A Data-Driven Approach to Teaching Research Methods: iMethod, a Proof-of-Concept

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Abstract: Courses in research methods play a critical role in postgraduate education. However, postgraduate students face considerable challenges in learning the subject matter. The present paper introduces iMethod, a software application designed to track students' engagement with the content of research methods courses. iMethod harvested data, analysed students' engagement, and presented the outcome to a teacher through a dashboard rendered in real-time. As a proof-of-concept, a usability study on iMethod was conducted with a sample of postgraduate students and early career academics (n=37) at a research-intensive university in New Zealand. Key findings suggest that students and academic staff found iMethod a valuable application for enhancing research methods learning. In particular, students value its content for understanding fundamental concepts while valuing its inquiry facilitation and providing helpful information on research methods. Participants said iMethod could expand knowledge, offers guidance, and the content is accessible to a diverse range of students. Lastly, participants reported that iMethod facilitated easy knowledge sharing, and the interface design was user-friendly and intuitive. The paper contributes to the growing need to promote research into the curriculum design of research methodology programmes and the quality of teaching research methods courses.

Keywords: Research Methodology, Learning Analytics, Visualisation, iMethod

1. Introduction

Research methodology is a foundational subject in postgraduate education, playing a critical role across various disciplinary contexts. It involves employing systematic approaches and procedures to investigate well-defined problems (Daniel & Sam, 2011). However, teaching research methodology or methods is challenging due to students' diverse backgrounds, prior knowledge, interests, and expectations (Earley, 2014; Kilburn, Nind & Wiles, 2014; Saeed & Al Qunayeer, 2021). The varied backgrounds of students and the pedagogical content knowledge and experience of teachers make teaching and learning this subject highly demanding.

This paper introduces iMethod, an online platform I developed in 2018 to track, gather, and visualise learning analytics related to students' engagement with content in the research methodology courses. iMethod allows teachers better to understand students' engagement patterns in online learning, tracking their progress and identifying specific challenges they may face with the course content. It presents a visualisation dashboard to research methods instructors, enabling them to observe how students interact with the content. With iMethod, teachers can analyse and gauge the correlation between the amount of time students spend viewing a piece of content and the difficulty level of a piece of content. Such information can be used to redesign learning materials or appropriately support students.

2. Related literature

Research methods learning is an integral part of postgraduate education. However, research indicates that research methods courses' learning outcomes are poorer than other subjects (Daniel, 2019; Earley, 2007; Lehti and Lehtinen, 2005; Murtonen, 2015). Students learning research methods face several challenges, including a mismatch between the content design and the expected learning outcomes, difficulty connecting theoretical constructs to practical aspects such as data analysis, becoming competent in data analysis and statistics, and engaging critically with literature. Some students associate quantitative methods with mathematical and statistical knowledge, leading to numerical anxiety and avoidance of the subject.

Additionally, framing the right research questions and responding to conflicting views and directions from multiple supervisors can be challenging for students (Daniel, Kumar & Omar, 2018). Research suggests that teaching research methods to meet diverse expectations is challenging due to the increasing diversity of students pursuing postgraduate education (Teddlie & Tashakkori, 2009). Research methods can be complex for some students to comprehend, and the time available for teaching is often inadequate (Benson & Blackman,
Given the complexity of teaching and learning research methods, it is crucial to research the pedagogy of research methods to improve learning outcomes (Kilburn, Nind & Wiles, 2014).

3. **Data-driven educational research**

For several years, research into students’ learning outcomes associated with research methods has depended on self-reported data. While providing valuable insights, surveys and interviews are unlikely to provide authentic information about students’ behaviour and how they engage with learning materials on research methods. I proposed a dual pedagogical research approach involving the combination of self-reported student surveys and learning analytics research. Learning analytics can capture various data and provide insights to enable users to make informed decisions (Susnjak, Ramaswami & Mathrani, 2022). By combining self-reported data (questionnaires and student evaluation forms) and learning analytics, teachers of research methods can examine students’ perceptions of the quality of the learning and how they experience the teaching process and gain some insights into students’ authentic behavioural patterns in a course.

