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**BIOMET-THINK AID: A LEARNING PACKAGE TO ENHANCE STUDENT PRACTICAL
EXPERIENCE IN BASIC BIOCHEMISTRY AND METABOLISM**

**Nurul Farhana Jufri¹, Farah Wahida Ibrahim¹, Nor Farah Mohamad Fauzi², Nor Fadilah
Rajab³, Asmah Hamid¹ & Mazlyzam Abdul Latif¹**

**¹Biomedical Science Program, Center for Toxicology & Health Risk Studies (CORE),
Faculty of Health Sciences, Universiti Kebangsaan Malaysia, Jalan Raja Muda Abdul
Aziz, 50300 Kuala Lumpur, Malaysia.**

**²Occupational Therapy Program, Center for Community Health Studies, Faculty of
Health Sciences, Universiti Kebangsaan Malaysia, Jalan Raja Muda Abdul Aziz, 50300
Kuala Lumpur, Malaysia.**

**³Biomedical Science Program, Center for Healthy Ageing & Wellness (H-CARE),
Faculty of Health Sciences, Universiti Kebangsaan Malaysia, Jalan Raja Muda Abdul
Aziz, 50300 Kuala Lumpur, Malaysia.**

Corresponding author: farahwahida@ukm.edu.my

Abstract

Basic Biochemistry and Metabolism is a compulsory course offered to the 1st year students of the Biomedical Science Program, Faculty of Health Sciences, Universiti Kebangsaan Malaysia. Understanding the theories and procedures concerning each practical is very crucial. All the techniques introduced are clinical biochemistry-based tests that are widely used in diagnostic lab. Previously, students were only given a practical manual which was disseminated days earlier followed by a short briefing before each practicals session. The students, however, could not fully grasp the content of the manual given, resulting in experimental errors, inaccurate findings and chemical wastage. Also, the instruments involved

were sometimes mishandled resulting in an increased risk of damage or untoward accidents. To overcome these problems, Biokimia Metabolisme Think Aid (BioMet-Think Aid) learning package was introduced to enhance students' understanding when performing the practical sessions. The BioMet-Think Aid package consists of a step-by-step video-based practical demonstration, reference posters for expected results and quizzes for assessing students' understanding. This package was distributed to the students to serve as a preparatory package for the practical sessions. The feedback showed that the BioMet-Think Aid package resulted in increased students' understanding (100%), adequate practical execution time (90%) and confidence in performing the experiments (100%). Positive feedbacks were also received from relevant teaching and technical staffs. Overall, the BioMet-Think Aid package serves as a catalyst to enhance students' experience in learning Basic Biochemistry and Metabolism and it will be continued to be implemented to the future enrolled students.

Keywords: Biochemistry, laboratory practical, learning package, teaching, undergraduates

1.0 INTRODUCTION

Laboratory practical session is the key element in most Biochemistry-related subjects, with the fundamental aim to provide hands-on skills to students. During the session, the students are expected to conduct experiments, generate data and analyse the results with minimal supervision from the lecturers. As the acquired skills are applicable at the professional level, the practical component is highlighted as an important practice especially at the tertiary level (Whitworth 2016). The Basic Biochemistry and Metabolism is one of the compulsory courses offered in the Biomedical Science Program, Faculty of Health Sciences, Universiti Kebangsaan Malaysia (UKM), Malaysia. As a basic course, this 4-credit hour course is offered in the first semester of the first year with lectures, tutorials, and practicals as the methods of choice for teaching and learning (T & L). Constructing an effective and conducive learning environment for practical sessions with a large number of students with limited facilities is a

challenge for any university. The common practice for any Biochemistry practical sessions around the world includes a whole class introduction with a demonstration, students emulating the demonstration in small groups guided by practical manual, gathering and analysing data, concluding with a discussion and submitting a report (Croker et al. 2010).

The practical briefing is commonly given via conventional didactic format and has both advantages and disadvantages. While it may be useful for students who are able to focus and organise their work, this method proves to be impractical to students who are non-auditory learners and can cause them to lose focus easily (Richardson 2008). There were several issues that arose with the previous briefing format. Due to a large number of students involved (~80-90 pax), they were usually found to be disengaged during the briefing process. Coupled with a limited demonstration space, the briefing delivery process was often inefficient. The lack of attention during the briefing session subsequently affected the students' performance in conducting the experiments leading to errors in executing the procedures and thus generating inaccurate results. As the consequence, the students would repeatedly redo the experiments hoping for better results for practical reports and thus wasting chemicals and consumables along the process. Repeating the experiments has resulted in prolonged practical sessions, extended beyond the allocated time given. In addition, improper usage and handling of laboratory apparatus were also observed among the students, which could increase the risk of apparatus damages and injuries to the students.

