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i-Slide: A Specimen Slide Innovation in Biology Experiments

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ABSTRAK

Slaid mikroskop digunakan untuk melekap spesimen bagi pemerhatian saintifik di bawah mikroskop. Ia biasanya diperbuat daripada kaca optik yang nipis dan berkualiti, serta memerlukan kos yang tinggi. Untuk mengurangkan kos pembelian slaid baru bagi setiap kali kerosakan atau hilang semasa eksperimen dijalankan, i-Slide telah dicipta dengan gabungan teknologi digital. Penggunaan gambar spesimen yang sama seperti slide specimen sebenar, dicetak pada i-Slide membolehkan para pelajar memperoleh gambar yang serupa seperti dalam buku manual, dan juga di antara rakan mereka. I-Slide mengandungi kod QR yang mengandungi fakta umum bagi spesimen yang diperhatikan beserta gambarajah berlabel lengkap. Kod QR pada i-Slide dicetak dengan menggunakan kertas berwarna yang sama dengan kertas berwarna yang dilekatkan pada kotak spesimen. Ini adalah bertujuan untuk memudahkan proses penyimpanan slaid spesimen. Kod QR yang dicetak pada kotak mengandungi pautan ke video VR yang menunjukkan gambaran keseluruhan spesimen untuk dilihat oleh pelajar menggunakan kacamata VR. Masa yang diambil untuk pelajar menyelesaikan eksperimen menggunakan mikroskop daripada pemerhatian di bawah mikroskop, menyiapkan lukisan saintifik dan proses penyimpanan semula i-Slide direkodkan. Kemudian dibandingkan dengan slaid konvensional. Sesi temu ramah soalan terbuka dan dua set soal selidik diedarkan kepada pelajar untuk mendapatkan maklum balas mengenai penggunaan i-Slide berbanding slaid konvensional. Dengan ini, dapat disimpulkan bahawa i-Slide yang menggabungkan kod QR dan teknologi VR telah memudahkan para guru menyampaikan pengajaran dan memudahkan pelajar untuk memperolehinya. I-Slide masih merupakan kaedah yang baru bagi kebanyakkan orang termasuk guru dan pelajar. Penggunaan teknologi VR dalam i-Slide telah menjadikan proses pengajaran dan pembelajaran di makmal sains lebih tersusun, bermanfaat dan lebih menyeronokkan.

Kata kunci: Mikroskop, Slaid, Digital, kod QR , Teknologi VR

ABSTRACT

Microscope slides are used to hold specimens for scientific examination under a microscope. It is usually made of thin optical quality glass, which are costly. To reduce the cost of buying new slides every time it breaks or lost during an experiment, i-Slide has been created with an integration of digital technology. The usage of the same printed image of specimens on the i-Slide has enabled the students to obtain a similar image as shown in the manual book, as well as among their peers. The i-Slide contains QR-code which codes for a general facts of the specific specimen observed with a complete labelled diagram. The QR-code were printed on different coloured paper respectively for easy colour-coding of the specimens. The same coloured paper were affix on the specimen box to

allow easy storing of specimens slides. The QR-code printed on the box contains a link to a VR-video showing the overview of specimens for the students to view using a VR-goggle. The time taken for a student to complete the microscopic experiments from observing, drawings and storing by using i-Slide were recorded and compared with the conventional slide. Besides open ended question interview, two sets of questionnaires were distributed to students to get their feedbacks when using i-Slide as compared to the conventional slide. It can be concluded that i-Slide which incorporates QR-code along with VR-technology have enabled the teachers to impart knowledge and have eased the ability of students to acquire it. I-Slide is still a novelty to many people including teachers and students. The usage of VR-technology in i-Slide has made the process of teaching and learning in science laboratory more arranged, rewarding and more enjoyable.

Keywords: Microscope, Slide, Digital, QR-code, VR-Technology

1. INTRODUCTION

Science laboratory are a place where students interact with specimens, objects or materials to observe and understand the natural world of science (Lunetta, Hofstein & Clough, 2007). Students in science laboratories can develop many skills in scientific investigations such as constructing and testing explanations, controlling necessary variables and interpreting results. Hence, providing the students for opportunities to build their constructive learning and conceptual understanding during science experiments are necessary.