The growing interest in data-driven instruction is evidence of the potential of utilising data to understand complex learning problems (Howard et al., 2022). When teachers use student-generated data, they will respond to learning problems effectively. Data-informed teaching practice allows teachers to collect, analyse and use data to shape their teaching and learning processes. This would also enable them to reflect and improve their teaching by utilising information collected from the learning environment, students and their learning processes (Ndukwe & Daniel, 2020). For example, while the student experience survey allows students to share their experiences and opinions on how research methods should be taught or to reflect on their learning, capturing student learning activities through examining how students engage with learning materials can better inform the identification of valuable pedagogical intervention.

4. **Learning analytics**

The learning analytics approach utilises computational tools to explore how students engage with content and the learning process to gain valuable insights for improving learning (Daniel, 2019; Gašević, Dawson & Siemens, 2015; Kaliisa & Dolonen, 2022). Analytics enable instructors to track and understand student engagement with the content of courses, understand their teaching approaches and develop appropriate pedagogical interventions to support students learning (AlZoubi, 2022; Bañeres & Serra, 2018; Ndukwe & Daniel, 2020).

Learning analytics provide teachers with insights they can use to develop a better quality of content, improve student learning activities, and provide real-time personalised feedback to students (Amigud et al., 2018; Jivet & Drachsler, 2022). Results of learning analytics are presented to instructors and students in the form of visualisation dashboards. Dashboards enable teachers and students to visualise learning activities and promote awareness, reflection, and sensemaking (Park & Jo, 2015; Susnjak, Ramaswami & Mathrani, 2022).

The personalisation of learning afforded by analytics through dashboards is critical to inexperienced learners interested in understanding their progress in a course and against others in the class (Wise, 2014); personal benchmarking against others will likely help students gain self-efficacy, self-awareness, and motivation. Looking at behavioural activities generated in the students’ dashboards, teachers can learn how, where and when students engage with learning online or in blended mode; the data can also be used to inform the learning design in the face-to-face classroom. Research shows that student dashboards can encourage conversation between teachers and students about their progress (Smith, 2019).

The dashboard in iMethod draws from the idea of early learning analytics dashboards for instructors presented in the signal system (Arnold & Pistilli, 2012). The signal systems use data collected from online learning environments to identify students who might risk failing a paper or programme of study. The signal system captures the student’s learning activities and predicts learning outcomes based on three indicators: grades on the course, time spent on a task, and past and present performance (Arnold & Pistilli, 2012; Jayaprakash et al., 2014). The prediction is carried out in real-time or near real-time based on data collected from the student’s engagement with content (readings, assignment performance, etc.).

The student dashboard serves as a mirror for the instructors to reflect on their teaching impact on students and make necessary changes to the pedagogy. For example, by analysing students’ access patterns, particularly the time spent viewing a piece of content, the instructor of research methods can revise the information contained in a particular learning object or resource to benefit students. For instance, revisiting a resource several times suggests that the content is necessary, interesting, or challenging to comprehend.
On the other hand, iMethod presents students with their learning analytics dashboard. Students use dashboards to understand their learning trajectories and possibly take control of their learning performance in real-time—examples of student visualisation dashboards present dashboards that visualise self-assessment exercises (Mazza & Dimitrova, 2007). In iMethod, the student dashboard enables the student to reflect on and manage their learning, and at the same time, they can use data from the dashboard to identify areas where they face challenges and need support. For instance, the student activity meter (SAM) tracks and visualises course progress for students and teachers (Govaerts et al., 2012). Students can monitor their progress in the course and, by comparing their progress to peers, dashboards can improve students’ motivation and incentivise change in study behaviours (Smith, 2019).

5. Overview of the iMethod Digital Learning Environment

I developed iMethod, a digital learning environment, to support teaching research methods courses and for students to access learning materials in place. Unlike other virtual learning environments, iMethod was intended as a hub for collecting analytics associated with students’ engagement with learning materials rather than a full learning management system. The environment provides sound bites and just-in-time research methods advice to postgraduate students and early career academics. The feedback is provided to system users in various forms (e.g. text, video and audio). Figure 1 provides a view of the main interface.

