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A Case Study of Using Mobile Applications and Peripherals to Encourage "Real-Life" Critical Analysis in Human Physiology

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ABSTRACT

This paper shares a practice of encouraging critical analysis in science students by comparing mobile applications and peripherals to traditional tools to record physiological variables such as heart rate and blood pressure. A progressive series of case studies is described with learning outcomes mapped to the benchmark statement for Bioscience from the United Kingdom's Quality Assurance Agency. A student reflection and staff commentary of the practice is also offered.

Keywords: Critical analysis, mobile technology, reflection, formative assessment, iPad.

INTRODUCTION

Critical analysis is a higher order skill promoted with Higher Education study (Bloom, 1956), and is acknowledged as a key graduate transferable skill for Bioscientists (United Kingdom Quality Assurance Agency (QAA), 2007). Specifically within Bioscience the QAA state that students should have knowledge of *'practical and theoretical methods of acquiring, interpreting and analysing biological information with a critical understanding of the appropriate contexts for their use'.* Despite this critical thought being an essential skill for graduates, it is thought that students find it difficult and may benefit from a case study approach

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to provide context (Herreid et al., 2012). This paper describes a case study approach to developing critical thinking skills in Human Physiology through problem based learning.

CONTEXT

Mobile health (mHealth) is a fast developing area of electronic health (eHealth), and there is now a vast array of mobile health applications (Apps) providing information for a range of health conditions (Martinez-Perez et al., 2013). Furthermore Torous et al., (2004) discovered that more than half of patients are interested in using such applications to learn and inquire about their health. However it must be considered that although some Apps are produced by recognised organisations from the relevant field, the development and sharing of these Apps is, as with some other information on the internet, often unsolicited and can be produced by anyone. This raises an issue in the quality, accuracy and reliability of the information that the general public can access on their mobile devices. In addition to the Apps that act as directories of information, some Apps also claim to collect and interpret physiological measures but offer no information as to their accuracy and reliability. This fact formed the basis of our case study, presented as a staggered approach in the following section.

APPROACH

Stage 1: Staff from the teaching team conducted a research study that acted to validate a number of freely available Apps that claimed to measure resting heart rate (Peart et al., 2014). A class of fifteen level 5 (second year undergraduate) Bioscience and Biochemistry students were introduced to the Apps in a research skills module and then the tutor shared the published article for the group to read. In a subsequent session the tutor facilitated a class discussion that critically analysed the research, and placed into context some of the methods of critical analysis and statistical analysis covered as indicative content for the module. Based on the discussion points students were invited to assist the staff team devise a follow up study.

Stage 2: A group of four students accepted the opportunity to work with the staff team on the second research project (Peart et al., 2015) in a formative manner. The students attended a meeting with the lead researcher to discuss a research design and methodology, which included considerations for reliability, validity and confounding variables. Following this the students were tasked with critiquing the proposed method and making any suggestions. Being involved from study conception also provided the students the opportunity to witness the process of applying for ethical clearance and participant recruitment. Their contribution to the project ended once all data had been collected.

Stage 3: Two of the students involved with step two enquired with the lead researcher about the opportunity to complete an internal work placement, with the aim of validating the accuracy of a mobile peripheral that the department had purchased but had yet to assess (Withings Wireless

Blood Pressure Monitor). The students worked together as a research team to propose and justify a methodology to the staff team, collect the data autonomously without staff assistance, and analyse and present the data in a report along with relevant conclusions. The next section presents a reflection on the process from the student perspective.

STUDENT REFLECTIONS

'Initially we agreed to partake in the research to achieve required placement hours. However during the research aspects beneficial to our personal development were identified and the project became more than just a work placement. We primarily hoped we would gain basic research skills and possibly an insight into research outside of a classroom environment.

