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Not Just for Laughs: When Comics Teach Science Lab Safety

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ABSTRACT

Traditional methods of teaching science laboratory safety often rely on lengthy manuals that are difficult for students to grasp. Despite the availability of the School Science Laboratory Management and Safety (SLMS) guidebook, students understanding of lab safety remain low. Research suggests that comics can improve student engagement and comprehension of safety protocols. This study investigates the effectiveness of an educational comic in enhancing science laboratory safety among secondary school students. A quasi-experimental design with pre- and post-tests was conducted involving total of 104 students in both the control and treatment groups. Results show a significant improvement in the treatment group's post-test scores (M = 30.92, SD = 5.57) compared to their pre-test scores (M = 13.96, SD = 5.78), t(51) = -26.06, p = .001. Meanwhile, the control group showed no significant change, t(51) = -1.00, p = .322. The findings indicate that comic-based instruction is effective in improving students' understanding of laboratory safety. This study affirms that comics are not just for laughs, but they hold meaningful value in education, particularly in teaching science lab safety, where their role extends beyond entertainment to becoming a powerful medium for learning.

1. Introduction

In Malaysia, students typically engage in practical work, experiments, and laboratory activities in student-oriented laboratories as a crucial part of science education. This emphasis on practical work aims to foster scientific inquiry and the acquisition of knowledge using scientific skills. By employing an inquiry-discovery approach, both teachers and students in science laboratories can explore scientific concepts through hands-on activities. Adane *et al.,* (2012) recognize that the use of science laboratories to test theories and nurture scientific ability is universally acknowledged, while Lunetta *et al.,* (2013) state that science laboratories help students build experience through interactions with various materials and equipment [1,2].

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However, it is important to recognize the risks involved in practical work, as the materials and equipment used in science laboratories can be dangerous if not handled correctly. Therefore, it is crucial to prioritize safety in science laboratories and for all parties involved, including students and teachers, to understand the safety aspects of science laboratory work [3]. National Research Council emphasize the importance of science laboratory safety at all levels, from primary to tertiary education, and the need for awareness on the importance of prioritizing safety in science laboratories due to the frequent occurrence of accidents in such environments around the world [4].

Malaysia Ministry of Education (MOE) has published the School Science Laboratory Management and Safety (SLMS) guidebook. This guidebook, first published in 1987 and revised in 1999 and 2010, aims to improve the quality of school science laboratories and equip school administrators and teachers to handle issues related to their management [5]. The SLMS guidebook covers two main management fields, including the management of science laboratories and laboratory safety. Moreover, the national science curriculum emphasizes the need for increased laboratory safety, with improved textbooks and science-based practical workbooks that include icons such as warning signs and precautionary measures for every experiment. These efforts highlight the MOE's commitment to science education and demonstrate that school science laboratory safety is taken seriously. The traditional instructional method of science laboratory safety was implemented via verbal explanation from educators using laboratory manuals with 5 to 10 pages which are too complex to comprehend without additional summarized information. Consequently, the level of knowledge and exposure to workplace safety in science laboratories among secondary school students is still low, despite the availability of the SLMS guidebook [6].

Comics have been proven to increase students' interest and awareness of safety in chemistry laboratories [7]. Comics have been widely utilized for educational purposes, as they make the teaching-learning process more engaging and entertaining. Researchers have also investigated whether comics have direct benefits in the instructional process, leading to the identification of three main uses of comics and caricatures: as a warm-up activity, as an instructional tool, and as an assessment tool. Comics are a suitable learning tool for economically and educationally disadvantaged children [8,9]. Moreover, Özdemir and Ertuğrul highlighted the advantages of comics in effectively communicating information, simplifying instructions, promoting discussions, and enhancing cognitive retention as a mnemonic tool [10]. Therefore, comics are not solely intended for entertainment and humor; rather, they also serve as effective learning tools, particularly in science education, including topics such as laboratory safety [11,12]. Therefore, this study aims to investigate the effectiveness of an educational comic to enhance laboratory safety understanding among secondary schools.