As the practical briefing is still considered relevant at the university level, the delivery would be more effective if activity-based teaching is implemented (Neik et al. 2016). This would help the learning contents to be in a tangible perspective for students who are first exposed to the laboratory environment. Efforts have been made to improve the quality of teaching by incorporating multiple approach teaching methods instead of conventional approach which could stimulate different skills in students involving cognitive, leadership and ability to work in

a team (Sawangsri 2016). Learning packages are one of the many innovative teaching formats to enhance students learning experience by combining several learning tools in order to transfer knowledge and experience more effectively and in an interesting manner (Veselinovska et al. 2011).

A preliminary survey was conducted before the new approach was implemented among the first-year Biomedical Science students in UKM (Supplement 1). The results revealed that 98% of students agreed that extra tool other than the practical manual given was needed in order to understand how to better conduct the practicals. Taking this into considerations, a learning package (BioMet-Think Aid) was developed by the educators to improve the delivery of the practical sessions. Therefore, the present study aims to determine whether the introduced BioMet-Think Aid learning package could improve students learning experience in Basic Biochemistry and Metabolism practical sessions among Biomedical Science undergraduate students of UKM.

2.0 MATERIALS AND METHODS

2.1 Participants and Course Plan

Two cohorts of Biomedical Science Program students enrolled in the Basic Biochemistry and Metabolism course at the Faculty of Health Sciences, UKM were involved in the study. Cohort 1 (n=83) (intake session 2017/2018) was given a conventional practical session (short briefing and practical manual) without any other approaches and cohort 2 (n= 87) (intake session 2018/2019) was given BioMet-Think Aid learning package approach. There were seven practical sessions in total: (i) basic of spectrometry, (ii) enzymatic analysis, (iii) carbohydrate, (iv) lipid, (v) protein, (vi) hemoglobin and (vii) kidney function.

2.2 BioMet-Think Aid Learning Package

The learning package contains several components as described below (Figure 1):

i. Video

Seven practical demonstration videos (basic of spectrometry, enzymatic analysis, carbohydrate, lipid, protein, haemoglobin and kidney function) were pre-recorded and edited with Camtasia video software (TechSmith, United States). The videos were in MP4 format and contained a step-by-step demonstration of the experiments, tips on proper handling techniques of apparatus and chemical reagents, the do's and don'ts, followed by a mini quiz at the end of each video. The duration of the videos was approximately 10 minutes and were uploaded on the university online education portal (currently known as UKMfolio - <https://ukmfolio.ukm.my/>) with a YouTube link for students to access before each practical session.

ii. Practical Manual

Students received a practical manual of the experimental procedures, data collection sheet and practical questions regarding the experiments to evaluate their understanding of the topic (Latif et al. 2018). The students need to read the manual, understand and summarize the procedures involved through simplified experimental workflow diagrams in individual logbooks prior to the practical session. The workflows and results obtained were marked and discussed upon by the lecturers involved towards the end of the practical sessions.

iv. Poster

Posters containing relevant information (expected outcomes or observations) were provided as references to guide students in analysing and interpreting the results of their experiments during practical sessions.

v. Quiz

The students can assess their understanding via two approaches; at the end of each video or

at the end of each practical session via Google form. The questions were served only as a formative assessment.



Figure 1 : Components of BioMet-Think Aid. Briefing was given prior to the practical by the lecturers (A). The learning package consists of practical manuals (B), practical demonstration videos (C), quizzes (D) and posters (E).

2.3 Conducting Practical Session

Several days before each practical session, students were given access to the demonstration videos and practical manual for them to understand and familiarize themselves with the practical instructions and later preparing the experimental workflow diagrams before attending the practical session. On the day of the practical, a short briefing was conducted as a formal introduction to the practical as well as to clear any doubts and address enquiries that the students forwarded regarding the experiments.

