Journal of Information Technology Education: Innovations in Practice

An Official Publication of the Informing Science Institute
InformingScience.org

JITEiip.org

Volume 17, 2018

A FULLY ONLINE RESEARCH PORTAL FOR RESEARCH STUDENTS AND RESEARCHERS

Angelos Rodafinos*	Monash University, Melbourne, Australia	arodafinos@gmail.com
Filia Garivaldis	Monash University, Melbourne, Australia	filia.garivaldis@monash.edu
Stephen McKenzie	Monash University, Melbourne, Australia	stephen.mckenzie@monash.edu

* Corresponding author

[**Author's Note**: A preliminary version of this paper was presented at the 2016 Edulearn conference. McKenzie, F., Garivaldis, F., Kaissidis, A., & Mundy, M. (2016). Developing a transferable research portal - Creating an on-campus equivalent fully online research course component. *EDULEARN16 Proceedings*, pp. 877-882. https://doi.org/10.21125/edulearn.2016.1171]

ABSTRACT

Aim/Purpose	This paper describes the context, development, implementation, and the potential transferability of an integrated online research environment that allows its users to conduct all aspects of research online.
Background	While the content of most traditional courses can be delivered online and learning outcomes can be achieved by adopting equivalents to face-to-face pedagogic approaches, certain courses, such as those that require a substantial research component, present significant constraints for delivery online. To overcome these limitations, Australia's largest university developed and implemented a Research Portal.
Methodology	The development team conducted a functional requirements analysis, identified the components that would be necessary to meet user needs, and reviewed existing solutions. The Monash University Psychology Research Portal was designed, tested, developed, tested for user experience, implemented, and reviewed. The Research Portal is structured according to the usual research sequence and provides users with access to supporting information and integrated capacities including research supervision, participant acquisition, and data collection, analysis, and storage.
Contribution	This integrated online research environment is equivalent to and, in some ways, superior to an on campus/non-online research capacity.

Accepted by Editor Donna Jean Satterlee | Received: June 28, 2018 | Revised: July 31, August 3, 2018 | Accepted: August 4, 2018.
Cite as: Rodafinos, A., Garivaldis. F., & McKenzie, S. (2018). A fully online research portal for research students and researchers. *Journal of Information Technology Education: Innovations in Practice, 17,* 163-178. https://doi.org/10.28945/4097

Findings	The usage of the Research Portal has grown rapidly and has satisfied the requirements and met the research needs of students of an online course that includes a research project, providing a common, ubiquitously accessible, and integrated online research environment.
Recommendations for Practitioners	Further refinement, personalization, and expanded implementation and dissemination of the Research Portal components are required. The formation of networks and working partnerships to operate, maintain, and promote Research Portal initiatives is recommended to reduce operational costs, increase access, and create an impact.
Impact on Society	The Research Portal is an efficient resource that provides easy access to a standard interface at any time and from anywhere and can potentially be used by other online research courses, as well as by online and non-online researchers.
Keywords	online research, virtual lab, innovation

BACKGROUND

There is a rapidly increasing demand for flexible and non-traditional learning and teaching. This demand is pushing universities and other educational institutions to produce new ways of achieving optimal course delivery and scope, such as by the increasing offering of online and blended courses of study.

The popularity of online courses keeps rising despite a decline in the total number of tertiary students, including both online and traditional students. In the United States alone, 6 million (29.7% of all higher education students) took at least one course at a distance in 2015, while approximately 2.9 million students (14.3% of all higher education students) took all their higher education instruction at a distance (Allen & Seaman, 2017). Online education is rapidly becoming more appealing to both students and faculty. Technology developments and advantages of remote studying (e.g., ubiquity, flexibility, personalization, convenience) make the online training system at all primary, secondary, and higher education levels more accessible and, according to some scholars, more effective (Aithal & Aithal, 2016). Faculty acceptance of the value and legitimacy of online education has also been rising, while chief academic officers view the learning outcomes for online instruction as the same or superior to face-to-face instruction (Allen & Seaman, 2016).

ONLINE STUDY OBSTACLES: SUITABILITY OF COURSES FOR ONLINE IMPLEMENTATION

An impediment to the expansion and improvement of online university education is the lack of suitability of some courses and course features for online implementation. While the content of most traditional courses can be delivered online and learning outcomes can be achieved by adopting equivalents to face-to-face pedagogic approaches, certain courses present significant constraints for delivery online. Examples of courses that are not currently suited to online education include medical courses that require clinical or other hands-on experience, and engineering courses that require hands-on labs for instrumentation awareness and the development of haptic skills (Abdulwahed & Nagy, 2011). Graduate psychology courses are also less suited to online delivery, due to their research and clinical components. Challenges for online graduate psychology course development and implementation include the translation of a traditional on-campus research project into an online mode that is equivalent, the ability to scale from small cohorts to several hundred students, and the development of clinical and research skills through virtual means.

The Research Portal

To overcome these limitations, Monash University developed and implemented an integrated online research environment that allows its users to conduct all aspects of research online. The development of the Monash Psychology Research Portal has allowed the creation of the new Graduate Diploma of Psychology Advanced (GDPA) course. The GDPA is a large new fully online psychology fourth year course, which has grown rapidly to now have over 500 enrolled students after operating for only two years. The course is equivalent to the on-campus psychology Honors course and is fully accredited by APAC, the Australian national psychology course accreditation body. In Australia, a fourth-year course such as this is typically a bridge between an undergraduate degree and a higher degree and is a pathway to registration as a Psychologist or to other psychology related employment opportunities. The GDPA includes a large research component and requires its students to conduct a major research project.

The driving force behind the development of the Monash Psychology Research Portal – and the most challenging and rewarding aspect of the development of the online course – has been the development of an integrated online research environment that is equivalent to and, in some ways, superior to an on campus/non-online research capacity.

The Monash Psychology Research Portal is user friendly and allows students and researchers to easily and conveniently conduct all aspects of a research project fully online, within a single integrated and accessible research environment. Specifically, the Research Portal enables the effective presentation and selection of online friendly research topics, logically guides users through the entire research process (planning, literature review, methodology, recruitment, analysis, and write up), and facilitates remote research supervision via electronic notebook/data workbook spaces. In addition, it allows for participant acquisition, provides access to a large online psychology test bank with experiments, surveys, tests and databases, facilitates online data collection via experiments or surveys, and offers access to statistical analysis software, and secure data storage and dissemination platforms.

