



Innovation of Bulletin Media in the Form of Pocket Book to Improve Students' Conceptual Understanding of Green Chemistry

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Abstract: Bulletins in the form of pocketbooks are one solution to help students master the conceptual understanding of green chemistry material in the emancipated curriculum. This research aims to develop a bulletin in the form of a pocketbook to increase students' understanding of concepts. Analysis, design, development, implementation, and evaluation are all included in the ADDIE model, which is used in this research together with the research and development technique. The sampling technique used simple random sampling. The population was 10th-grade students of senior high school in Banda Aceh. The results of the student response questionnaire show that the bulletin's attractiveness in the form of a pocketbook is 84.29%. The innovation of a bulletin in the form of a pocketbook has a good concept understanding ability based on the t-test value of $0.001 < 0.05$. This research concludes that the bulletin in the form of a pocketbook is more effective than textbooks in teaching green chemistry. Bulletins in the form of practical and appropriate pocketbooks can improve students' understanding of concepts. Using bulletins in pocketbooks can be a reference and achievement for chemistry teachers' learning in learning activities in the emancipated curriculum.

Keywords: bulletin, pocket book, green chemistry, conceptual understanding

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INTRODUCTION

The emancipated learning curriculum emphasizes essential material according to the ability of students based on their characteristics, needs, learning styles, and talents (Nursyaidah et al., 2023). The emancipated curriculum implemented green chemistry as a new material in chemistry learning activities, as much as 97.75% based on previously conducted research with students unfamiliar with green chemistry (Sari & Atun, 2023; Anisa & Mitarlis, 2020). The concept of green chemistry was first coined by Anastas and Williamson (1998) in connection with organic chemistry; the appearance of this material in high school is caused by environmental problems such as air pollution, so action is needed to apply the 12 principles of green chemistry (Marco et al., 2019; Martinez et al., 2022; Noor, 2023; Rodriguez et al., 2023).

The American Chemical Society sees green chemistry as innovation, new ideas, and revolutionary progress; in Andraos and Dicks' (2012) review introducing students to green chemistry ideas, for example, introduction into the curriculum, textbooks, and other learning materials (Ciriminna et al., 2024; Savec & Mlinarec, 2021). Education today requires mastery and understanding of the material, but students can solve any existing problems and produce a learning environment that encourages critical thinking in discussions together (Fors et al., 2023; Uliyandari et al., 2021). Green chemistry is the science of chemistry, designing products that are not harmful to the environment; a lack of understanding of this material can make students in the learning process (Izzania et al., 2024; Locatelli et al., 2023). Green chemistry is essential in learning for a sustainable future where developing products that are environmentally friendly and safe (Bodlalo et al., 2013). The factor of low understanding is caused by disinterest in repeating the subject matter and a lack of understanding of the problem, where green chemistry generally discusses theories and concepts (Puri & Perdana, 2023; Rahmah et al., 2023). According to 81.00% of respondents, green chemistry is a challenging subject that can be brought on by factors such as poor learning outcomes, students' lack of comprehension, and unattractive teaching materials (Suci & Zainul, 2023).

The availability of teaching materials is an essential factor in learning challenges; the issue is that several instructional materials continue to employ words and black-and-white visuals, so media innovation is needed to improve students' understanding (Amanda et al., 2023). Although teaching materials aid students in their education, most teachers still use the internet and textbooks for supplementary information (Fandi et al., 2023; Syahmani et al., 2022). Therefore, the current needs of students are in the form of media that can increase the

speed of understanding to improve learning outcomes (Ahmar et al., 2023). Media has an essential part in learning activities, including (1) clarifying the theme being discussed, (2) learning complex concepts, (3) helping students improve understanding, (4) and generating motivation (Lena et al., 2020). For the media to be utilized properly, it is necessary to have skills in obtaining, reading, and using it (Ningsih & Jha, 2021). Bulletin is one of the media options that provide real-world information to support students to learn independently and improve thinking skills, while the use of pocketbooks is effective in small size and practical to carry anywhere (Hidayah & Ridianingsih, 2022; Munawaroh et al., 2023; Taufik, 2023).

The observation at a senior high school in Banda Aceh shows that students are not familiar with being given problems and only receive information from the teacher, so they lack understanding of the concepts they have. Students need innovative learning media that summarizes the material's content to facilitate understanding and can be interesting to read; previously, teachers used textbook teaching materials. Textbooks that are large and thick make students not interested in reading. The results of daily tests on green chemistry material are still relatively low; some students get scores of 50, 57, 62, 60, and 64. In 21st-century education, learning is a process teachers design to maximize students' potential and ability regarding critical thinking, creativity, problem-solving, and curriculum comprehension (Salmia et al., 2023). Based on these facts, bulletin innovation in the form of pocketbooks is an effort that can be made to increase learning resources and make the learning process enjoyable (Muzzalifa & Oktaviani, 2021).