Science experiments mainly focuses on studying histology of plant and animal tissue based on a microscopic slides. Students learning it need to master the skills to observe specimens and interpret information from images observed. In a 'traditional' laboratory practice, microscopy is an individual undertaking where students are tasked to make sense of their observation of tissues and cells using their own knowledge. When a student does not understand what they are supposed to observe from a microscopic slide, the task can become frustrating to both students and lecturer. Also, much time is lost as a student waits for a lecturer to visit their workstation, and comprehend the images observed (Gould et. al., 2019).

A microscopic slide is a thin glass that are not easily scratched and are usually imported from overseas which may have caused the high cost and longer time to receive. The specimens obtained from the bought microscopic slides sometimes do not meet the required learning objectives in the matriculation syllabus. This have led the students to have difficulties in figuring out the correct images that they need to observe and relating it with what they have already learned. Simultaneously, have caused a setback in Teaching and Learning process during an experiment.

Hence, we have aimed in producing specimen slides that are effective in terms of the standard image of specimen used that based on the matriculation syllabus and are also inexpensive, easy to maintain and store. Since there is a wide expansion of the World Wide Web (WWW) and the technological field in education, virtual reality (VR) technology has been recognized as a technological advance to support a life-long education. Adopting VR-technology in education can create an Educational Virtual Environments, which enables students to learn by experience (Alexiou, Bouras & Giannaka, 2017). Incorporating VR technology with the microscopic slides not only to ease the students' method of learning, conducting the experiments and observation of slides, but also to allow the teachers to provide a more effective scientific teaching methods which ultimately creates a better and a productive experience for students in their classes.

2. LITERATURE REVIEW

Microscope is a laboratory tool of science that are used to examine and captures important scientific objects that are too small for a normal human being to observe. According to Ruscic et. al. (2018), it enlarges images of small specimens such as cells to allow the observer to have a close view of its structures. While microscopy is the technical field of using microscope to view prepared microscopic slides that cannot be seen with the normal eyes. Although microscopes are one of the important tools that contributes to learning the field of Biology, not understanding on how to handle the microscope and its slides makes learning scientific skills difficult. Scientific skills such as obtaining a sharp observation to interpret information from images observed are difficult to teach (Gould et. al., 2019). As been stated by Bian et. al. (2021), combining the power of microscopy and technology have brought many positive results in science laboratory experiments.

Biology is a branch from pure science that mainly involves experiments with living organisms. Even though Biology is interesting in which it involves examining living things, it is considered as one of the subjects where the students are having difficulties in learning. According to Gome et. al. (2019), developing a system that incorporates technology for Hands-On Biology experiments creates a better experience for students in conducting scientific skills in labs. Also, much time is lost as a student waits for a lecturer to visit their workstation, and comprehend the images observed (Gould et. al., 2019).

Due to the unlimited access to various applications of this digital world, students have improved their learning capacity through visual and tactile modalities (Paxinou et. al., 2020). As also been stated by Kara (2018), microscope simulation have improved the achievements and ability of the students in general Biology laboratory experiments. Despite the economic burden, the educational institutions have taken advantage of technological innovations so as to enrich the conventionally applied learning methods and curriculums. Technological educational tools have effectively engaged students in the learning procedure as additional materials to the classical learning scenarios, so the contents to be taught, are increasingly supplemented in the classroom with virtual reality technology, videos, etc. (Gamo J, 2018). The new proposed learning methods should be assessed in terms of accomplishing the desire learning goals or outcomes.

In respect to the laboratory experience in biology, it is widely known that virtual and augmented reality have shown a great potential in providing essential knowledge and ensuring students' active attendance (Paxinou et. al., 2020). The effectiveness of using virtual experiments have also been proven by Hamed & Aljanazrah (2020), where students were better prepared for carrying out real experiments and have provided them with a more flexible and rich learning environment.