2. Methodology

2.1 Research Design

This study was based on a quasi-experimental design. In this study, pre- and post-tests design groups were implemented. The pre- and post-tests were appropriate due to them consisting of two groups of respondents, one as a control group and another experimental group [13]. The control group did not receive any intervention, while the experimental group was exposed to the intervention in this study. In this study, the intervention was implemented using educational comic namely *Komik Makmal Sains* in the teaching and learning process in the topic of Laboratory Safety for 10 weeks. Meanwhile, the control group used the conventional method, the textbook. The initial preparation of the intervention was briefing the teachers on how to use the educational comic on how to conduct the teaching and learning process for 10 weeks. Structured lessons, interactive

activities, and formative evaluation were incorporated into the intervention to foster the engagement and enhance the science safety laboratory understanding among treatment group students. Figure 1 showed the intervention of the *"Komik Makmal Sains"* in schools.

Fig. 1. Intervention of the "*Komik Makmal Sains*" in schools

This study was conducted in secondary schools in the district of Guar Chempedak, Kedah and Cheras, Kuala Lumpur. The schools were selected for this study due to their position, the number of pupils and composition of the pupils. These schools were composed of various social-cultural backgrounds of students. Most of these students have medium socio-economy status. The students in these schools could be representing most secondary schools' students in general in Malaysia.

2.2 Research Samples

The intended population for this study is all lower form secondary school students throughout Malaysia. However, due to the large size of this population, it is not feasible to obtain a representative sample within a single experimental study [14,15]. Therefore, the accessible population for this study will be limited to lower form students from two secondary schools located in Guar Chempedak, Kedah and Cheras, Kuala Lumpur respectively. The lower form secondary school students selected as the study sample are intended to provide initial exposure and strengthen their understanding of the importance of maintaining safety while in the science laboratory [16]. The sample size should be ten percent of the population size to avoid the generalization issues [17]. In this quasi-experiment design study, there were a total of 104 secondary school students from two secondary schools in Guar Chempedak and Cheras. The study consists of two groups: the experimental group, which receives instructions using a comic as additional resources, and the control group, which receives traditional learning instructions. Out of 104 respondents: 52 students are in the treatment group, and 52 students are in the control group.

2.3 Instrumentation

The instrument used in this study consists of two instruments, namely the Achievement Test, and the comic instruments '*Komik Makmal Sains*'. The Achievement Test contains 20 items of multiple-choice questions that will be adapted and adopted from the Science laboratory safety aspects i.e., laboratory rules, safety measures, and emergency assistance [18]. This test was used to determine the students' achievement in the pre- and post-test. The questions symbolize the levels of the cognitive domain of Bloom's Taxonomy. Questions of low level and high level were included in the

test. There was a total of 16 high level questions, whereas the rest of the questions consisted of low order thinking questions. The items in the Achievement Test were validated by two experienced Science secondary school teachers. The pre-test was conducted a week before the intervention began, meanwhile the post-test was conducted a week after the intervention was completed. The educational comic of *'Komik Makmal Sains'* in this study was designed and developed with four sections based on the Science laboratory safety aspects i.e., laboratory preparations, disposal of waste materials, laboratory accidents, and fire extinguishers by a professional cartoonist. Upon creation of the comic, the laboratory safety aspects in the outline were evaluated and validated by an expert evaluator from the Department of Occupational Safety and Health, Faculty of Industrial Science and Technology, Universiti Malaysia Pahang. Figure 2 shows the illustration of *Komik Makmal Sains* that has been developed.