The Research Portal benefits online as well as on-campus research activities by providing a centralized, integrated and comprehensive online environment – or research one-stop shop – and by giving remotely located students an unprecedented opportunity to complete psychology graduate degrees online. It has therefore extended the scope of online education to courses that include a substantial research component.

This paper describes the context, development, and outcome of the Research Portal project, including the analysis of user requirements, design, components, and architecture of the system. The paper also describes the Research Portal's initial operationalization as an integrated research environment website, its initial utilization, and next steps to its expansion and dissemination.

Requirements of the Research Portal

This section describes the first step of the development of the Monash Psychology Research Portal. We firstly provide a description of terminology, followed by an identification of the intended portal users, and discussion of requirements and functions.

Terminology

To examine related literature and investigate related existing products, we searched Google scholar using the following query: "research portal" or "remote lab*" or "virtual lab*" or "remote experiment*" or "virtual experiment*" or "online lab*" or "online experiment*" or "web experiment*". Search results indicated that the term *research portal* is commonly used in most publications to denote web pages that offer information about the faculty's research focus or provide lists of active projects and opportunities to join a pool of participants.

Remote labs are operated by students using devices and equipment from a real physical laboratory set-up to perform experiments and collect data. *Virtual labs* refer to systems in which students use simulations. *Remote desktops* offer students access to a server or cloud service with preconfigured, ready to use applications (Heradio et al., 2016; Odeh, Abu Shanab, & Anabtawi, 2015).

Users

Research portal users currently include student researchers and their research supervisors. A *student* is a user who accesses and operates Research Portal related applications to carry out research project activities within it. A *supervisor* is an academic who is responsible for guiding and overviewing the activities of several student researchers using the Research Portal.

The Research Portal was developed to meet the research project needs of a specific research course; however, it also needed to be transferable to many other online research course and online research activities and applications. It was developed to be used by online research students and researchers, as well as by researchers with access to traditional research capacities such as laboratories.

Functional Requirements Analysis

A functional analysis of the Research Portal revealed that the portal needed to provide users with:

- Generic information on research in general and specific information on research at Monash University.
- Guidance to students on research topic selection and recordings of their preferences.
- A capacity for students and their supervisors to schedule, conduct, and record project meetings.
- Guidelines and information links on how to conduct a literature review, how to conduct statistical analyses, and how to write and reference a thesis.
- A capacity for finding research participants.
- Access to online and general psychology test banks.
- A capacity to conduct an online experiment, survey, or database analysis.
- A capacity to manage and analyze data.
- A secure data and drafts storage capacity and a platform for the dissemination of papers.

A User Story

The following user story provides more context on the Research Portal development and use. Emma is a research student who was required to conduct a research project for her fourth-year course in psychology. Emma accesses the Research Portal and browses its list of faculty research areas to identify an interesting and appropriate topic for her thesis. Emma finds an appropriate topic and consults with her supervisor using the communication tools provided in the Research Portal. Emma organizes a meeting with her supervisor, exchanges ideas, and records a plan of action on the supervision record using the related electronic notebook provided in the Research Portal. Following the steps outlined in the Research Portal's Research Process section, she uses the available learning materials to search the related literature, complete the ethics form, find measures, and select participants. Next, Emma makes use of the related applications provided in the Research Portal virtual lab to administer her tests, collect, and analyze the data. Emma then writes her thesis, stores the data in the secure applications provided in the Research Portal, and shares them with colleagues and other researchers. The whole process has taken place online and under the supervision of her supervisor.

Remote/Virtual Research Solutions

Web portals and virtual and remote labs have profoundly transformed computer desktops and offered a valuable alternative to classrooms and conventional hands-on labs (Heradio et al., 2016), and

have been described as *second best to being there* (Aktan, Bohus, Crowl, & Shor, 1996). In their extensive bibliometric analysis, Heradio and colleagues reviewed the research on Virtual and Remote Labs from its beginnings in 1993 to 2015 and explored the main topics studied (e.g., approaches to developing virtual remote labs, collaborative learning, their advantages and effectiveness) and how interest in those topics evolved with time.

Advantages of Online Research Solutions

Several researchers have described the advantages of virtual research labs and the solutions they can offer (e.g., Gravier, Fayolle, Bayard, Ates, & Lardon; 2008; Heradio et al., 2016; Mok, Lee, & Tan, 2012). These include the following.

Availability and ease of access

Virtual lab environments are available via the Internet. With the help of Windows remote access software, users can connect via a single sign-on profile authentication process to a server providing a standard interface and thus a consistent user experience, at any time and from anywhere with an Internet connection – whether at the institution, at home, or on the go. Traditional hands-on labs, on the other hand, may require extensive time and materials, supervision staff to operate, can only accommodate small groups, and are available only for short time periods during weekdays. Virtual labs support students geographically scattered, who may be working in different time zones.

Accessibility by handicapped people

This is accomplished via their availability and ease of access features described above.

Ease of use

Users can access online resources needed to conduct research within a centralized integrated online environment, which contributes to positive online research experiences and perceptions, and instant and integrated accessibility to a wide range of research functions.

Support

University IT staff oversees the centralized management of installations, can ensure smooth running of software and troubleshoot technical issues experienced by students or staff users. If new software is necessary, students need not invest large amounts of time installing and configuring unfamiliar software on home computers.

Financial/Cost efficiency

Benefits such as savings in software licensing fees associated with access of a single license by multiple users, and lower administrative overheads can be achieved. Streamlined centralized management of software installations patches and updates enable financial efficiencies, as can extended computer lifespan and reduced annual replacement costs.

Lowered environmental impact

Benefits include environmentally friendly usage, with reduced energy consumption costs, and smaller carbon footprint.

Faster computing environment

Virtual desktops run on powerful server infrastructure, hence, operating systems and applications run faster than they do on a local computer. Faster computing environments increase computing efficiency and improve user experience.

In terms of effectiveness, empirical studies have shown that, much like academic performance in traditional and distance learning (Shachar & Neumann, 2010), virtual remote labs and hands-on labs are equally or more effective than traditional labs in learning outcome achievement (Brinson, 2015).

Available Solutions

Most existing university research portals are designed to provide access to information and other sites or serve as information management systems, collating information from numerous systems (such as faculty's research interests, available tools, data, and publications) and displaying the information in one central location, and/or invite students to join a participant pool (see for example Lancaster University's "Pure" research information management system, developed by Elsevier). Another category of university portals offers access to resources and tools. Their related labs focus on physics, chemistry, engineering, and STEM. Examples include LabShare (www.labshare.edu.au), Go-Lab (www.go-lab-project.eu); also see Govaerts et al., 2013), LiLa - Library of Labs (http://www.lila-project.org), PhEt interactive simulations for science and math (https://phet.colorado.edu), etc.

