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ALTERNATIVE PRE-LAB ASSESSMENT FOR PRACTICAL CHEMISTRY COURSES IN PRE-UNIVERSITY: IMPLEMENTATION OF JOTTER BOOK

Ayu Afiqah Nasrullah[1], Sitty Nur Syafa Bakri[2*], Mohd Azrul Abdul Rajak[3], Suriana Lasaraiya[4]

[1] Preparatory Centre for Science and Technology, Universiti Malaysia Sabah, Malaysia
Email: ayu.afiqah@ums.edu.my
[2] Preparatory Centre for Science and Technology, Universiti Malaysia Sabah, Malaysia
Email: syafa@ums.edu.my
[3] Preparatory Centre for Science and Technology, Universiti Malaysia Sabah, Malaysia
Email: azrulrajak88@ums.edu.my
[4] Preparatory Centre for Science and Technology, Universiti Malaysia Sabah, Malaysia
Email: suriana@ums.edu.my
[*] Corresponding Author

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Abstract:

The jotter book concept is not a novel method in scientific research. This practice is common not only among undergraduate students but also among postgraduate students, scientists, and researchers who use it to understand theories, concepts, and newly learned experimental procedures since it is important and significant pre-laboratory (pre-lab) preparation before an experiment is conducted. However, using a jotter book as one component of alternative pre-laboratory (pre-lab) assessment in assessing student achievement at pre-University level is something that has never been done before. In this paper, we proposed the rationale in implementation of the jotter book as one of the alternative assessments for the Chemistry course (SK0011-Practical Chemistry I and SK0021-Practical Chemistry II) for the foundation of science students in the Preparatory Centre for Science and Technology (PPST), Universiti Malaysia Sabah. Sample of 353 students from the intake session 2020/2021 are involved in this study. The improvement in the student grade from semester 1 to semester 2 will be discuss in this paper as the preliminary study.

Keywords:

Jotter Book, Scientific Writing, Practical Chemistry, Pre-Laboratory Assessment, Pre-Lab

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Introduction

In higher education, laboratory work is a foundation of chemistry courses. Students' attitudes towards chemistry are likely to be improved in chemistry laboratory classes where laboratory activities are linked with the theory learned in non-laboratory classes and where clear rules are provided, according to research on the relationship between students' perceptions of their chemistry laboratory classroom environment and their chemistry-related attitudes in an Asian country (Wong and Fraser, 1996). The implementation of interactive teaching techniques in Science Technology Engineering and Mathematic (STEM) education, such as Problem Based Learning (PBL) and hands-on learning activities, has been successfully demonstrated (Kelly and Finlayson, 2007; Butai et al., 2020; Bakri et al., 2021; Nasrullah et al., 2021).

Laboratories are a distinctive feature of science education at all levels. It would be difficult to find a science course in any educational institution that did not apply a significant component of laboratory activity. The initial driving forces behind the development of practical chemistry were the requirement to provide highly skilled technicians for industry and researchers (Reid and Shah, 2007). The implication of chemistry practical work in enhancing student performance and scientific skills has been deliberately emphasized in the literature (Taber et al., 2000; Hofstein and Lunetta, 2004; Sella, 2017). In 2011, the United Nations Educational, Scientific, and Cultural Organization (UNESCO) and the International Union for Pure and Applied Chemistry (IUPAC) proposed that the science education curriculum be improved by including hands-on experimentation for a better understanding of science in order to increase the number of young people interested in science, as well as to promote scientific literacy for scientific careers and the development of scientific thinking and experimentation among elements (Abdussyukur et al., 2021).

The preparation of pre-lab materials is another instructional tool that can help students be ready before each experiment. According to Sella (2017) there are numerous studies in the educational literature that demonstrate how pre-lab materials, whether they be on paper or on video, along with testing helps students cope with practical classes; learning outcomes, though often limited, are improved. Rollnick et al. (2001) recognizes the need of thorough pre-laboratory preparation and has investigated the efficiency of various preparation methods and how they affect practical sessions, boosting both cognitive and manipulative learning as well as student satisfaction with laboratories. Before beginning the laboratory work, students must submit their pre-laboratory written work (a synopsis of the experiment). Ghannam (2020) mentioned that every experiment detail and idea needs to be well written, recorded, signed by author, and dated on each page. Moreover, all realities and deviation from original plan needs to be recorded as well as sketches and photograph must all be included in the jotter book.