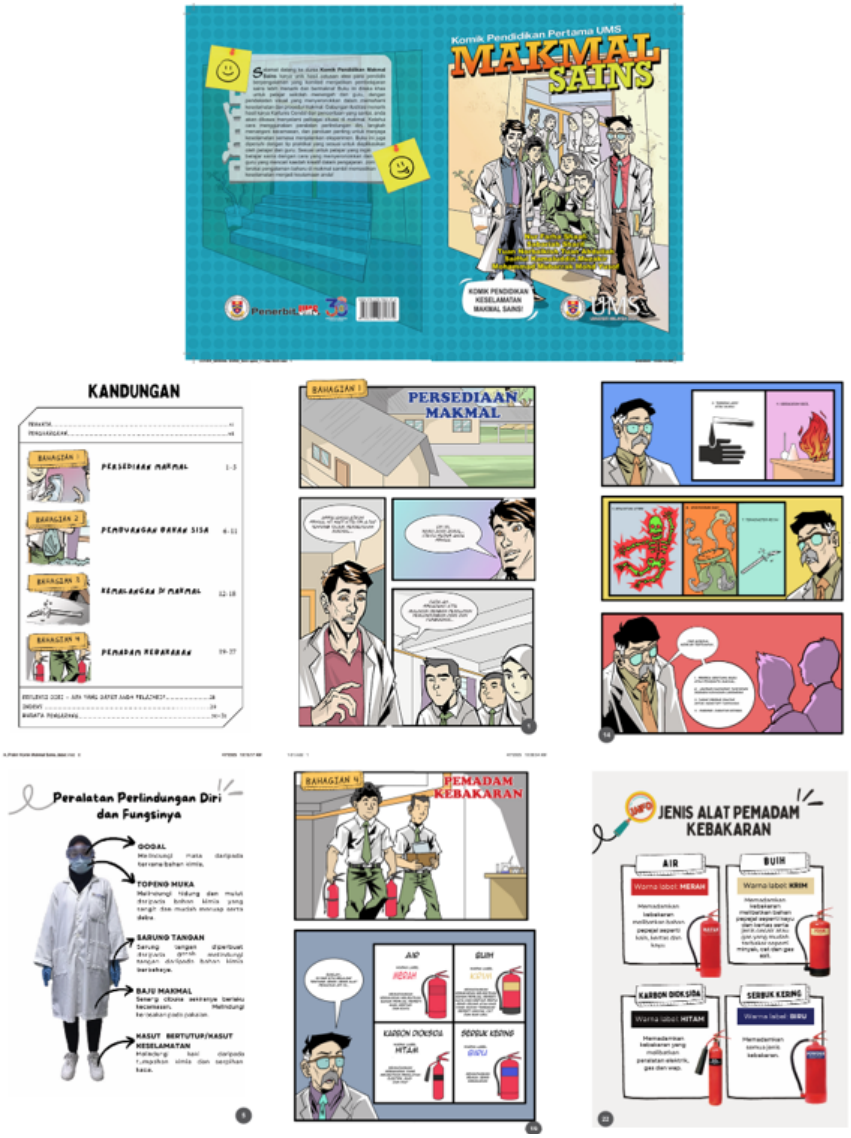

Fig. 2. Illustrations of '*Komik Makmal Sains*'

3. Results

Based on the Table 1 and Table 2, the results show that $t(51) = -1.00$, *sig.* value = .32, $p > .05$. Therefore, the null hypothesis is not rejected. This means there is no significant difference in Science

Laboratory Safety achievement between the control group (*M* = 12.04, *SD* = 5.95) and the treatment group (*M* = 12.08, *SD* = 5.93) before conducting the conventional classroom teaching and the science laboratory comic intervention. Therefore, the null hypothesis states that there is no significant difference in the mean scores of science laboratory safety achievement between the control group and the treatment group before the implementation of the teaching, is rejected. This suggests that both groups started at a similar level of understanding regarding laboratory safety, as reflected by their mean scores (control group: M = 12.04, SD = 5.95; treatment group: M = 12.08, SD = 5.93). This baseline similarity is essential for validating the impact of the intervention by ensuring that any post-test differences are not due to pre-existing disparities in knowledge.