![Figure 1: The main interface](image)

In order to help teachers gain knowledge of the challenges of learning research methodology/research method and propose strategies and models of teaching the subject matter, the environment is designed in a modular and systematic structure, and it incorporates a tool that presents a visual network of students’ questions. iMethod Proof-of-Concept (PoC) captures engagement analytics and presents visualisation dashboards for students and teachers. The core components of the prototype are presented in Figure 2.

![Figure 2: Example of the resources page](image)
6. **Behavioural analytics and teacher's dashboard**

Methods captures and presents behavioural learning analytics. This form of data analytics focuses on capturing actions of students' engagement with content and the overall time they spent interacting with the system. Information presented in the dashboard enables the instructor to gain insights into how students engage with content and use that information to improve the quality of teaching. Figure 3 illustrates students' interaction with learning materials, including total and unique views. This data helps educators evaluate engagement and understand individual or group difficulties with specific content. For instance, the "Introduction to Mixed Methods" had 14 views, including 4 repeat viewers, indicating specific access patterns that may require content resequencing or the instructor's attention. Teachers can also examine individual viewing patterns via the dashboard. Table 1 and Figure 4 further detail the time spent on different resources, providing insights into average and maximum engagement durations.

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<th>Median</th>
<th>Average</th>
<th>Max</th>
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<td>646</td>
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<td>3</td>
<td>37</td>
<td>106</td>
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<td>24</td>
<td>39</td>
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<td>6</td>
<td>6</td>
<td>7</td>
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<tr>
<td>Ontology, epistemology and methodology</td>
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<td>5</td>
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<td>5</td>
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<td>Qualitative research questions</td>
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<td>Theoretical and conceptual frameworks</td>
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<td>5</td>
<td>4.5</td>
<td>5</td>
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<tr>
<td>Introduction to Validity</td>
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<td>3</td>
<td>3</td>
<td>3</td>
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<td>Total</td>
<td>178</td>
<td>367</td>
<td>1263.706</td>
<td>4264</td>
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</table>

Table 1: Resources with time users spent engaging with each resource
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**Figure 3: User engagement analytics**

*iMethod* records the duration student spends on each resource, creating attention metadata (Table 1) that help teachers to provide targeted support to students. Attention metadata in *iMethod*, an approach that describes data gathered about a student’s focus within a digital platform. This can encompass details such as a student’s duration with certain screen elements and content, the items they select, and the sequence of accessed materials. The analysis of attention metadata helps the instructor gain an invaluable understanding of students learning behaviours, which can be used to inform the instructional design of learning materials that enhance the learning experience.

Maiorana Csizmadia and Richards (2021) noted that attention metadata enables instructors to track content interactions and identify where students dedicate most of their time. This helps tailor the necessary learning support. Table 1 shows students’ engagement durations for various research method resources, and Figure 4 displays the average and peak times spent with these resources.

**Figure 4: Average and maximum time spent on engaging with resources**
Figure 5 illustrates the correlations between access and views of different resources; the darkness of the line signifies the strength of the association between them. For example, a darker line would appear between the two resources if user A views resource ‘r’ and then views resource ‘q’ within a specific time ‘t’. This correlation implies that these two resources are often accessed or viewed in tandem, possibly because they are related in content or theme or because one resource naturally leads to the other in the progression of the course material. This information is invaluable for the instructor as it allows them to map out a network of resource access among students, potentially unveiling learning behaviour patterns. By analysing these associations, the instructor can better understand how different resources are interconnected in the students’ learning process. This can inform the structuring of the course content, ensure that related resources are appropriately linked, and even identify potentially confusing or difficult areas in the coursework.

Moreover, these correlations could help identify resources that consistently appear in close proximity, suggesting a possible relationship in the difficulty level. If a particular resource is viewed right after another, it could imply that the second resource is a more complex extension of the first or that students find it challenging to comprehend. Armed with this information, the instructor could revise the course material or offer additional support to ensure better student understanding and engagement.

![Figure 5: Resources viewing correlation matrix patterns](image)
7. The usability and user experiment

To test the usability of the software, user experience and the value of iMethod in supporting student learning, I developed an online questionnaire consisting of 8 items. The assessment items were measured on a Likert scale and were administered to postgraduate students and academic staff who had engaged with iMethod. The assessment items consisted of questions intended to learn about the learner's experience and the extent to which the analytics dashboard built into iMethod contributed to student learning—other assessment items examined learners' engagement with the various content provided in iMethod. In addition, users were asked whether accessing iMethod improved their learning experience.

