



Reformations and Promoting Active Learning via Course Based Research [CBR] at the University of Fiji

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ABSTRACT:

Learning and teaching is geared to provide lifelong skills to its pupils – who are able to contribute to the economy not only as physical capitals, more so as human capitals with the source of wealth for social and economic development. At the backdrop of this vision is the University of Fiji's five years Annual Strategic Plan 2017-2021, that relentlessly pursues to develop a knowledge society through the University's work-ready graduates. One of the undergraduate courses in the field of Science is exactly road mapping its course to expose learners to a great degree of research through hand-on research experience. This paper aims to investigate the merits of entailing Course-Based Research (CBR) practice in Science at undergraduate level at a tertiary institution. The paper further attempts to explore the plausible benefits of tying research experience at undergraduate study that is primarily content heavy and theoretical in nature. The paper provides recommendations for courses pitched at undergraduate level to consider entailing research experience in their programmes given the benefits it provides to learners venturing into the work field.

Keywords: Course-Based Research, Active Learning, Student Engagement/Participation, Higher Education, Fiji Islands.

1. INTRODUCTION:

Undergraduate science instruction is experiencing a shift in teaching pedagogies through an active learning, that has revealed to affect student learning (Burniston, 2017). Undoubtedly, undergraduate research are becoming an

emerging force in higher education especially the hands-on learning seen to professionally prepare students in the fields of teaching, medicine, science and social services (Schultz, 2016). For instance, science students without hands-on research experience may not firmly understand the

effects that variables have on the environment or the complex nature of the environment (Hodder, 2009).

According to Lopatto (2007), undergraduate research enhances educational experiences and retains talented students to careers in selected fields. An empirical study by Seymour *et al.* (2004) revealed seven different categories of valuables that research students usually attain and these are: personal/professional gains, ability to think and work like scientist, acquiring various skills, clarification/confirmation of career plans, enhanced career/graduate school preparation, shift in attitudes to learning and working as a researcher. In addition, undergraduate research enables students to develop independent critical thinking skills along with written and communication skills. The process of research also impacts valuable learning objectives to students and prepares them towards professional services (Petrella & Jung, 2008). Similarly, Lemaster (1997) stressed that undergraduate research is the culminating educational experience for students in making transition from learning to training world through the contribution of ideas that benefits the society as a whole.

Despite having the strong incentives, many students are leaving university without authentic research experiences (Russell *et al.*, 2007; Thompson *et al.*, 2016). Student dropout from any university is a matter of concern and the key factors contributing to the dropout are for academic and personal reasons (Shah, 2015). The government policies in the Fiji Islands has empowered educators, students and parents to ensure that everyone should have access to quality education (Shah, 2015). At the University of Fiji, where research experience in teaching curriculum has been immensely promoted in maintaining the quality output from the students and the staff, there is an ever-growing need to begin fostering research attributes in university graduates. This is explicitly drawn from the University of Fiji's five years Annual Strategic Plan – 2017 to 2021, which aims to cultivate a

culture of research, as stemming out from one of the eight strategic themes. The analysis of Strengths, Weaknesses, Opportunities and Threats (SWOT) within the Annual Strategic Plan – 2017 to 2021 recognizes limitations within its tertiary education. One of the threats stipulated in it is the 'weak research culture and engagement with public/community' (3). With the five years Annual Strategic Plan in place, it provides the leverage for building the knowledge society in Fiji.

The first Strategic theme in the Annual Strategic Plan of the University of Fiji is 'learning and teaching' (6). Under the first strategic priority as a goal 'learning and teaching' encompasses quality, friendly and relevant research-based content delivery in the classrooms for all our undergraduate and post graduate students to meet national and international demands. This evidently denotes that research is a priority in learning and teaching for the university. Thus, drawing parallels from the first and third Strategic theme, a newly introduced science based research course at the University of Fiji enable students to gain research experience at undergraduate level. The course (Research Topics in Biology – BIO311) is designed to build better understanding of research methods and introduces the concepts and principles of scientific and technological paradigms in terms of planning, organising, conducting and reporting the findings from scientific studies. Hence, providing students with research experience at undergraduate level will assist to develop the future generations of adequately trained researchers, and could possibly address some of the access issues in maintaining the quality education.