Apart from psychomotor elements and scientific problem solving, the culture of scientific work methods should be applied in the evaluation of practical courses for science students. This element helps in producing a holistic student apply practical skills when doing research. Hence, this project explains the rationale for preparing the Jotter book as one of the alternative assessments for the Chemistry course (SK0011 & SK0021) for the UMS Foundation of Science program session 2020/2021. The primary goal of this alternative assessment is to improve students' basic scientific skills and to develop scientific attitudes including curiosity critical reflection and objectivity through the preparation of the Jotter book prior to beginning the experiment in practical chemistry courses. Another goal is to teach students cognitive skills in the practical course, which is the process of interpreting, learning, developing functional

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scientific knowledge and principles before starting the practical session. We believe that STEM students who embrace this fundamental research practice are more likely to acquire some of the skills that are desperately needed by the rapidly shifting job market.

Methodology

For those unfamiliar with the educational system of Preparatory Centre for Science and Technology (PPST), Universiti Malaysia Sabah is a one-year pre-university level programme. A semester last 18 weeks, and two chemistry courses were offered per semester which are theoretical course (lectures and tutorials) and practical course (8 laboratory sessions). The practical course in Semester 1 is SK0011-Practical Chemistry I and in Semester 2 are SK0021-Practical Chemistry II enrolled by 353 students for session 2020/2021. Each laboratory session last 3 hours per week, with maximum number of 25 to 30 students. Due to space constraints, we divided our students into 5 to 6 smaller groups, allowing them just enough space to work while adhering to safety precautions.

In most curriculum of foundation science levels in Malaysia, the assessment of laboratory courses is embedded in the theoretical course. In PPST, we have 1 credit-hour practical course per semester which 100% assessment goes to the lab reports, lab management and jotter book, and lab test. The preparation of the jotter book is under the element of lab management assessment for the first learning outcome which is performing chemical experiments following the standard procedure guidelines. For this assessment, students need to prepare a jotter book that contains objectives and simplified experimental procedures for each experiment that will be done by them. Through the assessment analysis for this element, 100% of Foundation Science students session 2020/2021 achieves the learning outcomes of the course that have been set. Therefore, achieved the requirements of MQF3a i.e., practical skills.

Each student's jotter book will be examined by the lecturer/demonstrator, and a grade will be assigned in accordance with the predetermined marking criteria. Students who produce the jotter book and adhere to the graded guidelines will receive a maximum of 20 marks (equal to 5% overall), which is one of the evaluation components for laboratory management and jotter book. As a result, student performance is evaluated in a variety of ways, not only through the preparation of laboratory reports but also the student's preparation before and during the practical class. An example of student’s jotter book shown in Figure 1.

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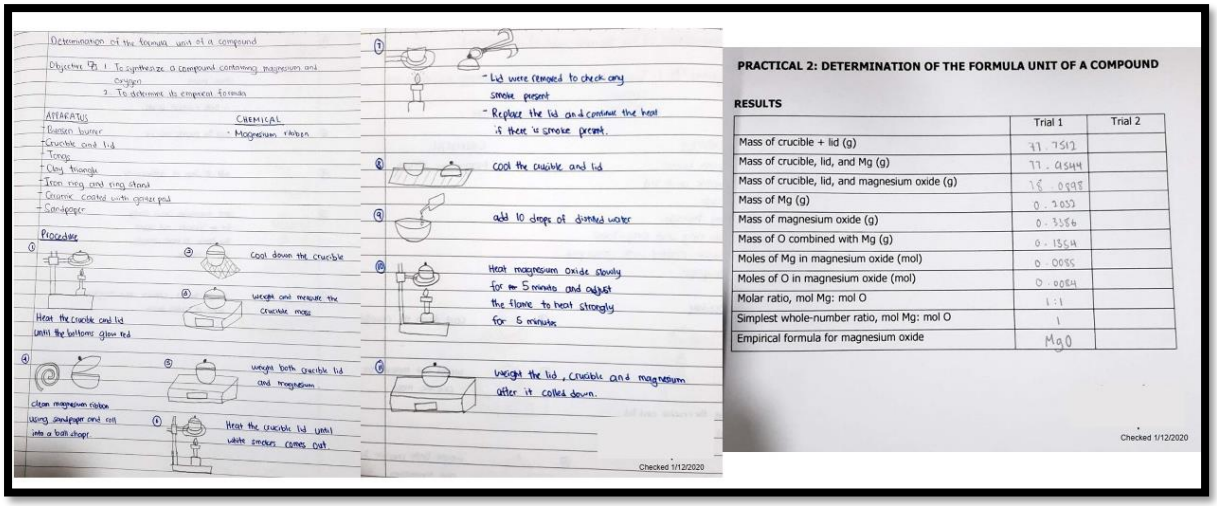