7.1 Methods and procedures

The experiment carried out engaged a convenience sample to enable us to collect data from students and academic staff. Participants (n=37) were volunteers who participated in a series of workshops on research methods and interacted with iMethod. Participants were self-selected—a non-representative sample recruited from students and academic staff in the institution where the research was conducted. They identified as PhD students (21, 57%), Master’s students (5, 13%) and academic staff (11, 30%). They came from various subject domains, including Sciences (8, 21.6%); Health Sciences (6, 16.2%); Commerce (3, 8.1%); Interdisciplinary (3, 8.1%) and Humanities (17, 45.9%). Data from the closed-ended questions were summarised using sample statistics (frequencies and proportions Table 2). Data obtained through the open-ended questions were thematically analysed.

8. Results

The overall usability and user experience results suggest that both students and academic staff found iMethod helpful in supporting the learning of research methods. Students, in particular, reported that the content provided in iMethod helped them better to understand the fundamental concepts of research methodology. One participant said: "iMethod is an excellent opportunity for the users to find all up-to-date and suitable resources in one place." Others said the application enables them to ask questions and acquire helpful information to support their learning: "...users can share relevant queries and request more resources...."

Through iMethod, some participants said they were able to extend their understanding of research methods and consolidate their knowledge of the fundamental concepts.

"This is an institutional treasure. This is invaluable for consolidating and increasing my understanding of research methods. Consolidating what I know has allowed me to focus on areas I want or require a more detailed understanding."

Table 2 represents survey responses where participants have rated different aspects of their experience using iMethod. The ratings are based on a five-point Likert scale, often used in questionnaires to ask respondents about their level of agreement with a statement.

**Table 2: Usability and user experience ratings**

| Statement                                                                 | F(%) | SA | F(%) | A   | F(%) | N   | F(%) | DA  | F(%) | SD
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<tbody>
<tr>
<td>The dashboard presentation increases my awareness of what content I must focus on.</td>
<td>17(45.9)</td>
<td>15(40.5)</td>
<td>(2.7)</td>
<td>2(5.4)</td>
<td>2(5.4)</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Access to the learning resources on iMethod helps me reflect on my learning</td>
<td>25(67.6)</td>
<td>7(18.9)</td>
<td>0(0)</td>
<td>2(5.4)</td>
<td>3(8.1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall, the content of the resources helped me better understand concepts in research</td>
<td>17(45.9)</td>
<td>15(40.5)</td>
<td>3(8.1)</td>
<td>1(2.7)</td>
<td>1(2.7)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>After using iMethod, I sought additional materials or help with research methods.</td>
<td>17(45.9)</td>
<td>6(16.2)</td>
<td>10(27)</td>
<td>2(5.4)</td>
<td>2(5.4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall, accessing materials on iMethod contributed to a better understanding of key concepts in research methods.</td>
<td>18(48.6)</td>
<td>15(40.5)</td>
<td>0(0)</td>
<td>2(5.4)</td>
<td>2(5.4)</td>
<td></td>
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</tr>
</tbody>
</table>

F = frequency; SA = Strongly agree; A = Agree; N = Neutral; DA = Disagree; SD = Strongly disagree

From this data shown in Table 2, it can be concluded that most respondents had a positive experience with using iMethod, as the most considerable portion of responses for each statement were either "Strongly Agree" or "Agree". However, there is some variation in the responses, particularly in the statement about seeking additional materials or help, where 27% of respondents remained neutral.
8.1 Interactive dashboard for soliciting feedback

Participants found iMethod a valuable platform for seeking advice on research methods. One teacher commented, "iMethod allowed students to ask questions and obtain answers". Another one said that "iMethod provided students with the opportunity to reflect on their learning." A student said: "iMethod allowed me to ask questions directly and share knowledge." Another student indicated, "iMethod was best for reflecting on my learning by accessing my Dashboard, and the software is user-friendly."