3. MATERIALS & METHODS

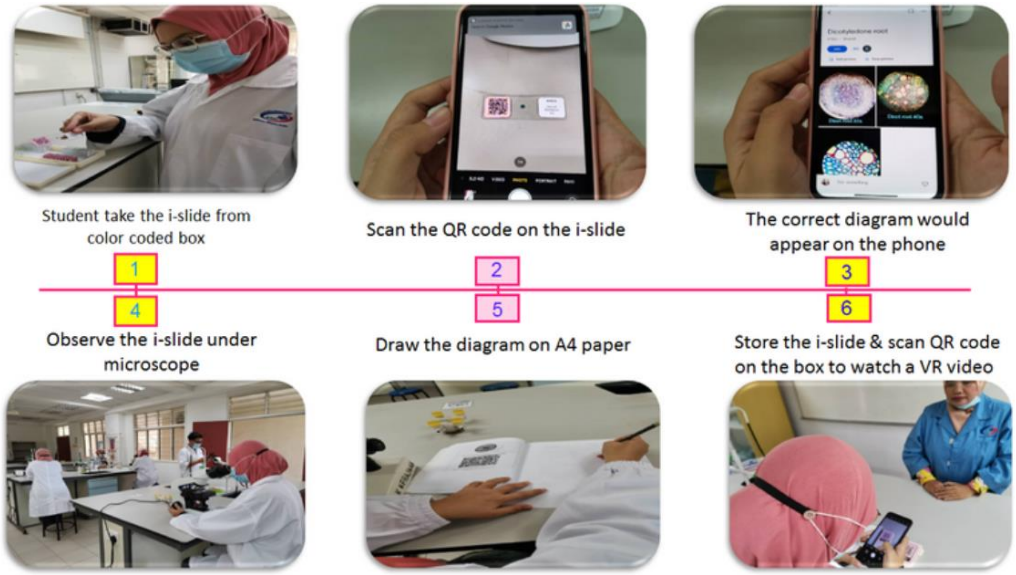
The development of i-Slide, research setting and data processing procedure was explained in this section.

3.1 Production of i-Slide

The i-Slide stands for integrated-slide, in which technology were integrated with a conventional specimen slide. A set of scientific images of specimens were printed and were mounted on an empty glass slide. Then, a cover slip were mounted by using acrylic glue. After the slide was dried, one side of the glass slide were labelled with the common and scientific name of the specimen, while on the other side of the slide were attached with a QR code that contains a labelled image of the specimen, with a basic information of its distribution and functions. This QR code located on i-Slide were printed on different coloured paper and placed in a box that are also colour-coded based on different types of specimens to be observed. A QR code that contains a VR (virtual reality) video of the specimen were also printed on the colour-coded boxes respectively.

3.2 User Manual

1. Take the i-slide that are placed in a colour-coded box.
2. Scan the QR-code on the i-Slide using QR-code reader.
3. The expected image of the specimen with its correct labelling and a brief facts about the specimen will be shown.
4. Observe the i-Slide under the microscope and draw the observations on an A4 paper with its correct magnifications.
5. After drawing, store the i-Slide back to its respective colour-coded boxes.
6. Scan the QR-code provided on the box to watch a VR video of the specimen through a VR-goggle provided.