An integral part of the Monash Psychology Research Portal is its Virtual Lab (vLab) component, which accommodates data collection, analysis, and storage. The vLab provides access to a suit of programs (including, SPSS, R, SAS, NVivo, MATLAB, Inquisit, and Microsoft Office) and allows online simulations of laboratory experiments via a virtual or remote cloud desktop service. Several other universities around the world have developed remote desktops offering access to a platform with a suite of applications. Examples in Australian universities include myDesktop (RMIT University), ADAPT (University of Adelaide), iLab (Macquarie University), Apps On Demand (Deakin University), UTS Remote Access Portal (University of Technology Sydney), and Thin Client (Charles Sturt University). In the US, examples include Online Student Software Lab (University of Chicago), Virtual Desktop (Binghamton University), Virtual Desktop (University of Iowa), Virtual Computing Labs (American University), and many others. UK institutions offer similar solutions, e.g., UniApps (University of Bath), Student Remote Desktop (Bristol University), Remote Desktop Service (University of Greenwich), etc.

Advantages of the Monash Psychology Research Portal

The above vLab systems only partially fit the Functional Requirements Analysis of the graduate psychology course with a substantial research component described earlier. Key system requirements such as step by step guidance on research topic selection, literature review, statistical analyses, the capacity to schedule and conduct project meetings, capacity to access test banks and research participants to conduct online experiments, and facilities to manage, analyze, and securely store data and disseminate papers are not supported by any of the existing portals.

Monash's Psychology Research Portal filled this gap by providing a complete and start-to-end research capacity to students and researchers. It offers a large, diverse, and on-campus equivalent range of research options. These research options are available fully online; however, students may choose to conduct research in non-online environments, such as within their own workplace or educational setting, using the Research Portal. The Research Portal provides a virtual research environment that offers the advantages of online solutions described earlier in this paper plus several other valuable features. These include centralized supervision and collaboration records; online research participant pools and easier access to these pools as well as to research data repositories; centralized management of participant payments; access to a range of measurement and data analysis tools; and centrally stored data, meeting ethics requirements, rather than on students' own computers.

Development

The theoretical framework for the development of the Research Portal consists of the previous identification of needs for and implementations of various virtual labs in other subject areas, which we

have described above. The demonstrated usefulness of these virtual labs in other contexts provides a justification and a theoretical framework for the expansion of previous virtual labs to an implementation within a broader research enabling online environment, the research portal.

Hence, the Monash Psychology Research Portal's development life cycle included the standard Planning, Analysis, Design, Implementation, Testing, and Maintenance stages and adhered to the guidelines for the development of an academic portal offered by Pienaar (2003). It was developed and refined via an ongoing process of collaboration between the developers of the GDPA course and various Monash University IT development and support personnel, including eResearch, a team that specializes in the development of innovative and potentially transferable IT applications. Additionally, a Research Portal project manager is overseeing the development of the Research Portal and interfacing between GDPA course needs and the development of a platform that meets these needs and potentially other research needs.

Key Development Principles

Key principles underlying the development and refinement of the Research Portal were (a) pragmatism, which included responding to development timelines by identifying and developing shorter term non-optimal component solutions, as well as identifying and developing longer term optimal solutions, and (b) flexibility, which includes identifying and testing a wide range of possible component solutions, as technology improves and new application become available, and implementing whichever solutions work best.

Planning

The development of the Research Portal commenced with an overall plan, produced as a working text document, which specified the needs that the Portal had to meet and the components, identified by a business analyst, that would be necessary to meet these needs. This plan was disseminated to various Monash IT and IT related groups, who have contributed to the operationalization of the Research Portal plan. This plan was operationalized as an integrated operating environment, created as a prototype-working website. Using Squiz matrix the prototype system was then further developed and refined and became the Research Portal front end.

Ongoing Developments

Key ongoing developments to the Research Portal/vLab environment have been made in the 18 months since it went live to GDPA students, in response to feedback from a formative evaluation and usability testing from current and potential users. These developments and refinements have included the following: an increasing user friendliness and experience of participation in an online research community, which was achieved by re-structuring components so that they provide a more intuitive user experience; adding and improving instructions and instructional videos; adding a News and Events section that allows users to share and be informed by research news; and upgrading the vLab component of the Research Portal with a CITRIX based operating system. The Research Portal's pioneering use of Monash University's new CITRIX based vLab capacity allowed us to reduce vLab user complexity and user support requirements substantially by removing the need for a remote VPN log in procedure. The popularity of the Research Portal since it was originally developed and implemented is evidenced by increasingly high usage and high user satisfaction including, as evidenced by the research project units that the Research Portal supports, achieving increasingly high student satisfaction scores.

Initially, Research Portal users accessed it from links in all GDPA course's units, including its four research units. The Research Portal can now be accessed both directly and by links within the new courses that are using it. The design, development, and production stages lasted 12 months and the site was initially implemented in September 2016. The full Research Portal/vLab was launched in

January 2017. The university procurement team purchased remote desktop and software application licenses for departmental or faculty use.

Improvements and modifications to the site's content and structure were ongoing during the next 18 months following the launch of the Research Portal. Specifically, focus group interviews with N = 8 GDPA instructors and N = 9 GDPA students were conducted in March 2018 to obtain their views on the usability of the research portal concept and to support data triangulation. Questions put to the participants of the focus groups invited suggestions and feedback regarding the Research Portal interface and appearance, the use of multimedia, the degree to which the portal caters to their needs, its usefulness, most helpful features, and possible improvements.

In general, participants were positive about the Research Portal including its ability to provide information, knowledge, and tools to support their research projects. Participants' comments were recorded and grouped into two main categories: (a) page-specific comments, which included suggestions regarding the layout, content and wording of some pages, and (b) instructions, which included recommendations to improve scripts, screenshots, and videos explaining how to use tools within the research portal. These comments were reviewed by the Research Portal managers, who applied changes to the content and the structure of the portal based on these comments.

Training sessions (webinars) explaining how to access and use the Research Portal and its tools were offered to each new cohort of Monash University students and staff to use the research portal.