2. METHODOLOGY

The focus of this research is to successfully report the accomplishments and quality of the newly introduced course – Research Topics in Biology (BIO311) offered to Year 3 Bachelor of Science (BSc) students in Semester II, 2018 at the University of Fiji. The design of the course is a new approach into teaching and learning with a special research emphasis,

aiming to shift the teaching pedagogies from content and concept to inquiry and discovery based learning.

This course is a hundred percent coursework involving the development of research procedures and planning, use of lab notebooks, writing of literature reviews, scientific findings and papers, writing proposals and presenting in seminars. Students are expected to invest approximately 395 hours per semester that include, lectures (12 hours), workshops (42 hours), library research and team discussions (84 hours), writing research proposal (35 hours), conducting research (56 hours), report writings (35 hours) and independent study (131 hours). In addition, the resources in form of lecture notes, workshops, background materials, various user guides, practice tests, sample code, data files and weekly forums were made available through the University of Fiji Moodle shell/website.

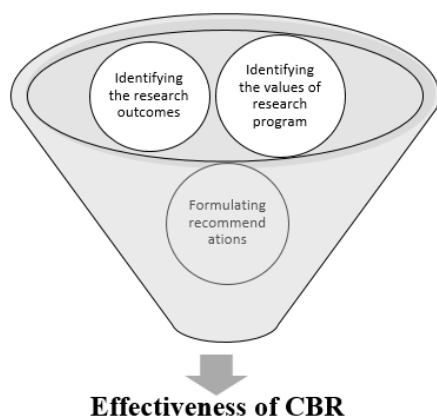


Figure 1: Evaluating the overall effectiveness of Course Based Research (CBR) programme offered to Year 3 Biology students at the University.

The principal objective of the CBR programme is to identify the values of undergraduate research offered to final year Biology students at the University of Fiji through the course outcomes and formulating recommendations for such courses (Figure 1).

In addition, semi-structured interviews with students were conducted after the course outcomes were achieved in summer 2018. The interviews (44 participants) were mainly focused as to how the course might have been different from other courses such as adapting to learning style, duration and mentorship provided throughout the programme, benefits associated with research experiences and student expectation and recommendation for improving the quality in future. The teaching associates were also interviewed to evaluate the effectiveness of CBR at undergraduate level.

3. FINDINGS

Course Based Research (CBR) assessment is successful in providing undergraduate students with authentic research experiences (Table 1). Students are assigned with reading materials in order to facilitate understanding of core literature. The reading materials were chosen by the Course Coordinator to serve as a primary research tool when designing their own research questions. The literature papers were discussed with students using a Socratic approach where series of questions (for probing, extending and elaborating ideas) were used to guide students' thinking rather than just piling students with mass of information (Chin, 2007; Sweat *et al.*, 2018). During the first few weeks of lectures, students discussed their reading materials to get a hand-on understanding on the processes involve in conducting science related research in groups and concluded with their first draft research proposal. The research proposals were designed in liaison with external organizations and industries to enhance students with opportunities to work with 'real-life' problem solving. More importantly, industry-academia

collaboration fosters to ensure industrial relevance in academic research which stimulates students thinking and understanding (Sweat *et al.*, 2018; Wohlin *et al.*, 2012). In the follow-up weeks, students engaged in data collection from industries and organizations,

analysis/interpretation of data and seminar presentation. Students received coaching and introduction to the usage of Endnote Referencing Tool and Statistical Package for the Social Sciences (SPSS) software for the course.