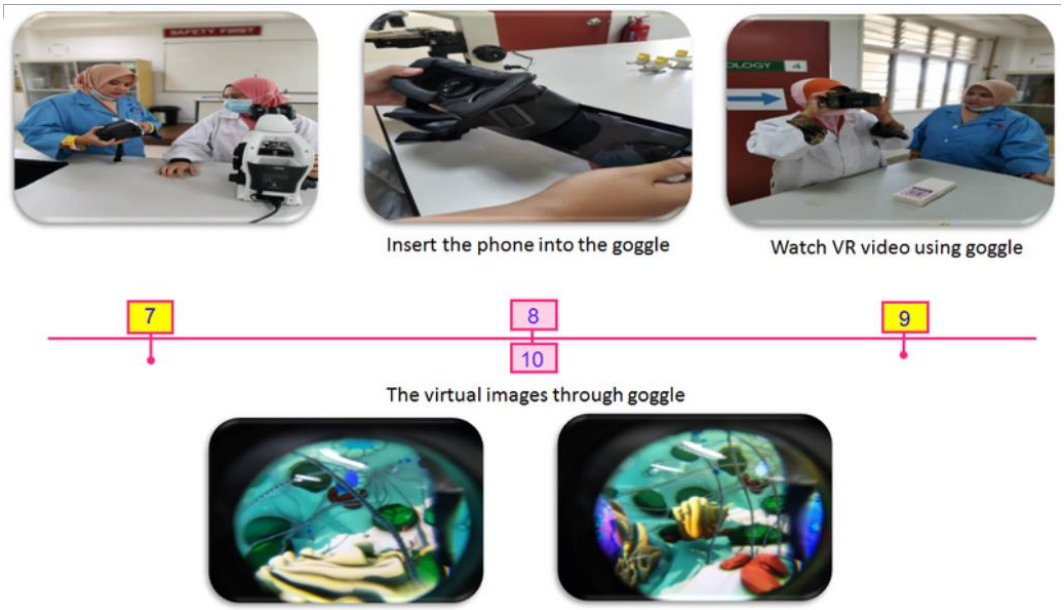


Figure 1: User manual

3.3 Research Design

In this study, case study design with comparison between pre and post intervention was adopted to determine the effects of using i-Slide for microscopy Biology Laboratory. The comparison were based on the duration taken by students to obtain the correct image and drawing of the correct scientific image of specimen by using i-Slide compared to the conventional slide. This study was carried out within the scope of Plant Tissue in Matriculation Syllabus. For this reason, 8 Biology classes which comprised of 112 students under the 4 semester programs in Matriculation College session 2020-2021 were chosen. First, all the students were given conventional slide of plant tissue and need to observe the slide under microscope. After that, the students must draw and complete the scientific drawing with the correct label of each cell in the plant tissue specimen given. A week after, all the students were provided with i-Slide of a plant tissue and were required to draw and complete the scientific drawing with the correct label for each tissue. Time was taken during the experiment which starts from taking the slide from the specimen boxes until the scientific drawings. The duration taken to complete the experiment by using i-Slide was compared with the conventional slide for each student. According to Nyberg and Berg (2014), to obtain data for perceptions, a qualitative method were used. Hence, After each of the experiment, likert-scale questionnaire was distributed through google form followed by an open-ended questionnaire interview was conducted.

3.4 Data Processing

The time taken to complete the scientific drawing was recorded and compared with the conventional slide. The data was analysed using excel and illustrate by bar graph. While the data recorded from likert-scale questionnaire was group according to number of students' responses for each each of questions. Students also was interviewed to get their perception about using i-Slide for

microscopy experiments. Their response was also recorded. Other than that, the cost production for one i-Slide was compared with the conventional slide.

4. RESULTS & DISCUSSION

4.1 Duration

All 112 students had completed the pre (conventional prepared slide) and post (i-Slide) laboratory practical and have answered the questionnaire provided. From the pre and post laboratory practical, the time taken to complete the finding of accurate image of specimen until drawing the scientific image were taken. Table 1 shows 50 out of 112 students took about 3-5 minutes to complete the laboratory practical when using conventional prepared slide, 78 out of 122 students took less than 3 minutes when using i-Slide. This indicate that the i-Slide that contains QR-code of a labelled image have eased and caused the shorter amount of time taken to complete the practical session. More time can be used for an interactive discussions among the students and teacher regarding the specimens. Despite the use of hybrid microscopy methods, the proper use of optical microscopy is not ruled out. Usually in 1 period of practical session, many histology slides must be observed within 2 hours. If the conventional prepared slide was used, histology learning would become time consuming and less effective as stated by Nur (2020). Hence, students and also the teachers become frustrated and tiresome as they need to get the accurate image and the best magnification of the image.

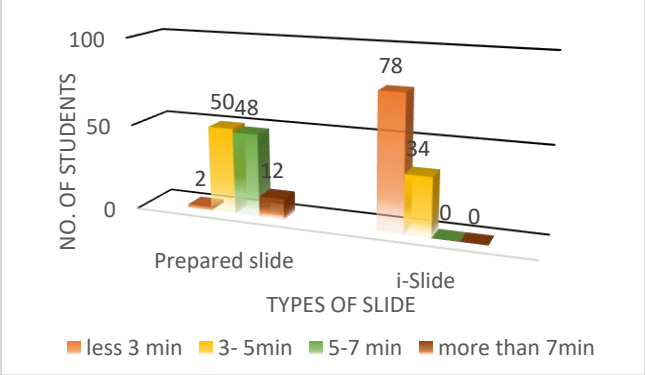


Figure 2: Comparison of time taken for pre (conventional prepared slide) and post (i-Slide set)

4.2 Student perceptions

To get the student perceptions, 2 sets of questionnaires was distributed. Each of set the questionnaire was distributed after each type of laboratory practice was completed. **Table 1** showed the frequencies of student responses to likert-scale questions when using conventional prepared slide and i-Slide respectively. According to the results, 71% of the students have problem in obtaining correct image and 51% get confused during storing the conventional prepared slide.