ARCHITECTURE OF THE RESEARCH PORTAL

To address its requirements, the Monash's Psychology Research Portal (https://www.monash.edu/research-portal/home):

> (a) Links students to all the capacities they need to successfully and rewardingly conduct an online research project and leads them through each step of their research project: identification of topic, literature review, method (selection of participants and measures), data analysis and writing, and
>
> (b) Assists their instructors in the supervision process: schedule, conduct, store data and paper drafts, and record meetings.

The high-level architecture of the Research Portal consists of three major sections each serving a different purpose, namely, the *Research Process*, the *Virtual Lab,* and the *Supervision and Communication* section, and two additional sections, the *Support* and the *News and events* sections. These sections are directly accessible from the main menu bar as shown in Figure 1.

The *Research Process* section of the Research Portal outlines each step of a research project, from selecting a topic and identifying a research question, setting up the methodology, collecting and analyzing data online, and finally writing up a thesis or a research paper.

The *Virtual Lab* section of the Research Portal is a practical online laboratory fitted with the tools needed for most end-to-end research workflows. It is a gateway to the tools a researcher needs to collect and analyze data online. It allows users to access software, such as Inquisit, SPSS, NVivo, R, and common Microsoft Office applications, from any internet connected device.

The *Supervision and Communication* section of the Research Portal describes the supervision process and lists several tools (e.g., LabArchives, Google Calendar, and Zoom) students can use to communicate with their supervisors and research team members.

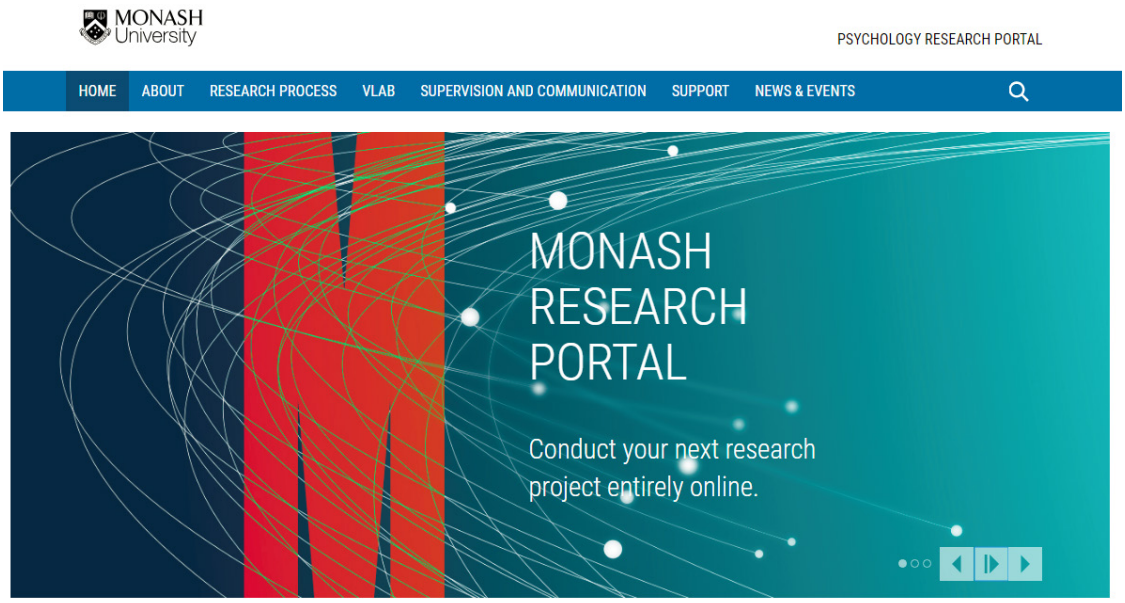

Figure 1. Screenshot of home page and first level menu options of the Research Portal

Two additional Research Portal sections are the *Support* and *News and events*. We next describe the five sections of the Research Portal in detail.

The Research Process

This section outlines the content of each of the eight steps in the research process: choosing a topic, reviewing the literature, ethics, selecting measures, selecting participants, collecting and managing data, analyzing data, and writing the report. Figure 2 illustrates the structure of the Research Portal, the research steps, and the tools available under each section.

Research topic selection

The first step in the research process consists of choosing an area of interest and a specific research topic. The Research Portal offers Psychology students and potentially other research students and researchers the opportunity to select a topic in one of over twenty interesting, innovative, and online friendly psychology research areas. Supervisors are then assigned to students working on research topics, and specific research questions are devised in consultation between supervisors and their students.

Literature review

This section provides ideas and tips on how to approach the literature review and research proposal, and guides students through specific preliminary research steps, such as how to start thinking, reading to get an initial understanding of the literature to form the context for a research project, and how to generate a specific research question.

Ethics

This section provides information on the ethical requirements for conducting research, the application process, and the types of ethical clearance required for various studies (e.g., human, animal ethics, low risk).