Table 1
Recommended timeline for the Course Based Research Programme

Timeline	Activities expected throughout the course	Outcomes	Course objectives
Week 1	Introductory Understanding the processes of conducting science related studies and recognizing ethical issues	Identifying suitable research topics	Knowledge and understanding a. Demonstrate good knowledge of plans and conducting scientific research; b. Identify or critically analyzing key ideas of a research paper; and c. Critically review the current methods used in research and applying these to complete the research proposal of your own interest.
Week 2-3	Literature Review and brain storming on different topics	Collaborative research work and learning Endnote referencing tool.	Practice: Applied knowledge and understanding a. Use a selection of principal skills and techniques relevant to research.
Week 4-7	Data collection and independent group work		
Week 9-15	Data analysis and report submission	<ul style="list-style-type: none"> • Use of Excel and <i>Statistical Package for the Social Sciences</i> (SPSS) for the analysis of data. • Submission of report/ article and seminar presentation 	Communication, ICT and numeracy skills a. Know how to make a seminar presentation on selected topics; b. Demonstrate the basic skills in computer use relevant for research; and c. Interpret and use graphs with scientific information. Autonomy, accountability and working with others a. Work effectively under guidance with other students on a small research project; and b. Work independently on literature-based assignment

Moreover, the study formulated the following claims for offering Course Based Research (CBR) in undergraduate programmes:

1. *Course Based Research (CBR) enables an opportune way of engaging students actively with*

hands-on experience

Course Based Research (CBR) provides a bona-fide research experiences, enabling students to better recognize published work, establish their scientific research with hands-on experience (Auchincloss *et al.*, 2014; Bangera & Brownell, 2014).

Unlike the traditional teaching method where students have access to predetermine outcomes, a CBR experience involves activities with open-ended results relating to authentic research. Active learning pedagogies using research encourages metacognition and reflection among students. A study by McParland *et al.* (2004) revealed a significant difference in traditional and problem-based learning among the clinical students. The significant differences were indicated in the examination performance among the two cohorts of traditional and problem based learning curriculum and this could be clearly supported with the effectiveness of problem based learning curriculum. Likewise, Laursen *et al.* (2014) stressed the importance of inquiry-based classes having a positive impact on women attitudes and interest in attending classes.

Conversely, the Course Based Research (CBR) offered to Year 3 Biology students at the University of Fiji provides a valuable experience to beginners and an opportunity to immerse in culture of research, involving active learning, seeking assistance from mentors and overcoming problems. These experiences provides students with better and clear perceptive of nature of undergraduate research, further fostering the abilities needed to participate actively in research with faculty members through analysis of data and running of experiments. In addition, the CBR encompasses research or design experiences that allow students to have on-site experiences through enhanced learning outcomes. Beilock (2015) also claims that hands-on approach to learning has led to activation in sensory and motor-related parts of the brain that particularly coincides to better performance amongst college students.

2. *Transition/Development of content knowledge to the area of research*

Course Based Research (CBR) promotes an understanding on research skill-building continuum as a formidable

stumbling experience, enabling the development of critical thinking and problem solving amongst students (Quade, 2004). Through CBR, students learn that knowledge is contextual and not simply remembering accumulation of information. The experience exert greater influence on students' academic and career path (Auchincloss *et al.*, 2014).

According to National Science Foundation (2018), undergraduate research assists students transition from novice to expert learners, whereby students learning are enhanced through the organization of new information and reinforcement to learn effectively. The levels of questioning or learning comprise from the lowest to highest: knowledge or remembering, understanding, application, analysis, evaluate and create. In the process of learning, students will start with remembering or knowledge and then move to other subsequent levels until they reach the highest level, which is create (Anderson *et al.*, 2001). Bloom's basic philosophy is that learners cannot comprehend a concept if they cannot, first, remember it (Furst, 1981). The concepts and knowledge cannot be applied if one has not understood them. Hence, the transition from novice to expert learners featuring the undergraduate research promotes cognitive or metacognition (Kuiper & Pesut, 2004). Students identify with the processes of learning, thus enhancing their own learning capability. A few students reported that "CBR provided an excellent opportunity in active learning through real life data collection" (pers.comm, 2018). The CBR enables students to develop research plans, following and adapting to the challenges in the process will also reflect the technical aspect of student learning (National Science Foundation, 2018).

In other words, CBR enables student to think harder along with their team in tackling research related issues. Studies has shown that students might initially feel uncomfortable, if they have not experienced research since more is asked

then the typical course and students are usually accustomed to be challenged academically (Harris *et al.*, 2015). Students usually develop skills that are needed in evaluating research claims and being involved in the process of discovery learning.