We assisted Dr. Peart in a research study likening the sensitivity of three blood pressure (BP) monitors, in the hope of assessing the sensitivity of the Withings' Bluetooth BP monitor. The skills gained during this research included research and transferable skills alike, which are learnt in one area and can be directly applied to numerous other scientific areas (OECD, 2012). One particular skill gained was the use of Microsoft Excel for inputting data and statistical analysis. Once data was inputted we were given advice on how to statistically analyse the data and then left to our own devices, which was challenging but proved fruitful.

Once we had worked out the coefficient of variance for the measurements there was a sense of accomplishment. Statistical analysis was not a skill we felt we had developed earlier in the programme. Statistical analysis is an important skill within research, which Sunal et al (2004) stated many undergraduates lack, and is also crucial when reading and comprehending results from other publications (Bauer, 2009).

According to the QAA (2007), bioscientists should have developed sufficient personal development skills including the ability to critically appraise their own and others work, identify and apply concepts or principles and acquire enough evidence to devise and test hypotheses. We feel all of those skills were enhanced, particularly within the research due to the need to devise our own hypothesis based on previous research.

Although we were both theoretically familiar with the procedure of testing BP using a manual sphygmomanometer, in practice only one of us felt confident enough to execute it practically. In hindsight we felt this particular issue could have been prevented prior to data collection with more meticulous practice, ensuring a smoother execution (Monsen and Horn, 2008). We feel time could have been taken prior to data collection to practice a basic, yet important clinical testing procedure.

During this research we effectively integrated ourselves into a multidisciplinary team and demonstrated the ability to work intuitively and in accordance with demands of applied practice. Although many of the skills mentioned throughout could have been acquired in different ways other than this research project (e.g. by reading how to statistically analyse data using excel), we feel the overall experience was key to our personal development. Research allows undergraduates to understand how the industry works (Castanho and Güner-Akdogan, 2012) and the problematic occurrences encountered gave us a realistic expectation and reiterated that not everything goes according to plan every time.'

DISCUSSION AND CONCLUSION

Stage 1 exposed all students enrolled in the module to the concept of critical analysis, and the presence of the author and technology used in the discussed paper allowed students to put the paper into context. The purpose of this session in the scheme of the module was to facilitate student understanding of research articles. Stage 2 was a voluntary form of formative assessment that was less passive and rather more inquiry based as students were encouraged to begin with a question, investigate a solution and discuss discoveries with other students (Savery, 2006). Such activities may facilitate student learning in context (i.e. outside of the classroom) and meet more of the suggested outcomes from the QAA (Table 1).

Table 1. Mapping the three stages of student participation to the QAA Benchmark Statement for Biosciences

Stage 1
Subject knowledge and understanding • Understanding the applicability of the biosciences to the careers to which graduates will be progressing. *Subject-specific skills* • The ability to read and use appropriate literature with a full and critical understanding, while addressing such questions as content, context, aims, objectives, quality of information, and its interpretation and application • Critical and analytical skills: a recognition that statements should be tested and that evidence is subject to assessment and critical evaluation
Stage 2
Subject knowledge and understanding • Understanding the applicability of the biosciences to the careers to which graduates will be progressing. *Subject-specific skills* • The ability to read and use appropriate literature with a full and critical understanding, while addressing such questions as content, context, aims, objectives, quality of information, and its interpretation and application • Critical and analytical skills: a recognition that statements should be tested and that evidence is subject to assessment and critical evaluation

Intellectual skills

- Apply subject knowledge and understanding to address familiar and unfamiliar problems
- Recognise the moral and ethical issues of investigations and appreciate the need for ethical standards and professional codes of conduct.

Practical skills

- Design, plan, conduct and report on investigations, which may involve primary or secondary data (eg from a survey database). These data may be obtained through individual or group projects
- Undertake field and/or laboratory investigations of living systems in a responsible, safe and ethical manner. For example, students must pay due attention to risk assessment, relevant health and safety regulations, issues relating to animal welfare and procedures for obtaining informed consent.