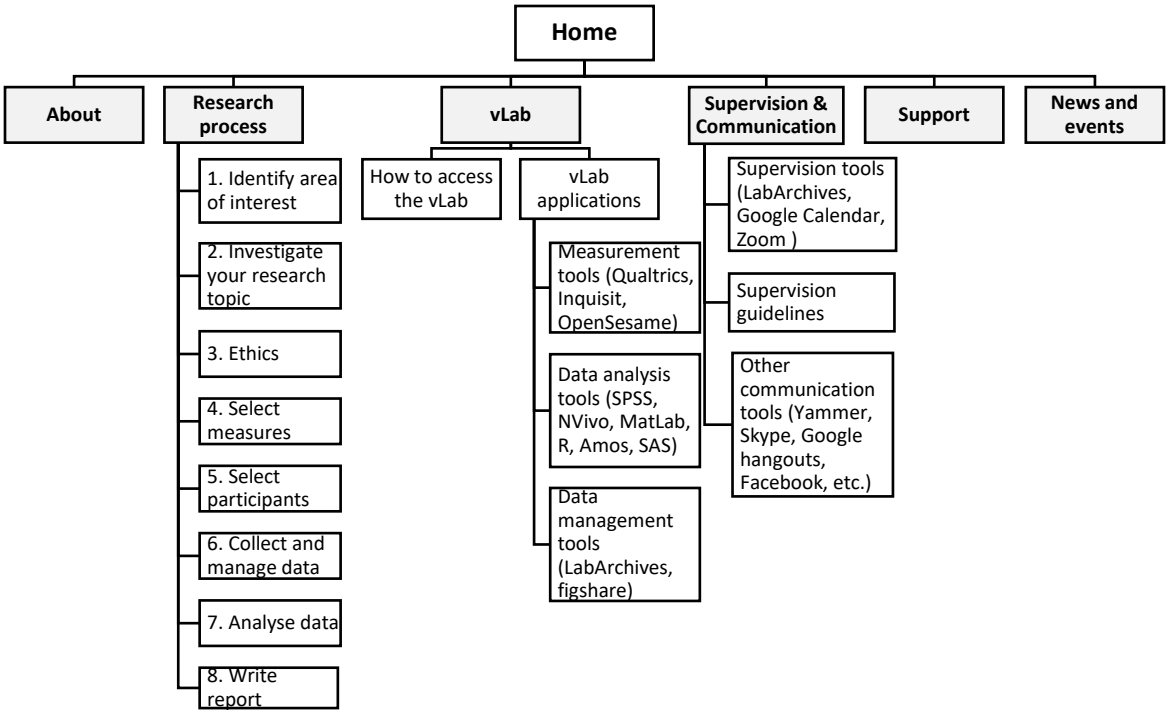

Figure 2. The Research Portal architecture, reflecting the research process and the tools available within the portal

Selecting measures

After deciding on a research question and conducting a literature review, the next step on the research journey is to identify the variables that researchers intend to measure and to select the assessment tools they will use to collect data. This section offers general guidelines to consider when deciding which tools to utilize based on the study's methodology, copyright considerations, and where to find a measure that will suit their research requirements. This section includes Monash's online test repository, a large psychology test bank consisting of validated online psychology tests. The test bank is populated with descriptions of and access details for a wide variety of valid and free online Psychology tests and is constantly updated and expanded while students source and use additional tests. The site also provides several links to free and open-access resources as well as tests that can be purchased for use online.

For researchers who wish to develop and/or administer their own research platform or questionnaire, the Research Portal presents links to a large collection of online resources and various study generators and editors that are available. These include OpenSesame, E-Prime, DirectRT, Psytools, MediaLab, CANTAB cognitive research products, WEXTOR, JATOS, psiTurk, Jspysch, PEBL Test Battery, PsychoPy, Psychtoolbox-3, Tatool, and WebExp.

In addition to the above tools, the Research Portal offers students free access to the proprietary survey and experiment generation platforms Qualtrics and Inquisit, both of which are available via the Virtual Lab, which is described in the next section. Qualtrics is a web-based survey creation and distribution platform, flexible and easy to use. For example, researchers can upload pictures, videos, and sounds, while nearly everything is customizable. Data can be downloaded from specific time periods and in different formats (e.g., Excel, SPSS, or CSV). Qualtrics can be used in tandem with Inquisit to create integrated experiments online. With Inquisit, researchers can design and administer psychological tasks and studies that use behavioral/cognitive paradigms. Inquisit can be run either on a local

desktop (Inquisit Lab), in which case subjects need to be with the researcher and use the specific laptop/PC), or over the web to distribute experiments online (Inquisit Web), in which case subjects can log on and complete an experiment from anywhere in the world.

Selecting participants

Recruiting participants and getting people to be part of a research study can be challenging, particularly for students who are studying online and are based in remote locations. Researchers need to consider the population from which they will draw participants, how best to recruit them, and how to conduct their research project in a way that optimizes both the participant experience and data integrity. Participant pools are a convenient way for researchers to access individuals who are willing and ready to participate in research. The Research Portal provides users with several options for recruiting participants (i.e., TurkPrime, Sona Systems, and Social Media; described below). Finally, the "Selecting participants section" guides students on (a) how to calculate their sample size by using GPower to conduct sample size estimation and power analysis, to achieve meaningful results and justify their study and findings, and (b) ethics considerations and options on reimbursing the participants for their time and any incurred costs.

TurkPrime. The Research Portal offers access to a large international publicly available online research participant pool, TurkPrime, which supplements the above local participant pools and supplies a more representative research sample than do samples consisting predominately of students. TurkPrime allows the acquisition of large numbers of research participants relatively quickly and economically. Using TurkPrime, researchers can post studies and instantaneously make them available to thousands of participants all around the world. It runs on any browser and does not require any downloads or installation. TurkPrime integrates with Mechanical Turk, a large, well known, and widely used commercial publicly available online research participants' pool administered by Amazon. Literature has validated the representativeness of Mechanical Turk research participants, who are typically from the USA and India (Buhrmester, Kwang, & Gosling, 2011; Paolacci & Chandler, 2014). TurkPrime supports tasks that are common to the social and behavioral sciences (Litman, Robinson, & Abberbock, 2017). On average, participants complete studies within hours following launch, thus dramatically increasing the speed of data acquisition compared to traditional methods. TurkPrime was chosen for inclusion in the Research Portal rather than Mechanical Turk due to its being better suited for the handling of international participant payments in an online research environment.

Sona Systems. Sona Systems is an online platform used to manage and schedule research projects within the Monash community. It is included in the Research Portal and currently provides a pool of over 2,000 research participants. This system enables researchers, including student researchers, to enter their study and solicit participants from a growing research participant pool. Anyone enrolled as a participant in the participant pool can view and participate in current research projects. Monash Psychology, Monash Online, and other Monash students (including education students), the public, and members of public strata, such as members of certain age groups and workplaces, are invited to join a Monash research participants' pool. This pool is utilized for research in Psychology and beyond. Invitations to students and the public to volunteer to join the broad research participants' pool are circulated via individual course and broader Monash networks and via social media. Invitations to students to participate in research studies are limited to third year students and above to ensure that there is full understanding of what they are engaging in.

Social media. Facebook, Twitter, and LinkedIn provide a means for generating, sharing, and discussing ideas and content and have made it possible to advertise studies to large and heterogeneous pools of participants around the world for both online and face-to-face research studies, easily and quickly. An important advantage of research participant recruitment via social media over other recruitment methods is that it allows special and low frequency populations to be targeted, which broadens research capacity. A growing body of literature supports the effectiveness of social media in recruiting research participants from cancer research to studies on smoking cessation (Whitaker,

Stevelink, & Fear, 2017). The social media participants' recruitment section of the Research Portal provides tips for researchers on how to recruit participants via social media successfully.

Collecting and managing data

Collecting data involves gathering the information obtained from participants using the selected measures to help test a research question. Data management tools that are available for Research Portal users include LabArchives and Figshare.

LabArchives is a cloud-based Electronic Lab Notebook that provides a shared environment for students and supervisors to interact within, and for supervisors to keep track of their students' work, as well as an environment for independent work by students who can organize, store, and share their data.