Entry into the CBR unit at the University of Fiji requires students to satisfactorily complete Year 2 undergraduate courses. The course was developed and initiated in 2018, with funding received from the School of Science and Technology to address relevant topics/issues that was aimed at providing research aspects at undergraduate studies. It also offers different opportunities for students to develop ownership of the projects, building industrial collaboration and importantly, students are encouraged to complete and publish their research work to peer-reviewed journals.

3. *Ownership of project fosters a sense of responsibility*

Another key area in introducing research based course was to bring to the fore the concept of ownership in students at an undergrad level. Irrefutably, the inclination toward increasing the CBR learning in applied sciences form part of an on-going effort by the Department of Science at the School of Science and Technology to ensure that students have adequate skills and experiences to tackle real-life problems. Jollands *et al.* (2012) identified a proficiency gap between graduates' professional attributes and the expectations of their employers, in critical areas of communication, analytical skills, leadership, and emotional intelligence. A CBR learning approach can be highly effective in preparing work ready graduates, considering that learning under this approach occurs via developing critical thinking skills, teamwork, good oral and written communication and time management in the students (Kokotsaki *et al.*, 2016). It also provides the students

with the opportunity to formulate their own research questions based on their specific topic of interest, thus giving a sense of ownership to the project. According to Dounas-Frazer *et al.* (2017), ownership may refer to students autonomy in leading their projects and taking responsibility for the outcomes of their efforts. Dounas-Frazer *et al.* (2017) further stated that "ownership may manifest as a sense of pride over, intense commitment to or a personal connection with the activity". A highly student-centered approach to scientific studies is inefficient if it does not promote strategic facilitator intervention. In view of that, CBR methods must enable students to solicit support and direction from the course instructor (Mikalayeva, 2015). Students' sense of project ownership fluctuates over time, decreasing during difficult times and increasing in the moments of success. Thus, it is essential for the students to consistently interact with their peers to solve problems, and strengthen teamwork, which is an essential social component of ownership. In addition to balancing student autonomy, team interventions and instructor guidance, the notion of CBR also calls for an integrative approach within the whole undergraduate programme, as it applies concepts from other interdisciplinary courses. The project must attempt to incorporate different areas of knowledge replicating traditional industry practices by including elements of science and management. Dounas-Frazer *et al.* (2017) argues that student projects must have ambitious-but-achievable goals to capture their attention. It is not necessary for students to attain the overarching project goal, provided that they make tangible progress on one or more challenging research objectives.

4. *Value of teamwork and mentorship in Undergraduate Research Study*

At its best, mentoring can be a life-altering relationship that inspires mutual growth, learning, and development. Its effects can be remarkable, profound and

enduring; mentoring relationships have the capacity to transform individual groups, organizations and communities (Gibson, 2009).

The etymology of the word mentor is from the mid-18th century Greek word meaning advisor (Kram & Isabella, 1985). The concept of mentorship connotes a degree of guidance usually provided by an adviser, particularly an experienced person either in the field of corporate sector, company, or an educational institution. In the simplest sense, mentorship, or the act of mentoring, describes an experienced person (mentor), guiding a less experienced person (mentee/protégé) (Eby *et al.*, 2007). This means that the mentor has a crucial role to play in guiding mostly in the capacity of advisement to the mentee. Similarly, Kokotsaki *et al.* (2016) points out in 'Studying the Role and Impact of Mentoring on Undergraduate Research Experience' that within the domain of higher education, incorporating mentoring for any research learning experience provides a pathway to both academic as well as career success across disciplines and career stages. Hence, team play and mentorship forms a solid base for graduate students as they are more likely to persist in their academic decisions. Correspondingly, Lopatto (2010) mentions in 'Undergraduate Research as a High-Impact Student Experience' the significance of having a research mentor for learners enrolled in undergraduate research studies. Lopatto points out that a great deal of responsibility is placed on research mentor. The Summer Undergraduate Research Experience (SURE) survey depicted that 'over 80 percent of these students agree or strongly agree with the assertions that the peer mentor "helped me appreciate the significance of the research;" "understood my concerns about doing research;" and "had a significant positive impact on my research experience" (2010). Lopatto's study supports the findings that entailing

inclusion mentors in research based undergraduate study enhances the experience of both the mentors and the mentored. Both are gaining from the experience they share as Ragins and Kram (2008) shared that 'mentoring can be a life-altering relationship that inspires mutual growth, learning, and development'.