2.4 Assessments

i. Final Practical Examination

A dry practical exam was conducted at the end of the semester to evaluate the student's performance. The exam was divided into seven parts representing all the practical sessions involved. The marks of each part were calculated separately, and the results were tabulated.

ii. Feedback from the students

Feedback from the Cohort 2 students were collected through Google form at the end of the semester to record their responses and comments regarding the new approach and suggestion for improvement. The questions were in "agree" or "disagree" format and the feedbacks were collected in an open-ended format.

iii. Feedback from the staffs

Feedbacks from the technical laboratory staffs involved in the preparation of practical sessions were gathered via open-ended questionnaires to record their opinion on the implementation of the learning package.

3.0 RESULTS AND DISCUSSION

3.1 Final Practical Examination

The marks of the specific practical session were analysed at the end of the semester. The average marks based on the practical session for each cohort were calculated (Table 1). Overall increment of marks was observed in each practical session after the learning package was introduced in Cohort 2, with the exception of carbohydrate practical session that decreased from 56% in Cohort 1 to 46% in Cohort 2. Cohort 1 recorded a moderate percentage of overall practical examination performance, with enzyme practical session recorded the lowest mark at 21% while the highest mark was recorded in protein practical session at 58%. However, after the BioMet-Think Aid was introduced, the increment in percentage was observed as the lowest mark was recorded at 46% for carbohydrate practical, while the highest mark was recorded by protein practical at 79%.

Table 1: Average of practical examination marks based on practical sessions for Cohort 1 and Cohort 2 students.

Practical Session	Cohort 1 (n=83)	Cohort 2 (n=87)
Spectrophotometry	44%	51%
Enzyme	21%	70%
Carbohydrate	56%	46%
Lipid	35%	54%
Protein	58%	79%
Haemoglobin	43%	50%
Kidney	51%	60%

3.2 Feedback from the students

A survey was conducted on Cohort 2 students following the full implementation of the learning package (Figure 2). From the survey result, all three aspects of experiments recorded positive improvements from students' perspectives. All students in Cohort 2 agreed that they gained confidence and understanding in performing the experiments. Next, the majority of the Cohort 2 students (90%) (n=78) agreed that they had sufficient time to perform the experiment in comparison to 63% (n=52) from Cohort 1 students.

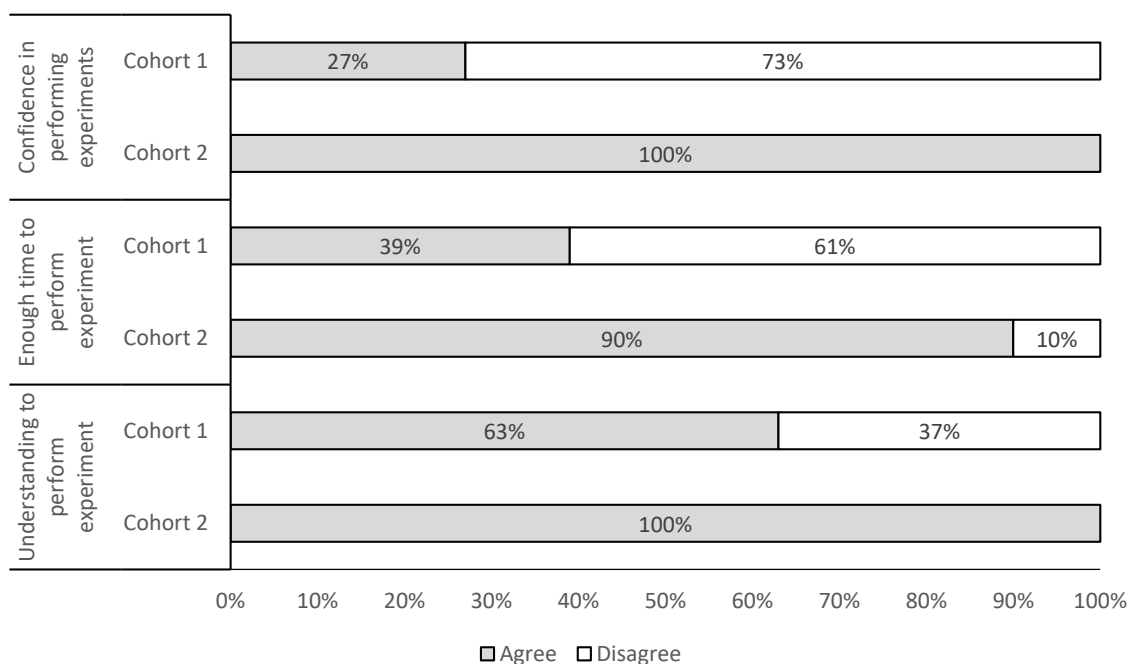


Figure 2 : A survey Conducted on Cohort 1 (n=83) and Cohort 2 (n=87). Cohort 1 is the conventional group prior to the introduction of Biomet-Think Aid and Cohort 2 used Biomet-Think Aid during the Basic Biochemistry and Metabolism course.