For high school students in Indonesia, understanding is a skill that can help increase intelligence, creativity, and innovation in obtaining information in the current era, not just using textbooks as a learning medium (Annisa & Susanti, 2024). Samuel (2024) shows that the influence of media is a source of cognitive achievement and students' interest in learning chemistry during learning activities. The purpose of the bulletin is as a resource for readers, including students and teachers, and the findings of bibliometric studies show that the theme of chemistry education bulletins is the most trending subject in learning activities (Ahmar & Azzajjad, 2024). The results of achieving learning completeness using bulletins were 76.47%, so there is a need for learning media that is appropriate to today's times with a more attractive appearance and makes students avoid the problem of misunderstanding concepts when taking part in learning. (Rizkia et al., 2021; Nurmala, 2024). The level of ability of each student is different; the use of bulletin learning media in the form of a pocketbook makes it easier to understand the concepts and skills of working together in learning to solve problems contained in the green chemistry material chemistry (Hasibuan et al., 2024; Yarmasi, 2024).

Based on the previous description, previous research has examined the innovation of bulletins in the form of pocketbooks in increasing students' understanding of concepts in chemistry learning activities. However, research regarding bulletin innovation in the form of a pocketbook related to green chemistry has not been found because the emancipated curriculum has only been running for one year in class 10 at a senior high school in Banda Aceh. Therefore, this research aims to assess the feasibility of developing an innovative bulletin in the form of a pocketbook related to green chemistry material that can improve students' understanding of concepts. Bulletins in the form of pocketbooks require students to actively study available problems so that students have a higher curiosity. It is hoped that the results of this research will benefit teachers and students and add learning media references to the emancipated curriculum.

METHODS

The ADDIE model was employed in this study along with the research and development (R&D) method (Sugiyono, 2019). This research yields products in the form of pocketbooks for bulletin media. In class 10 at senior high school in Banda Aceh, the course of the book bulletin medium—pocketbooks filled with information on green chemistry—was introduced. The sampling method used in this project is probability sampling with a simple random sampling technique because all 10th-grade students consist of 8 classes totaling 288 people consisting of regular classes. This research design was with posttest-only control at the end of the learning activity by giving a cognitive test of concept understanding. This research innovation's data analysis method describes all validators' comments and recommendations while critiques, recommendations, and enhancements are being made in small groups (Asma, 2023).

Analyzing, Designing, Developing, Implementing, and Evaluating are the phases of ADDIE (Sugiyono, 2019). Based on the ADDIE stages, such as (1) The analysis stage collects information based on needs and characteristics based on chemistry teacher observations and interviews, (2) the design stage is designing a bulletin media product in the form of a pocketbook and preparing instruments, in the form of creating a teaching module with three meetings in the experimental and control classes using a problem-based learning model with 90 minutes each meeting, preparing a concept understanding posttest which has been designed based on Bloom's cognitive level according to indicators of green chemistry material with a total of 20 questions, (3) In the development stage, an expert validation test was carried out by high school teachers and chemistry lecturers in the form of a checklist using a Likert scale and a small group trial of 15 respondents to determine the

attractiveness of the product that had been developed based on a student response questionnaire. (4) the implementation stage is carried out in large groups with a sample of class 10. As many as 72 students of class 10-1 are applied as an experimental class, and 10-2 is used as a control class. (5) the evaluation stage obtained research results by giving concept understanding tests to students. The results of concept understanding analysis are presented in criteria: very high, high, medium, low, and very low. The level of concept understanding criteria are shown in Table 1.

Table 1. Criteria for conceptual understanding ability

Conceptual Understanding Score (%)	Criteria
90-100	Very High
75-89	High
55-74	Medium
40-54	Low
<39	Very Low

(Yanti et al., 2020)

The students' ability test is then analyzed using the percentage of students' scores. Criteria are used to see the ability of conceptual understanding. After implementing normality and homogeneity tests, the evaluation results were followed by a t-test to determine the conceptual understanding of implementing the bulletin media in the form of a pocketbook. The t-test answers whether bulletin media innovation, such as pocketbooks in the experimental class, can overcome students' comprehension of green chemistry concepts. The normality test determines whether the data from the experimental and control classes are normally distributed (Utama & Sudarsana, 2023). Next, we will conclude whether the innovation of bulletin media as a pocketbook can increase students' understanding of green chemistry concepts.