Figure 1: An Extract Of A Student's Jotter Book On The Determination Of Formula Unit Practical.

Measurement of Learning Outcomes

Assessment to measure learning outcomes of these courses is divided into several levels. The following infographic in Figure 2 explains the stages involved in this alternative assessment. First stage is rubric evaluation which comprehend assessment of teamwork, science at work, cleanliness, and time management of the students. The second stage of the assessment is program evaluation, during which qualitative and quantitative data are evaluated, and comments on student performance is provided by a lecturer or demonstrator. UMS reflection featured examples of reflection from students and lecturers from other faculties in the third stage of assessment. This measurement of learning outcomes applicable for both SK0011 and SK0021 practical chemistry courses.

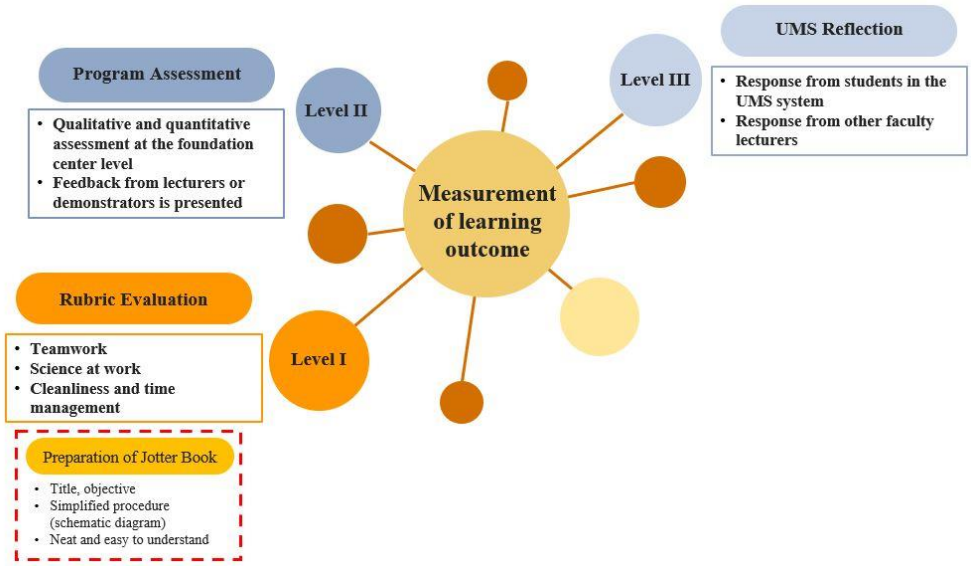

Figure 2: Infographic on the Measurement of Learning Outcome in Practical Courses (SK0011 & SK0021)

Students must read and comprehend the provided lab instructions before the practical session starts. Students must next simplify the experimental technique using an appropriate drawing or

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graphic based on their comprehension in the jotter book. Here, independent learning based on cognitive abilities can be utilized and includes interpretation, understanding, and students' capacity for understanding common practices. Additionally, the inventiveness of the students in creating neat and captivating jotter book can be evaluated. The creation of this jotter book can help students be more prepared to organize and carry out relevant experiments during practical classes. Figure 3 shows the advantages of preparing a jotter book among Foundation Science students involving before, during and after the practical session implemented.