Table 1: Frequencies of student responses using conventional slide

	Likert Scale				
	1	**2**	**3**	**4**	**5**
I know what the expected image should be before observing under microscope	18	49	17	16	12
When observing under microscope, i have no problem in obtaining the correct image	37	48	10	8	9
I have difficulties in finding image that are exactly the same as the ones in the internet	0	3	10	20	79
I get confused when storing the specimen prepared-slide back to its respective boxes because it all looks the same	8	10	11	26	57

Note : Scale 1(never), 2 (rarely), 3 (sometimes), 4 (often), 5 (Always)

In contrast, by using i-Slide, problem in obtaining correct image and get confused during storing the conventional prepared slide seemed to be solved. **Table 2** showed 98% of the students agree that the i-Slide eases them to get the correct image in shorter time and eases them to store the slide in respective boxes.

Table 2: Frequencies of student responses using i-Slide

	Likert scale				
	1	**2**	**3**	**4**	**5**
I think using i-Slide during an experiment can lessen so much time	0	0	0	14	98
i-Slide eases me in obtaining the correct image of specimen faster	0	0	0	2	110
I do not need to waste time searching information about the observed specimen through the internet	0	0	5	13	94
i-Slides guides me to correctly draw my observed image	0	0	0	0	112
Using i-Slide eases me to store slide in respective boxes	0	0	0	119	101

Note: Scale 1 (strongly disagree), 2 (disagree), 3 (no strong opinion), 4 (agree), 5 (strongly agree)

From an open ended question interviewed, most of the students stated that they found the i-Slide is a fun and beneficial equipment during microscopy practical session and allowed them to see the whole specimen through a VR platform. Hence, the i-slide material appeared ‘more real’ and are similar with conventional prepared slide. The findings were in-line with the studies by Hagge, (2021), where there were positive views and responses by the students when conducting class using VR-technology. They are able to obtained similar standardized image of specimen as their classmates and as stated in the laboratory manual. Due to this, the students’ intrinsic motivation also was

stimulated when using i-Slide ('*makes us more confident using microscope in correct technique*'). In comparison with conventional prepared slide, few of the students have stated that "*I don't know the correct image that I am supposed to obtain*". The students tend to search the image from the internet, which is not the same as the specimen provided. Moreover, the code colour at the i-Slide and the respective boxes have eased them during storing process compared to the conventional prepared slide where students always get confused to which specimen box the conventional slide belongs to. This is similar with the research done by Durukan, Artun & Temur, (2020) where a comparison of a conventional science laboratory practices which have been applied with VR method were found to be more effective as compared to the conventional science laboratory practices.

4.3 Production Cost

There is also a logistic issue with the use of microscopy slide, whereby maintaining and replacing damaged histology slides are very costly (Neuhaus, Schmid & Riedel, 2017). In parallel with this statement, **Table 3** shows the actual cost of production per slide for conventional prepared slide and i-Slide. It clearly stated stat i-Slide have reduced the cost by 98% compared to conventional slide.

Table 3: Comparison cost of production per slaid

Prepared slide	i-Slide
RM 40	RM 0.85

5. CONCLUSION AND FUTURE RECOMENDATIONS

Overall, the data showed that students required less time to complete a microscopy experiment and more time can be used for them to discuss with their teachers about the respective experiments. This simultaneously creates a more organized laboratory practices. Nevertheless, by using i-Slide students have a much better understanding of the specimen they were observing, due to the labelled image that were linked with the i-Slide. The integration of VR-technology in i-Slide indeed have created a realistic experience for the students in the science laboratory. We believe that the i-Slide could be applied and used for other experiments in science laboratories and also possibly to certain topics in tutorial classes. In addition, i-Slide could also be improved with simple assessment and video explanation of the specific specimen to be observed. With this not only the teachers are able to assess the students' drawings but also evaluate the students understanding of the specimen that are being observed. Hence, with all these added features in i-Slide, it is feasible that i-Slide could be commercialized to every other pre-university colleges, and even to secondary schools that would like to prepare their students on how to handle a microscopic slide and at the same time enhance their scientific skills.

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