RESULT AND DISCUSSION

Students can study a summary of the material on green chemistry at any time using bulletin media in the form of pocketbooks. Additionally, the pocket books that serve as bulletin media are attractively packaged and relate to everyday topics in order to support students' understanding of the concept of green chemistry. The analysis stage, which involved watching class 10 students at a senior high school in Banda Aceh learn chemistry, is the first outcome of the ADDIE stages. In order to gain a general understanding of the state of affairs in schools, observations were made. (a) needs analysis revealed that learning issues appear passive and necessitate new media because school textbooks cannot motivate students to complete assignments and engage in active learning. Senior high school students in Banda Aceh class 10 use the emancipated curriculum. Characteristic analysis (b) shows that students do not participate in class; instead, they merely listen to the teacher explain things. Under the direction of the emancipated curriculum, researchers created a pocketbook-style bulletin of green chemistry information.

The design stage, which takes the shape of a pocketbook or bulletin medium, is created using the Canva application. It measures 9 cm by 13 cm and uses an amaranth font size of 12 to draw readers. The idea is that this will help students better understand the concept of green chemistry when solving problems. The bulletin medium is a pocketbook with the following contents: cover, CP, TP, concept map, evaluation, summary, and bibliography of green chemistry material. Environmental issues are connected to the green chemistry summary material and illustrative photos sourced from Canva. Examples from daily life and bulletin materials, such as pocketbooks compiled based on applying the 12 green chemistry principles, can enhance comprehension of the material covered in green chemistry classes (Zahari & Taha, 2021). Figure 1 shows the bulletin layout in the format of a pocketbook. The instruments designed include creating expert assessment validation sheets; material experts and media experts must validate media developed by the emancipation curriculum.

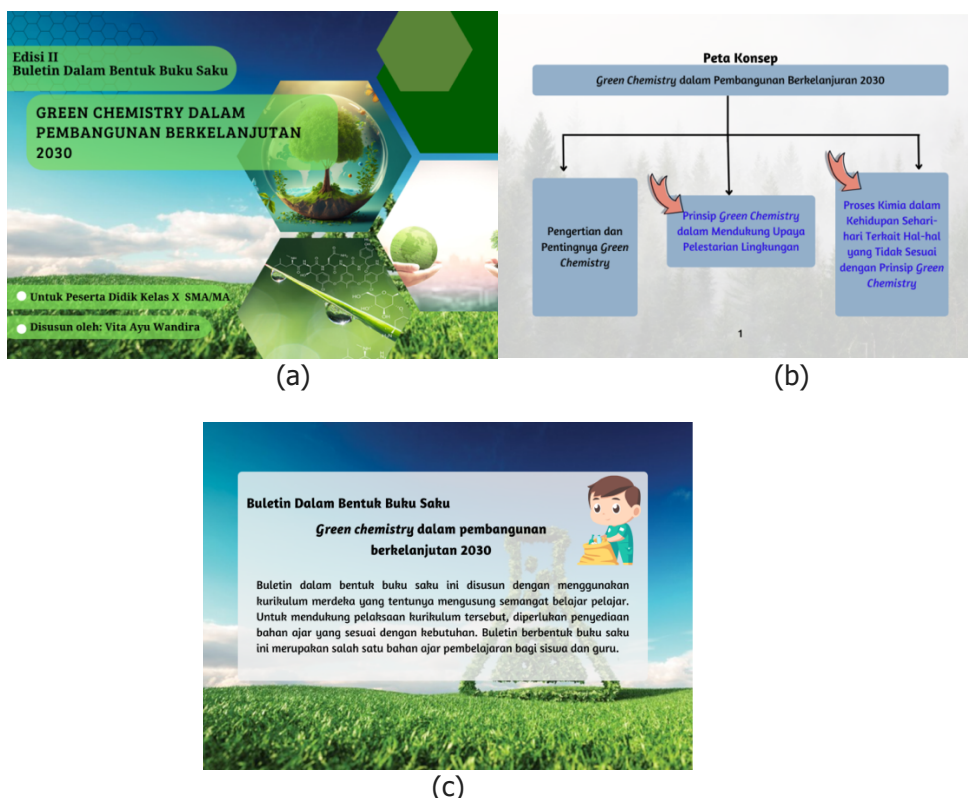


Figure 1. Bulletin layout design in pocketbook form
(a) cover, (b) mind map, and (c) bibliography

At the development stage, pocketbooks designed as bulletin media were created based on validator recommendations and feedback. The bulletin medium, which took the shape of pocketbooks, was created following three rounds of revisions before the product's viability was evaluated. Table 2 displays the findings of the material and media expert assessment. The validation results from material expert validators were 95.49%, and those from media experts were also 95.68%. As per the experts, the material developed for the bulletin media, a pocketbook containing green chemistry, was deemed highly feasible for educational activities. Before being applied to class 10, a small group trial using bulletin media in pocketbooks was carried out on respondents who had studied green chemistry material.