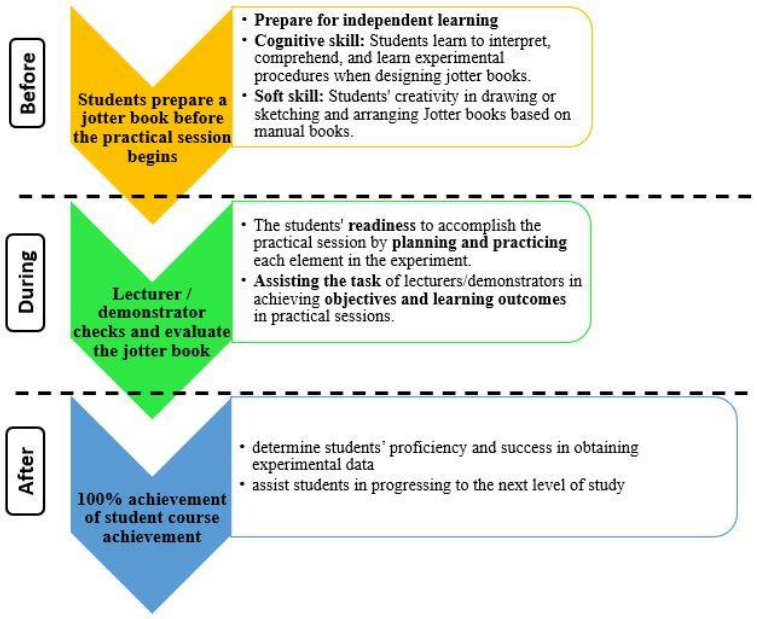

Figure 3: Infographic on the Flow of Jotter Book Implementation in Practical Courses (SK0011 & SK0021)

Findings & Discussion

This study obtained general information on the effect of implementing jotter book as an assessment for practical chemistry courses in pre-University level. We observed the overview of improvement in students grade from Semester 1 to Semester 2 in Figure 4. There are 84% students obtained grade A, 12% grade A- and 4% obtained grade B+ in chemistry practical course semester 1 while 89% students obtained grade A, 9% with grade A-, 1% with B+ and another 1% for grade B- in chemistry practical course semester 2 as shown in Table 1. Significant improvement can be seen in Figure 4 where group of students that obtained grade B region decrease 2% in semester 2.

Table 1: Overall Grade Analysis for Practical Courses (SK0011 & SK0021), Session 2020/2021.

Grade	Semester 1 (SK0011)		Semester 2 (SK0021)	
	No. of student	Percentage (%)	No. of student	Percentage (%)
A	297	84	313	89
A-	43	12	30	9
B+	13	4	5	1
B-	0	0	5	1
Total	**353**	**100**	**353**	**100**

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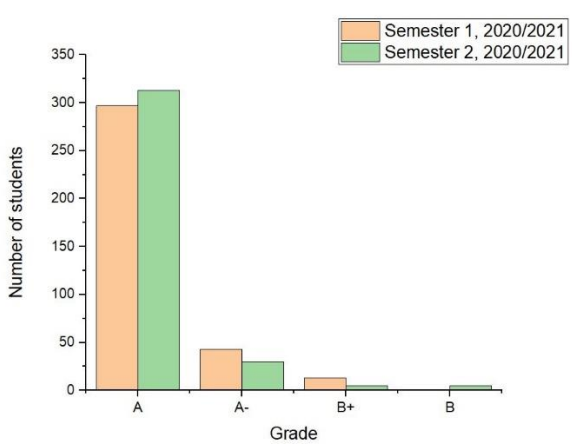

Figure 4: Overview Comparison of PPST's Student Grade for Chemistry Practical Courses in Semester 1 and Semester 2, Session 2020/2021.

This achievement shows jotter book as an alternative assessment in practical courses improve students' cognitive skills. Students are able to interpret, understand and learn the experimental procedure before entering the laboratory through the preparation of the jotter books. This matter also determines the smoothness and success of students in obtaining experimental data. Reid & Shah (2007) mentioned that the pre-lab elicits pre-existing knowledge and concepts and prepares the ground for the actual laboratory. The objective and character of the upcoming laboratory experience are now more known and understood by the learner. The length of laboratory guides needs to be much reduced, and students should be encouraged to organize the actual experiment and understand why they are doing it.