Table 1
Mean and standard deviation of the pre- and post-tests for the control group

Control group	Mean (*M*)	Standard deviation (*SD*)
Pre-test	12.04	5.95
Post-test	12.08	5.93

Table 2
Paired samples t-test of pre- and pots-tests for the control group

Pre-and post-tests (control group)	Paired differences				Significance			
			95% CI of the difference					
	M	*SD*	Lower	Upper	*t*	*df*	One-sided *p*	Two-sided *p*
	-.038	.277	-.116	.039	-1.00	51	.161	.322

Besides, result in Table 3 and Table 4 shows that *t*(51) = -1.00, *sig.* value = .001, *p* < .05. Therefore, the null hypothesis is rejected. This means there is a significant difference in science laboratory safety achievement between the control group (*M* = 13.96, *SD* = 5.78) and the treatment group (*M* = 30.92, *SD* = 5.57) after conducting the conventional classroom teaching and the science laboratory comic intervention. Therefore, the null hypothesis states that there is no significant difference in the mean scores of science laboratory safety achievement between the control group and the treatment group after the implementation of the teaching, is rejected. Therefore, the science laboratory safety comic is effective in enhancing students' understanding in science laboratory safety. The significant improvement in the treatment group's scores compared to the control group after the intervention suggests that the comic-based approach had a positive and meaningful impact on learning outcomes. This indicates that the science laboratory safety comic had a significant positive effect on students' understanding of laboratory safety. The notable increase in scores for the treatment group strongly suggests that the comic-based approach was effective in enhancing students' knowledge and understanding, thus supporting its use as an engaging and impactful educational tool.

Table 3
Mean and standard deviation of the pre- and post-tests for the treatment group

Treatment group	Mean (M)	Standard deviation (SD)
Pre-test	13.96	5.78
Post-test	30.92	5.57

Table 4
Paired samples t-test of pre- and pots-tests for the treatment group

Pre-and post-tests (treatment group)	Paired differences				Significance			
			95% CI of the difference					
	M	*SD*	Lower	Upper	*t*	*df*	One-sided *p*	Two-sided *p*
	-16.96	4.70	-18.27	-15.66	-26.06	51	.001	.001

Based on the findings presented in Tables 5 and 6, there is a statistically significant difference between the mean scores of the pre-test and post-test for both the control and treatment groups. Specifically, the paired samples t-test results indicate a significant improvement in the post-test scores (t = -24.05, p = .001) compared to the pre-test scores (t = -2.53, p = .015). Notably, the treatment group, which was exposed to the educational comic '*Komik Makmal Sains'*, demonstrated a higher mean score improvement than the control group. This suggests that the comic was effective in enhancing students' understanding of science laboratory safety. The data supports the conclusion that integrating educational comics into science education can positively influence students' comprehension of safety practices in the science laboratory setting.

Table 5
Mean and standard deviation of the pre-tests for the control and treatment groups

Group	Mean (*M*)		Standard deviation (*SD*)	
	Pre-test	Post-test	Pre-test	Post-test
Control group	12.04	12.04	5.95	5.95
Treatment	13.96	13.96	5.78	5.78

Table 6
Paired samples t-test of pre-test for the control and treatment groups

Control & treatment groups)	Paired differences				Significance			
			95% CI of the difference					
	M	*SD*	Lower	Upper	*t*	*df*	One-sided *p*	Two-sided *p*
Pre-test	-1.923	5.48	-3.45	-.40	-2.53	51	.007	.015
Post-test	-18.85	5.65	-20.42	-17.27	-24.05	51	.001	.001

4. Conclusions

In conclusion, the findings of this study demonstrate that the use of educational comics, specifically *Komik Makmal Sains*, has a positive impact on enhancing secondary school students' understanding of science laboratory safety. The significant difference between pre-test and post-test scores in the treatment group indicates that comics can be an effective instructional tool, promoting better comprehension of essential safety procedures in the science lab. This suggests that incorporating visual and narrative elements into educational materials can increase student engagement and knowledge retention. Ultimately, the study affirms that comics are *not just for laughs*, but they hold meaningful value in education, particularly in teaching science lab safety, where their role extends beyond entertainment to becoming a powerful medium for learning.

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