Figshare is a collaborative digital repository for researchers and graduate research students. Monash users can make all their research outputs available in a citable, shareable, and discoverable manner. Functions include managing data privately and securely on Monash storage, accessing files remotely, allowing other researchers to collaborate, and sharing files privately or publicly.

Analyzing data

The Research Portal, via its Virtual Lab, provides cost effective access to a suit of quantitative and qualitative data analysis software. These include SPSS, Amos, NVivo, MATLAB, R, SAS, etc. The related Research Portal page also includes links to handy online tools and resources (i.e., websites and education programs) that can help users understand which data analysis to conduct.

Writing a report

Writing a thesis is probably the biggest and most complex writing task a student will ever undertake, and the first time is probably going to be the hardest. This section offers advice on how to tackle the project, build and structure the paper, and bring it all together; it presents tips on writing and provides links to online resources and guides, including previously written theses and tutorials on communicating ideas. Links to the American Psychology Association (APA) style and referencing guidelines and templates are also provided.

The Virtual Lab

The Virtual Lab (vLab) is designed to streamline a typical research workflow for students and has been adapted to fit within the requirements of each distinct stage of the research process. Traditionally, students have been limited in the software they had access to. However, the vLab has built-in provisions that accommodate data collection, analysis, and storage as well as migration between these processes. Rather than providing students access or links to individual software, the vLab provides access to a suit of programs via a virtual or remote desktop. Students navigate to the Research Portal and log on to the vLab via Monash's Virtual-learning Environment (MoVE) from anywhere in the world. The Citrix Receiver application launches the vLab desktop, a desktop with icons linking to several research tools (see Figure 3) that can be run directly on one's personal computer or device.

These licensed software tools are installed on a remote Windows cloud based machine (known as a virtual machine or VM) that is preconfigured and maintained by Monash IT resources. Specifically, the vLab desktop has been populated with platforms for acquiring (Qualtrics, Inquisit, OpenSesame), analyzing (SPSS, Amos, NVivo, MATLAB online, R, RStudio, SAS) and managing (LabArchives, monash.figshare) data, as well as popular office applications (Excel, PowerPoint, Word). Hence, the vLab provides users a centralized, integrated online environment with powerful research tools, ready to use, right on the students' personal computer. In doing so, it not only intuitively facilitates students' workflow but also provides an inclusive and supportive environment from which students can advance their research skills.

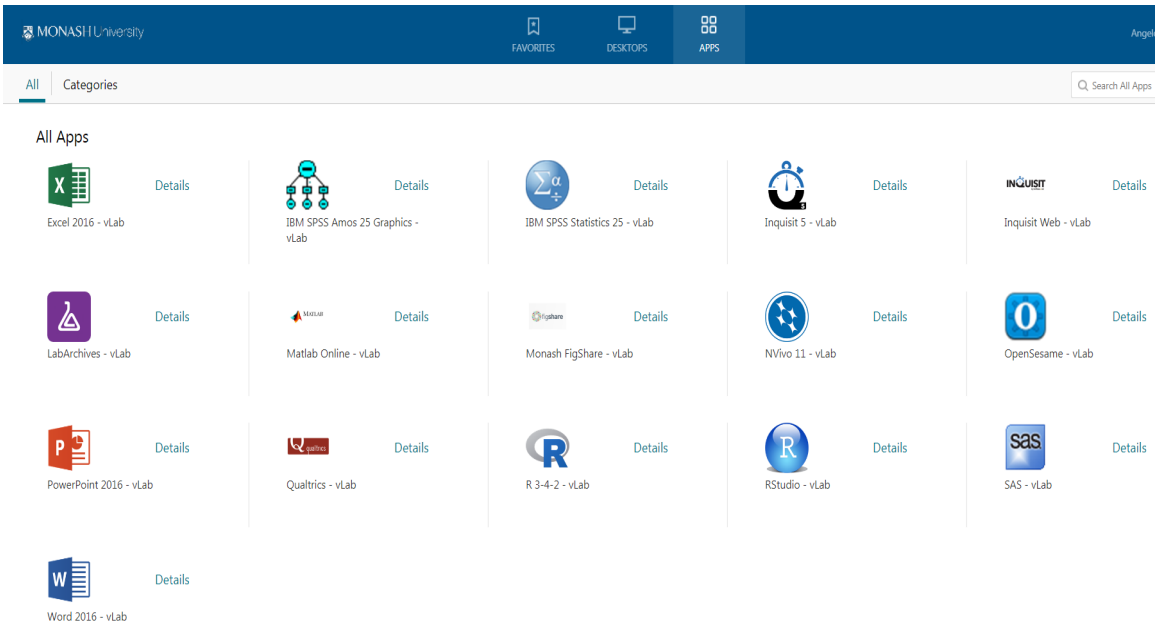

Figure 3. Screenshot of the vLab desktop with icons linking to applications

The vLab also allows the convenient and integrated transfer of data between the research stages. For example, students set up experiments using the web based Qualtrics or Inquisit tools and participants complete them. Students then download the results to a location from which they can retrieve this data for processing in an analysis tool such as SPSS. Finally, students may want to share their work with their supervisor and/or research team using the web based LabArchives electronic notebook or publish the outcome to monash.figshare. In this example, students moved their data from the web to their drive, into and out of an analysis tool, and finally shared and published it.

Supervision and Communication

An important aspect of conducting research is working with one's supervisor and peers or colleagues. Sharing ideas, asking questions, and working with fellow researchers promote brainstorming new and effective ways to approach research and can be a great way to provide ongoing support and motivation for one another. For this purpose, this Research Portal section provides access or links to supervision (e.g., LabArchives, Google Calendar) and communication (e.g., Zoom, Yammer, Skype, Google hangouts, Facebook) tools, as well as supervision guidelines. We will describe LabArchives and Zoom, as these tools are integral to online supervision and collaboration on online projects.

LabArchives. In the Research Portal's integrated environment users can conduct, store, and track email conversations and other research communications. A link to the Monash University LabArchives electronic notebook, which Monash has implemented for higher degree supervision in 2016, provides this capacity. Eblen-Zayas (2015) has outlined the reasons for switching to Electronic notebooks and the considerations in selecting ELN software, while Puccinelli and Nimunkar (2014) reported instructor and student experiences and feedback from using Electronic Laboratory Notebooks in real world design courses. The electronic notebook offers a shared environment for students and supervisors to interact within, and for supervisors to keep track of their students' work, as well as an environment for independent work by students. Hence, LabArchives supports off-site research co-supervision and potentially other research collaborations by giving supervisors access to their students' data, results, and research processes. LabArchives' second function is to serve as a repository of supervisory and potentially other research collaboration sessions, work plans, manuscripts, and other presentation development. In terms of structure, LabArchives allows multiple folders (e.g., data storage, drafts, and presentations) that individual students (owners) can work on

and share with their supervisors (users). Hence, supervisors have a LabArchives folder that includes a notebook for each of their students. Additional levels of an access structure can be created, so that senior supervisors can access the notebooks owned by several individual supervisors.