Jotter book preparation before laboratory session will also enhance student curiosity and inquiry towards the topic of experiment. Understanding theory, concepts, experimental procedures, and safety precaution before entering the laboratory is critical to determining experiment success. Furthermore, application scientific work must be practiced in this basic study so that it can be applied to further research. A key teaching and learning technique in science is inquiry-based learning and independent learning where it entails critical thinking, which improves and solidifies a student's comprehension of an idea. In inquiry-based learning, a question or topic frequently motivates students to think, and teachers serve as facilitators to encourage reflection and the application of information. The technique improves the pupils' memory skills and helps them comprehend the idea more fully (Ong & Melissa, 2022). By sketching the experimental procedure as an example shown in Figure 1, students will have better confidence executing the experiments since they had to visualize the written instruction and translate it into an illustration. Additionally, because some students had trouble distinguishing the laboratory apparatus described in the lab manual from incorrect sketches of the apparatus, the lecturer or demonstrator will be able to identify the weaker students with the help of the jotter book preparation.

The use of jotter books as one of the assessment components for our chemistry practical courses was successful in this pilot study, which can be attributed to a number of variables. The effectiveness of this implementation needs to be further examined while taking all relevant elements into account. The student's willingness to study independently, their participation in group work, laboratory equipment and environment, the lecturer's or lab demonstrator's

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knowledge, competency and communication abilities, and other elements may require further investigation. Discussion in depth addressing the contribution of the lecturer, demonstrator, or teaching assistant to the success of the practical chemistry courses and students' learning experiences were mentioned by Othman, *et al*. (2021) and Herrington & Nakhleh (2003). When compared to an individualized laboratory work teaching/learning technique, Tsobaza & Njoku (2021) found that group work teaching/learning considerably improved students' acquisition of practical Chemistry abilities. Students invariably learn the scientific abilities necessary to compete with their peers wherever they are in the world when laboratories are well-equipped with the necessary tools and laboratory activities and experiments are taught.

According to Shallcross *et al*. (2013) in their research quoted a survey of former students conducted by Hanson and Overton, the following skills were rated as useful or extremely useful: analytical techniques (70%), safe handling of chemical materials (75%), manipulative practical skills (71%), planning and design of experiments (63%), interpretation of experimental data (76%), report writing skills (81%), problem-solving skills (92%), team-working skills (87%) and time management and organizational skills (94%). Therefore, it would appear that practical work has a significant role in fostering a variety of talents that graduates value, regardless of their future career. The difference between conducting practical exercises and performing real experiments in the teaching labs goes beyond simple semantics. Students need to be made aware of the fact that the science they conduct has significant ethical and political ramifications. Science has traditionally been presented as a series of truths and certainties, and more recently in the press as a never-ending stream of eye-catching claim (Sella, 2017).

This study serves as a springboard for other, more significant studies. An overall image of the use of teaching and learning of chemistry in pre-university or matriculation institutions throughout Malaysia cannot be provided by current research that are perceptual and solely focused on the improvement of students' grades. The results are not necessarily generalisable across cultures and grade levels. Future study could consider comparing and contrast the findings from both the lecturers' and the students' perspectives with modest research instrument. The goal of this study is to contribute our perceptions towards the implementation jotter book as alternative assessment in chemistry practical courses at pre-university.

Conclusion

Students entering the pre-university or matriculation level have little or no experience in understanding how to deal with a jotter book due to less exposure of jotter book in laboratories curricular in school level. The use of this scientific work practice will also give the students scientific knowledge and abilities for the subsequent educational level. A jotter book is one of the scientific work practices for improving students' practical skills. By using a preparation of the jotter book, students can master cognitive skills by interpreting, learning, and understanding a topic. As a result, the learning outcomes of the practical chemistry course which is performing a Chemistry experiment in accordance with standard guidelines and safety measure is appropriate to achieve assessment objectives in this alternative. Implementing jotter book as one of the elements for assessment in practical courses will help improve students understanding towards scientific practice. Therefore, we strongly recommend that STEM students maintain good research practise by documenting all their experimental work in a jotter book. As a conclusion, we encourage all pre-University level in Malaysia ought to use the jotter

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book as supplementary evaluation for practical courses so that STEM students can treat this recording of experimental data with responsible and ethics.

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