Communication, presentation and information technology skills

- Cite and reference work in an appropriate manner, including the avoidance of plagiarism
- Use the internet and other electronic sources critically as a means of communication and a source of information.

Stage 3

Subject knowledge and understanding

- Understanding the applicability of the biosciences to the careers to which graduates will be progressing.
- Methods of acquiring, interpreting and analysing biological information with a critical understanding of the appropriate contexts for their use through the study of texts, original papers, reports and data sets

Subject-specific skills

- The ability to read and use appropriate literature with a full and critical understanding, while addressing such questions as content, context, aims, objectives, quality of information, and its interpretation and application

- Critical and analytical skills: a recognition that statements should be tested and that evidence is subject to assessment and critical evaluation
- The ability to think independently, set tasks and solve problems.

Graduate and transferable skills

- Practical skills
- Numeracy skills
- Interpersonal and teamwork skills

Intellectual skills

- Apply subject knowledge and understanding to address familiar and unfamiliar problems
- Recognise the moral and ethical issues of investigations and appreciate the need for ethical standards and professional codes of conduct.

Practical skills

- Design, plan, conduct and report on investigations, which may involve primary or secondary data (eg from a survey database). These data may be obtained through individual or group projects
- Undertake field and/or laboratory investigations of living systems in a responsible, safe and ethical manner. For example, students must pay due attention to risk assessment, relevant health and safety regulations, issues relating to animal welfare and procedures for obtaining informed consent.

Numeracy skills

- Carry out sample selection; record and analyse data in the field and/or the laboratory; ensure validity, accuracy, calibration, precision, replicability and highlight uncertainty during collection
- Prepare, process, interpret and present data, using appropriate qualitative and quantitative techniques, statistical programmes, spreadsheets and programs for presenting data visually
- Solve problems by a variety of methods, including the use of computers.

Communication, presentation and information technology skills

- Cite and reference work in an appropriate manner, including the avoidance of plagiarism
- Use the internet and other electronic sources critically as a means of communication and a source of information.

Interpersonal and teamwork skills

- Identify individual and collective goals and responsibilities and perform in a manner appropriate to these roles, in particular those being developed through practical, laboratory and/or field studies
- Recognise and respect the views and opinions of other team members; negotiating skills
- Evaluate performance as an individual and a team member; evaluate the performance of others

Although stage 2 was more interactive for the students and offered more opportunity for development, it was still predominantly staff directed with some independent reading tasks. Stage 3 however placed much more onus on the students, and was an example of problem based learning as the tutor did not provide information related to the problem (Savery, 2006). The students had to work together as a team to identify literature that would provide a rationale for the research (e.g. Pavlik et al., 2000, Ostchega et al., 2012, Myers et al., 2008, Handler, 2009), and identify similar previous research (e.g. Topuchain, 2014) with which they could justify their chosen methodology. Data collection itself promoted a recurrent approach to practicing skills from other modules, and the analysis of the data also reinforced skills from earlier in the programme (e.g. applied statistical analysis and use of spread sheets). Furthermore the reflection offered in this article encouraged the students to take time to consider how their actions have supported their own learning, and not simply complete the task and move on to something else.

In summary this article shares a series of interrelated case studies that progresses from passive classroom learning to more active inquiry based learning and finally an example of independent problem based learning, with the aim to encourage critical analysis in Bioscience students. The progression of potential learning outcomes have been mapped to the QAA benchmark statement for Biosciences in Table 1, providing evidence of a tiered approach to learning the same topic. Whilst this approach has been considered successful by the teaching team it could be considered that it is not necessarily inclusive across the whole cohort as only 4/15 students participated in stage 2, and only 2/15 students participated in stage 3. Moreover an argument can be made that the students volunteering for stages 2 and 3 may not necessarily be the students who needed encouragement and extra support to develop their critical analysis skills. Methods of initiating and maintaining student enthusiasm for voluntary formative work need to be considered.

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