Zoom. Zoom is a cloud-based service conferencing/virtual teaching environment that allows conducting online video meetings in one easy-to-use platform. It offers high-quality video and audio, and its basic version is free.

SUPPORT

Research Portal users have several options when seeking support. They can:

a) Use the search button (located at the top right of all pages) and enter their query. For instance, "I cannot access the vLab" will provide a link to a related page with instructions.

b) Directly access the specific application information pages (e.g., Qualtrics, SPSS, NVivo, LabArchives) and find instructions, screenshots, videos, resources, and FAQs.

c) Contact the Research Portal support staff via email. The support team addresses student requests within a business day and helps with the acquisition of tests, participant payments, use of applications, and resolves or escalates issues of technical nature to the University's IT team.

NEWS AND EVENTS

The final section of the Research Portal presents the latest news from researchers who have used the Research Portal and information about upcoming events (e.g., conferences). It also is a place where researchers can advertise their research and seek participants.

PORTAL USE AND ANALYTICS

The usage of the Research Portal has grown rapidly from approximately 80 GDPA students to currently approximately 600 GDPA students and staff, 400 on campus and online undergraduate Psychology students, and all 90 on campus Psychology Honors' students. It is important to note that as the Research Portal (but not the vLab) is publicly available, students and researchers from other institutions appear to have also benefited from accessing it, as the number of users greatly exceeds the number of GDPA students.

Specifically, in the first 18 months of the Research Portal's implementation, 9,372 users accessed it, which resulted in 30,978 sessions and 134,074 page views. As expected, visitors came mostly from Australia (83%), although 7% accessed the portal from the US, India, and Malaysia and the rest from various other countries. The portal was accessed mainly from desktops (92.4%, as opposed to mobile 7.3% and tablets 0.3%). There is good engagement with the portal with close to half of all users viewing the entire front page (100% scroll depth) and 70% returning to the site; only a very small percentage (.3%) of users did not engage with any of the content. The three most popular pages of the Research Portal included the home page, the vLab page, Sona systems, and SPSS. Embedded video content was also well received with close to 64% of all viewers watching the video in full.

In terms of the level of support required, during the last six-month period, student users (95%) and supervisors and staff/lecturers (5%) sent 247 emails to the Virtual Lab manager seeking access to the vLab (54%) and the remaining asked for assistance with the applications within the vLab. Regarding the latter, 21% of the emails included queries on uploading, downloading, and exporting files in SPSS. Other application inquiries included Inquisit (3.2%), Qualtrics (2.4%), AMOS (1.6%), and NVivo (1.2%).

The GDPA course supports students by funding the recruitment of their participants. Researchers can reimburse participants by offering some form of monetary exchange, entry into a raffle-type draw for a prize, etc. Managing funding requests and allocating money is a sensitive and relatively

complex process. For this reason, a research participants manager was appointed to coordinate and handle financial matters. The volume of related email requests by students and supervisors during a six-month period was moderate, with approximately 68 individual requests from students in the first half of that period, which dropped to 38 requests from supervisors in the second half when modular projects were introduced.

CONCLUSION

The Monash Psychology Research Portal's development, architecture, content, functions, and implementation described in this paper has satisfied the requirements and met the research needs of students of an online course that includes a research project, providing a common, ubiquitously accessible and integrated online research environment. It has considerable potential to be expanded and customized to meet the needs of students of many other courses that include a research project component and to meet many other online research needs, and non-online research needs.

The learnings from the development of the Research Portal include recognition of the importance of using a wide variety of expertise in the various development stages, identifying a wide range of potential users and encouraging their input into its development and refinement, and the importance of pragmatism and flexibility in the development and dissemination of a Research Portal.

Challenges to the development and implementation of the Research Portal included understanding the requirements and coordinating a diverse team of people, the complexity in the process of accessing the remote desktop for first time users, opening and saving files from within applications (due to the difficulty users face in discerning between the server's drive and their Monash and local drive), and the slowness of demanding or resource-hungry software such as SPSS. Upcoming challenges include providing quality and timely support to an expanding user base, with new users from other Departments and Faculties.

The Research Portal is now providing an online research and research teaching capacity beyond the GDPA to other online and on-campus Monash University student and staff users from the Graduate Diploma of Professional Psychology, other Psychology courses, and other Monash Schools and Faculties such as the Nursing School. Eventually it will be expanded to allow use by universities beyond Monash.

The next steps in the development of the Research Portal include further refinement, personalization, and expanded implementation and dissemination of its components, possibly assisted by grants and other funding opportunities. The formation of networks and working partnerships to operate, maintain, and promote Research Portal initiatives are required to reduce operational costs, increase access, and create an impact.

ACKNOWLEDGMENTS

We would like to thank George Vidalis (Business Analyst), Sarah Van Dam and Kate Thompson (vLab Managers), Nicole Stefanac and Zahra Aziz (Research Portal managers), Fernanda DaMata Gomez and Jae Won Oh (Research Participants Managers), and Christopher Holt for their contribution in the development and support of the Research Portal, Assoc. Prof. Matt Mundy for his key academic role in the Research Portal's vision and realization, and Monika Oudendyk for her key project management role.