The feedback received from Cohort 2 (Table 2) demonstrated that the introduced learning package was well-received by the students. The student reported that the instructions on the learning package were clear and easy to follow. They also claimed that through the learning package, their understanding of the subject matter increased and that they gain more confidence to execute the experiments thus able to complete their experiments within the allocated time frame. Other comments for improvements include the suggestion to replace the background music with a fast tempo rhythm and to use formal sentences for instructions.

Table 2 : Overall Comments of Staffs and Students on the BioMet-Think Aid Implementation

	Comments	Explanation
Students	The learning package enhanced students understanding.	The learning package consists of practical manual, videos, poster and quiz to enhance students understanding
	The videos were clear, organised and easy to follow.	The videos provided step by step guided instructions for students to follow.
	The videos were interesting but need improvement on the background sound.	The medium tempo background music and quiz were included in the videos.
Staffs	The students can perform the experiment systematically.	The students know the expectation of the practical after watching the videos.
	The students less asking basic questions during the practical.	The video gives clear instructions on how to perform the experiments.
	Damage of apparatus and chemical insufficiency was reduced.	Students can observe instruments, apparatus and chemical handling before experiments.

3.3 Feedback from the staffs

Feedbacks from teaching and technical staffs (n=7) were collected at the end of the semester (Table 2). In their opinion, the students were able to perform the practical more systematically after the learning package was introduced. Besides, it was noted that the students asked fewer questions regarding the common procedure as they have already watched and understood the content of the videos beforehand. Finally, as the students can readily access the videos

regardless of time and place, this approach was more effective compared to watching live demonstrations during the practical session. This overcomes one drawback for a live demonstration with a high student number in a limited space as it can interfere with one's attention or focus during teaching and learning activities. In addition, damages of apparatus and chemical insufficiency due to lab errors were reduced noticeably compared to the previous session.

The Basic Biochemistry and Metabolism practical course was offered during the first semester to the first-year undergraduate students of the Biomedical Science Program, Universiti Kebangsaan Malaysia. As the students were newly enrolled in the university and still in the adaptation phase at the tertiary level, they need support and guidance from the academic staffs. The previous approach to the practical was to circulate the manual book prior to the practical session for the students to understand the experiment protocols followed by a briefing by relevant lecturers on the day of the practical. As they are new to the university life, the traditional approach by giving brief explanation and laboratory manual prior to the experiments are the main mode of delivery and these are considered to be a passive endeavour as the students are instead expected to put in their own effort for their better understanding (Karim et al. 2017). However, as several problems arise from this approach, a new paradigm shift has been taken involving inventing a learning package that contains several teachings approaches and learning tools.

Pre-laboratory activity is widely applied in the Science subject of higher education involving the introduction of the concept, introduction of laboratory techniques and affective activities for laboratory works (Tomanek & Montplaisir 2004). The pre-laboratory activity is suggested to be part of the overall laboratory experience and hence should be imposed in the curriculum (Tomanek & Montplaisir 2004). The application of preparation is crucial in the learning aspect as the students need to familiarize themselves with the theoretical background

and understanding the protocol (Agustian & Seery 2017). Thus, with the invented learning package, several activities are serves as pre-laboratory activities such as watching the video demonstration and preparing the workflow diagram based on the practical manual. In comparison, the previous method only involved a manual book that was circulated prior to the practical session as an intervention to the students.

The main tool in this learning package is the practical video that serves as an instructional video. The videos act as a visual approach that contains the demonstration of the experimental procedures and eliminates the students' doubt of the written manual protocol. Previously, the use of videos has been reported to have positive effects on students' perception and engagement, and is an effective tool in the teaching kit (Bree 2017, Aziz et al. 2011, Dabbour et al. 2018, Ismail et al. 2020). This approach is recommended as it is a dynamic way to enhance students learning motivation because it allows rapid and clear demonstration, contains interesting materials and allows quick viewing as it only has specific contents (Chan 2010). Furthermore, the students can replay the videos multiple times at their convenience depending on their level of understanding. In addition, the quiz given at the end of the videos served as the formative assessment to evaluate whether they are well prepared before the practical session. The brief explanation and posters will serve to strengthen their understanding and guidance for data analysis. Thus, these elements incorporating visual, auditory and cognitive skills could cater to the different learning abilities of the students.

