves"
- Discuss the social and historical context, and decolonise the subject by considering non-western contributions (eg China, India, Egypt, Sumeria, ...)
- Use of examples (qv LCT concept of a "semantic wave") to help embed theoretical concepts – anti-Bourbakist approach
- Traditionally pure maths has avoided discussion of applications (qv Hardy and Littlewood) but we actively want to examine interdisciplinary connections
- Avoid the "great man" model of history: "we are all standing on the shoulders of giants".

I like your manifesto, put it to the test-oh!

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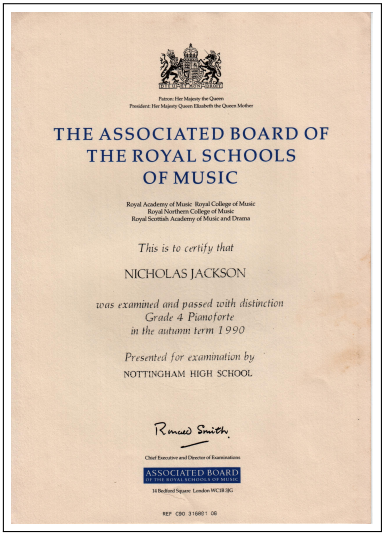
Distinct



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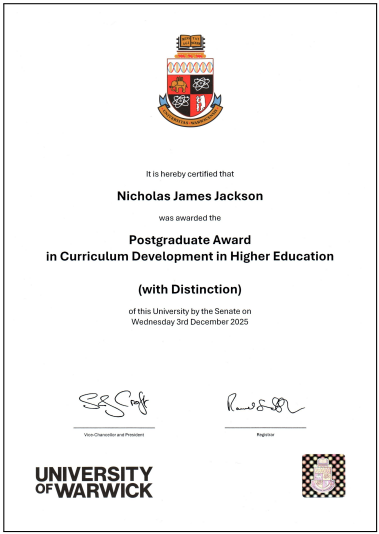

It is hereby certified that

Nicholas James Jackson

was awarded the

Postgraduate Award
in Curriculum Development in Higher Education

(with Distinction)

of this University by the Senate on
Wednesday 3rd December 2025

Vice-Chancellor and President

Registrar

UNIVERSITY OF WARWICK