REFERENCES

Abdulwahed, M., & Nagy, Z. K. (2011). The TriLab, a novel ICT based triple access mode laboratory education model. Computers & Education, 56(1), 262–274. https://doi.org/10.1016/j.compedu.2010.07.023

Aktan, B., Bohus, C. A., Crowl, L. A., & Shor, M. H. (1996). Distance learning applied to control engineering laboratories. IEEE Transactions on Education, 39(3), 320-326. https://doi.org/10.1109/13.538754

Aithal, P. S., & Aithal, S. (2016). Impact of on-line education on Higher Education System (SSRN Scholarly Paper No. ID 2977427). Rochester, NY: Social Science Research Network. Retrieved from https://papers.ssrn.com/abstract=2977427

Allen, I. E., & Seaman, J. (2016). Online report card: Tracking online education in the United States. Babson Survey Research Group. Retrieved from https://eric.ed.gov/?id=ED572777

Allen, I. E., & Seaman, J. (2017). Digital learning compass: Distance education enrollment report 2017. Babson Survey Research Group, e-Literate, and WCET. Retrieved from http://digitallearningcompass.org

Brinson, J. R. (2015). Learning outcome achievement in non-traditional (virtual and remote) versus traditional (hands-on) laboratories: A review of the empirical research. Computers & Education, 87, 218-237. https://doi.org/10.1016/j.compedu.2015.07.003

Buhrmester, M., Kwang, T., & Gosling, S. D. (2011). Amazon's Mechanical Turk: A new source of inexpensive, yet high-quality, data? Perspectives on Psychological Science, 6(1), 3-5. https://doi.org/10.1177/1745691610393980

Eblen-Zayas, M. (2015, July 22-24). Comparing electronic and traditional Lab Notebooks in the advanced lab. Paper presented at 2015 Conference on Laboratory Instruction: Beyond the First Year of College, College Park, MD. Retrieved from https://www.compadre.org/Repository/document/ServeFile.cfm?ID=13799&DocID=4219

Govaerts, S., Cao, Y., Vozniuk, A., Holzer, A., Zutin, D. G., Ruiz, E. S. C.,… Gillet, D. (2013). Towards an online lab portal for inquiry-based STEM learning at school. In Advances in Web-Based Learning – ICWL 2013 (pp. 244–253). Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-41175-5_25

Gravier, C., Fayolle, J., Bayard, B., Ates, M., & Lardon, J. (2008). State of the art about remote laboratories paradigms - Foundations of ongoing mutations. International Journal of Online Engineering, 4(1), 19-25.

Heradio, R., de la Torre Cubillo, L., Galan, D., Cabrerizo, F., Herrera-Viedma, E., & Dormido, S. (2016). Virtual and remote labs in education: A bibliometric analysis. Computers & Education, 98, 14-38. https://doi.org/10.1016/j.compedu.2016.03.010

Litman, L., Robinson, J. & Abberbock, T. (2017). TurkPrime.com: A versatile crowdsourcing data acquisition platform for the behavioral sciences. Behavioral Research, 49, 433-442. https://doi.org/10.3758/s13428-016-0727-z

Mok, H., Lee, Y., & Tan, W. (2012). Setting up a low-cost lab management system for a multi-purpose computing laboratory using virtualisation technology. Australasian Journal of Educational Technology, 28(2). https://doi.org/10.14742/ajet.873

Odeh, S., Abu Shanab, S., & Anabtawi, M. (2015). Augmented reality internet labs versus its traditional and virtual equivalence. International Journal of Emerging Technologies in Learning (IJET), 10(3), 4-9. https://doi.org/10.3991/ijet.v10i3.4354

Paolacci, G., & Chandler, J. (2014). Inside the turk: Understanding mechanical turk as a participant pool. Current Directions in Psychological Science, 23, 184–188. https://doi.org/10.1177/0963721414531598

Pienaar, H. (2003). Design and development of an academic portal. Libri, 53(2), 118-129. https://doi.org/10.1515/LIBR.2003.118

Puccinelli, J. P., & Nimunkar, A. J. (2014, June). An experience with Electronic Laboratory Notebooks in real-world, client-based BME design courses. Paper presented at 2014 ASEE Annual Conference & Exposition, Indianapolis, Indiana. Retrieved from https://peer.asee.org/20047

Shachar, M., & Neumann, Y. (2010). Twenty years of research on the academic performance differences between traditional and distance learning: summative meta-analysis and trend examination. MERLOT Journal of Online Learning and Teaching, 6(2), 318-334.

Whitaker, C., Stevelink, S., & Fear, N. (2017). The use of Facebook in recruiting participants for health research purposes: A systematic review. Journal of Medical Internet Research, 19(8), e290. https://doi.org/10.2196/jmir.7071

BIOGRAPHIES

Angelos Rodafinos is a higher education consultant with extensive experience in educational technologies, online learning, process and systems improvement, technology innovations, and program development. He obtained his Ph.D. in Psychology from the University of Wollongong, Australia, an M.Sc. in Sports psychology from Ithaca College, NY, and a B.Sc. in PE and Sports Sciences from Aristotle University, Greece. Dr Rodafinos has lectured in introduction, applied, social and work psychology at several universities and served as Head of the Department of Psychology at the International Faculty of the University of Sheffield UK for nearly a decade, as Program Director for Social Sciences at Swinburne Online Learning, and as Research Portal Manager at Monash University, Melbourne. He is the author of several articles and two books, one on Stress management and problem solving and a second on the Psychology of change.

Filia Garivaldis is a Lecturer and Course Convenor of the Graduate Diploma of Psychology Advanced (GDPA), Australia's largest and first fully online 4th year APAC accredited course in psychology, at Monash University. Dr Garivaldis is responsible for the development and delivery of the coursework units of this course, where she has introduced several innovations, such as simulated activities. Dr Garivaldis was also one of the founding members of the Monash Online – Psychology Education Division (MO-PED) research group, which provides evidence-based improvements to the GDPA course, and other courses, particularly in the areas of online learning, online teaching, and student support. Her research in this group, specifically, is concerned with developing work readiness in online psychology students, and the experiences of teaching and working online. Dr Garivaldis has worked in academia for over 15 years, previously as a Senior Lecturer at Regent's University London, where she developed an MSc in Occupational and Organizational Psychology, accredited by the British Psychological Society. She has authored several peer-reviewed publications and has attended many conferences, where she has presented her research on self-regulation and cognitive regulation, motivation, and implicit affect states. Dr Garivaldis has also worked in industry, across training and organizational development functions, due to her specialization in organizational psychology.

Stephen McKenzie was awarded a B.A. Honors' degree in Psychology in 1982, and a PhD in Psychology in 1987, from Deakin University. Dr McKenzie is a Course Convenor for and the co-developer of Monash University's large new fully online fourth year course – the Graduate Diploma of Psychology Advanced – Australia's largest Fourth Year Psychology course. Dr McKenzie co-led the development and implementation of the Monash Online - Psychology Education Division (MO-PED) online research program, whose international collaborators include King's College, London, and co-led the development and implementation of the Research Portal fully online research system. Previously Dr McKenzie conducted preventive health related research at the Centre of Excellence in Intervention and Prevention Science (CEIPS) and was a lecturer and researcher at Deakin University. Dr McKenzie's research interests and publications include in online education, mindfulness and addiction.