This learning package also gave a positive impact academically as the practical examination results exhibited an increase in the students' performance in the practical examination of 7 practical sessions after the learning package was introduced. The enzyme practical reported the highest mark increment in Cohort 2. This could be contributed by the clear video demonstration produced and the students could plan their work well as the enzyme practical session is the most tedious session in this course.

In addition, positive and constructive comments were given by the students via the survey conducted. The survey demonstrated the difference in responses between Cohort 1 before the introduction of BioMet-Think Aid and Cohort 2 that used BioMet-Think Aid in the practical sessions. Students in Cohort 2 gained better understanding and confident in handling the practical compared to students in Cohort 1 (Figure 2). Meanwhile, the feedbacks from the technical staffs revealed that several problems encountered in the previous sessions were noticeably reduced. As the students could get clear instructions before the practical begins, it reduces the risk of experimental errors and subsequently improves the practical running time, safer handling of the apparatus, prevent wastage or chemical insufficiency and hence reduces the university expenditure. The number of questions asked on the protocol was reduced as the approach enable them to do self-learning. Thus, this learning package may benefit larger crowds involving students, lecturers, technical staffs and the university system. This learning package is practical to be used remotely, through e-learning via online education platform in instances whereby students are restricted to be in the lab or on-campus but at the same time teaching and learning must be executed although virtually as dry labs, for example during Covid-19 pandemic.

4.0 CONCLUSION

Learning package is one of the innovative teaching formats that aim to enhance students learning and improve the quality of teaching by incorporating multiple approach teaching methods instead of the conventional approach. Application of BioMet-Think Aid learning package in Basic Biochemistry and Metabolism course was found to improve students learning experience in understanding and conducting experiments during the practical sessions. Thus, this package will continue to be applied in future practical sessions among Biomedical Science undergraduate students of UKM and even to students from other institutions that offer Basic Biochemistry and Metabolism course.

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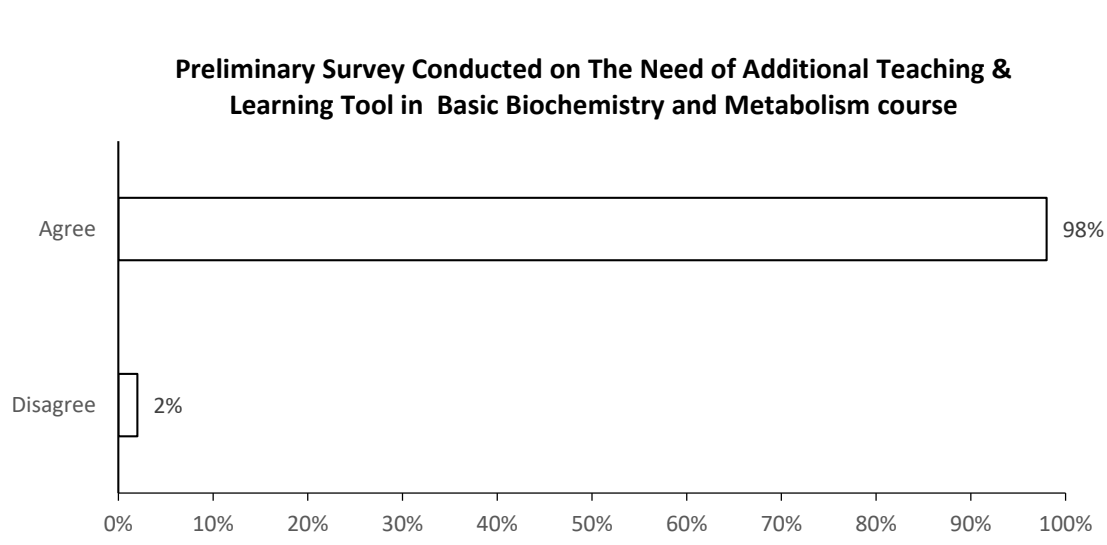
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Sup 1. Preliminary survey conducted before the BioMe-Think Aid was introduced. A question was asked to the cohort 1 (n=83) students on the need of additional teaching and learning tool in Basic Biochemistry and Metabolism course.