5. *Students' Observations and Evaluation of CBR*

For the purpose of this study, semi-structured interviews with the cohort (BIO311 students) were conducted after the course outcomes were achieved in summer 2018. The structured interview focused on four questions pertaining to the research course: (1) describe your research experience associated with BIO311 course, (2) List the benefits you have gained upon the successful completion of the course, (3) Did your team manage to publish the project work?, and (4) any other information you wish to share in relation to this course. Of the four questions for the structured interviews, 39 respondents were interviewed.

Foremost, for the first question regarding the research experiences associated with BIO311 Course, majority of the respondents favored the introduction of research component in their undergraduate science study. The overall feedback clearly indicated students' fulfillment of the course objectives as the course was mapped to provide learners with hands-on research experience in the field of science. One of the interviewees mentioned that 'This course helped students to experience research work practically rather than content heavy theoretical work that most of the courses designed in the undergrad study does' (pers.comm 2018). The preponderance impression gathered from the first question was that the course provided learners an opportunity to venture into active research work rather than the general tendency of being passive recipients of the content during specific lecture sessions in face-to-face mode of

courses. One of the interviewees also mentioned that it was the first time in their three year study duration that they have enrolled in a research course that allowed students to actually conduct their own research in relation to science and presented with an opportunity to be active researcher.

The course being a hundred percent coursework, entailed learners to develop research procedures and planning as per the methodology, thus allowing them to engage in a lot of self-directed learning hours (SDL). The concept of SDL for Year 3 students actually provides a pathway for learners to venture into postgraduate studies, primarily focusing on research components. The interviewees by far depicted a degree of contentment for BIO311 being their first research based courses. The feedback explicitly revealed students' level of confidence has been boosted due to the nature of the course, providing them the autonomy to venture into active research, creating a greater degree of understanding of science related issues in Fiji.

The second interview question aimed at exploring the plausible benefits of tying research experience at undergraduate study that is primarily content heavy and theoretical in nature. For this matter, all the 39 respondents shared their contentment for the research course BIO311. A lot of the respondents said that through exposure to research as undergraduates, they have begun to discover their passion for research and continue on to graduate studies and faculty positions in future. One of the respondents pointed out during the interview that 'An unswerving advantage of research begins in the classroom and when probing any observable fact in the class, it is practical to know how the original study was carried out. By giving students research course in the undergraduate study engages learners in research firsthand, thus, making it easier for students to understand the rationale underlying others research'(pers.comm 2018). This thought shared by one of the respondents ties with

others who shared similar sentiments. One undergrad student in the course who happened to have published a peer reviewed paper shared the experience that 'only after forming one's own hypotheses does one truly understand the tinge of research designs and fully conceptualize the course content, and I for one finally grasped the gamut of the course, since it being a research based course.

Additionally, majority of the interviewees stated that BIO311 provided students with an ongoing source of one-on-one mentorship that is otherwise unheard of in the undergraduate curriculum. This also provided learners to advance into independent studies and engage in collaboration work. One of the other palpable benefits that majority of the respondents pointed out was that since research is often performed in teams, and the course required them to engage in active field study as well (Project Writing), this allowed learners to balance a collaborative effort in the laboratory with what one is capable of accomplishing independently. More so, all the respondents said that any concept that seems complicated to be taught in the classroom, is gratifying and engaging when the same on-the-job experience with team play is fostered in field study –that is exactly what the course did according to all the respondents.