Participants also mentioned that iMethod enriches the student learning experience and makes research methodology accessible to many students, as one student participant observed: "iMethod improved my learning experience. I love iMethod; it has made my study easier with resources provided there." iMethod also served as a helpful support platform, "It is a useful platform for an audience who seek advice on research methods". "It is helpful because it has a discussion forum for students in different disciplines."

Both students and teachers found iMethod convenient because it facilitates knowledge sharing and access to various resources on research methods.

"iMethod is a great platform for users to find all current and suitable resources in one place. The platform enables users can share relevant queries and request more resources!"

1. Scale usage to other courses in the programme

Participants said iMethod is a valuable learning resource and suggested that it be widely deployed in other subjects.

"iMethod is a valuable resource that needs to be deployed widely across courses. I used it only when studying ....research courses. If they resolved to do so, it could similarly be used to easily upload material for other courses, such as for other courses. The research methods lecturer uploaded materials often for the course, which was a valuable course information source to us students."

Others remarked that... "more courses should use this platform." And that they found it helpful. "It is beneficial and can be applied in difficult courses to make learning easier."

8.1.1 Usability findings

Overall, participants found the design of the iMethod user-friendly, "iMethod is user-friendly, an observation also echoed by a second participant: "user-friendly and easy to navigate through."

"The interface is simple and loads fast." The simplicity of the presentation of the interface made it appealing to those who feel they are technologically challenged. "Extremely practical to use even for a techno dinosaur like me." Some reported that the materials were well-organised and with a well-balanced structure. "I thought the layout and the style make the software easily accessible. The folders on the homepage are well-arranged."

Participants also commented that it was easy to navigate. "Entering iMethod only takes a few minutes to figure out how it is structured; it is straightforward." Those who described iMethod as user-friendly said, "It is extremely user-friendly." In addition, one participant said that their experience was improved. "User friendly with user experience enhanced." Others found it suitable for learning research methods and simple to use. "Stable, convenient and user-friendly." One participant commented: "At the moment, it seems simple. The dashboard is an interesting feature."

9. Conclusion and future directions

Research methodology plays a vital role in postgraduate education, but it remains a challenging subject to teach. This paper reports a data-driven approach to pedagogical research design to understand students' challenges in learning research methods. It draws from previous research on the challenges postgraduate students face in learning research methods and the difficulties teachers of research methods encounter when teaching the subject to diverse students. The paper presents iMethod, a software application designed and developed to track students' navigation and behavioural patterns, thus allowing teachers of research methods to collect, analyse, and visualise learning analytics that they can use to optimise teaching and provide better support to students.

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The feedback from students and academic staff on the usability and user experience of iMethod highlights the application’s significant contribution to research methods learning. Students, in particular, found the content available in iMethod highly valuable for understanding fundamental concepts and found the application’s ability to facilitate inquiry and provide helpful information on research methods. Participants who took part in the usability and user experience study said iMethod served as a valuable tool for expanding knowledge and solidifying understanding, offering guidance and accessibility to a diverse range of students. Both students and teachers praised iMethod’s convenience, as it facilitated knowledge sharing and provided easy access to research method resources. The user-friendly design and intuitive interface were positively received by participants, emphasising its ease of navigation.

Data generated from the iMethod environment provides instructors of research methods courses with helpful information to understand students’ specific challenges in learning research methods. For example, the outcome of the learning analytics led to various workshops with tools and templates to help students navigate the complexity of learning the content of the research methods course (Daniel, 2019). The design and deployment of an analytics and research methods workshops programme demonstrated the need to focus on curriculum interventions instead of learning analytics approaches focusing on only identifying at-risk students.

10. Limitations

As iMethod is currently deployed as a proof-of-concept in a beta version, data collected and used in the paper were limited to six months. As such, the observed learning analytics may not reveal stable patterns. In the future, it is necessary to broaden the software deployment to classes for both undergraduate and postgraduate students, extract longitudinal learning analytics, and develop student learners’ models that can be used for personalisation and adaptive learning. In order to acquire an understanding of the vast-scale utility of the software and examine user experience, a large sample size will be required. Moreover, the usability and user experience sample is limited to 37 users.

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