In light of the CBR offered to Year 3 Biology students at the University of Fiji, the third question focused on whether the students enrolled in BIO311 published their project work that they engaged in during the course of the programme. Here, since the course expected learners to conduct field study during the successful completion of their project writing, the view of mentorship and team play saw six students in the course write a paper titled: *Traditional use of Medicinal plants among selected villages in Fiji Islands*(2018).The six students were constantly mentored in the undergrad research course, thus allowing them to venture into having a publication. This milestone would not be achieved without the assistance, guidance and advisement of the mentor. The same

publication features in Pacific Medical Students' Journal and the students also get an opportunity to share their findings during the Southern Hemisphere Medical Camp to be held in Fiji Islands in December, 2018.

Also, the same course has provided the team of students who collaborated in the initial project writing stage to write their papers after the successful completion of the field study. Nine teams are currently in the process of putting their manuscript together as listed in the Appendices section of this paper. Some topics for future publications are 'Effect of Climate Change on the Sugarcane yields in Fiji Islands', 'Climate Change impacts on Root Crop growth in Viti Levu, Fiji', 'The effects of Climate Change in Votua Village in Fiji Islands; Socio Economic Perspective', 'Effects of changing Rainfall, Temperature and Soil Acidity on Sugarcane growth and yield', 'Effect of Climate Change on Weevil Borer pest in Sugarcane plantation', 'Effects of Sugarcane Diseases on its Varieties' 'The effects of Giant African Snail on plants and the environment', 'Positive and negative impacts of the Nabou green energy towards the people nearby, environment and Climate Change as a whole' and 'The impacts of Climate Change on Tuna catch in Solomon Islands'(pers.comm 2018). These nine work-in-progress papers are a testimony of the success of CBR in undergrad science programme. The respondents mentioned that exposure to an area of research undeniably guides students to explore career fields. After seeing that their project writings and field study has borne them such accomplishments, the learners, some of the ones interviewed stated that they are now considering research as a career path, as their own experience in a research setting is invaluable after enrolling in BIO311. The interviewees mentioned that the earlier students become involved, the more experience they attain, which enhances their career choice. BIO311 provided the learners with exactly the kind of breakthrough that was needed from

content heavy theoretical classes to a hundred percent research-based course. Firsthand experience to novice researchers' maps out passion for research they did not know existed. Institutions of higher education have a way of attracting the most curious minds, provided more courses of such nature are included in the undergraduate study. The final questions responses are predominately tied up with the benefits that all the respondents mentioned.

6. SUMMATION

The key findings of this research are largely positive in regards to the efficacy of BIO311, a Course-Based Research. The outcomes of the student interviews indicated that students are content with the opportunity to undertake an active research work at the final level of their undergraduate studies. Besides providing an opportunity to reflect and build up, in practice, the research approach enabled students to collaborate and generate a deliverable in the form research publication. The students' interest in tackling real-life problems, particularly current environmental issues has profoundly sharpened and there is a strong indication that science students wish to pursue higher studies in science. This has enormous potential to improve student retention rate in the science stream. The course also embraced the strategic needs of Department of Science to foster interdisciplinary teaching and learning. This has led to research outputs that represent multiple disciplines, including climate change, biodiversity and conservation and natural resource management. The integration of these disciplines, as well as the opportunity to interact with the external stakeholders and possibly future employers, exposes students to the way problems are tackled in the real world. It is also evident from the findings that students' level of confidence and communication skills has increased, while boosting independent learning as a result of the practical nature of the course. Since the onus was with the

students to ensure that the project objectives are completed in a timely manner, there was an on-going discussion with the course coordinator, which further increased student-teacher interaction. In addition to demonstrating the benefits to the course itself, the contributions of this research to the existing knowledge base are twofold. At the outset, the study indicated that students have vast potential to contribute effectively towards research publications and secondly, it draws a fine line between a teacher centered and learner centered pedagogy, signifying the need to integrate both to ensure effective course delivery. This study clearly implies the benefits of a research-based course, but calls for further exploration on the integration of the research-based course within the overall undergraduate programme structure. There is a need to answer questions such as how course-based objectives could be aligned to meet the overall university objectives, and how to financially assist students on their research mission.

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