Table 2. Material and media expert suitability assessment

Material Expert			Media Expert		
Validator	Score (%)	Criteria	Validator	Score (%)	Criteria
I	96.96	Very Suitable	I	98.15	Very Suitable
II	97.92	Very Suitable	II	97.22	Very Suitable
III	89.58	Suitable	III	91.67	Very Suitable
Mean	95.49	Very Suitable	Mean	95.68	Very Suitable

The trial consisted of 15 students in class 11 KP-1. By providing a response questionnaire, students respond to the created pocketbooks that serve as the bulletin medium. 84.29% of the criteria yielded interesting student response questionnaire results. All students agreed that the bulletin media, in the form of pocketbooks, is portable and can aid in understanding the concept of green chemistry, while 2.14% found it uninteresting. The students also reported that the writing is less creative, and the content is more condensed to prevent readers from becoming bored. The response form from the students helps determine how visually appealing the pocketbooks designed with a Likert scale are as bulletin media. The bulletin medium, a pocketbook, is created with the reader in mind by using clear, concise language, well-structured sentences, and consistent use of terms and symbols (Lolita & Ikhsanudin, 2023). Students prefer engaging reading materials that lack a lot of colour or detail and are created using an emancipated curriculum to help them strengthen their critical thinking abilities (Setiyaningrum & Suratman, 2020; Sukadari et al., 2023). As a result, the researchers continued with the large group test stage after fixing the mistakes in the bulletin media, which took the form of pocketbooks.

A large group test was conducted during the implementation stage, with 36 respondents per class. While the control class received a textbook, the experimental class used a bulletin in the form of a pocketbook.

Students receive a concept understanding test in the form of a posttest question following the conclusion of the learning process. This stage was carried out to obtain data regarding the students' green chemistry concept understanding test ability to experience the advantages of using bulletin media as a pocketbook by categorizing the concept understanding test with the lowest to very high percentage scores. The test for understanding the concept of green chemistry is given in multiple-choice questions with 20 questions suitable for study during learning activities.

The posttest results of comprehending the concepts of the two classes that were covered were obtained for the evaluation stage. Table 3 displays the findings of the posttest on comprehension of the concepts taught in the experimental and control groups. The experimental class received moderate criteria with values of 65 and 70, high criteria of 75, 80, and 85, and very high criteria of 90. In contrast, the control class received moderate criteria with values of 55, 60, 65, and 70, high criteria with values of 75, 80, and 85, and very high criteria with a value of 90. Three students were in the experimental class, and the control group, consisting of eleven students, had a lower completeness score than the required seventy-seven. According to the posttest results, students in both classes scored as low as 55 and as high as 90. The number of KKTP determined in class 10 chemistry was 70; in the experimental class, three students did not complete it, while in the control class, there were 11 students who did not complete it.

Table 3. Conceptual Understanding Score

Experiment Class		Control Class	
Total of Students	Criteria	Total of Students	Criteria
8	Medium	22	Medium
25	High	12	High
3	Very High	2	Very High

Students with strong conceptual understanding abilities stand a good chance of answering questions correctly (Almubarak et al., 2023). Students who struggle with chemistry and receive a low grade because they do not fully grasp the question are more likely to struggle with conceptual understanding (Mulyatna et al., 2020). Finding the 12 principles of green chemistry—namely, (1) preventing waste and (2) maximizing atomic economic value—proved to be a challenge for the majority of students. Safer chemical synthesis, safer chemical design, safer use of solvents and auxiliaries, students are still confused about determining these three principles in applying environmental problems: energy efficiency design, use of renewable raw materials, prevention, and prevention of accidents turning into environmental problems are just a few of the initiatives that need to be taken. This relates to students not working on problems regularly and instead just listening to the teacher explain them, which prevents them from understanding the problem. By studying green chemistry material, students learn to think at a higher level to find solutions to environmental problems (Constable, 2021). Figure 2 compares the concept understanding posttest results for the two classes.

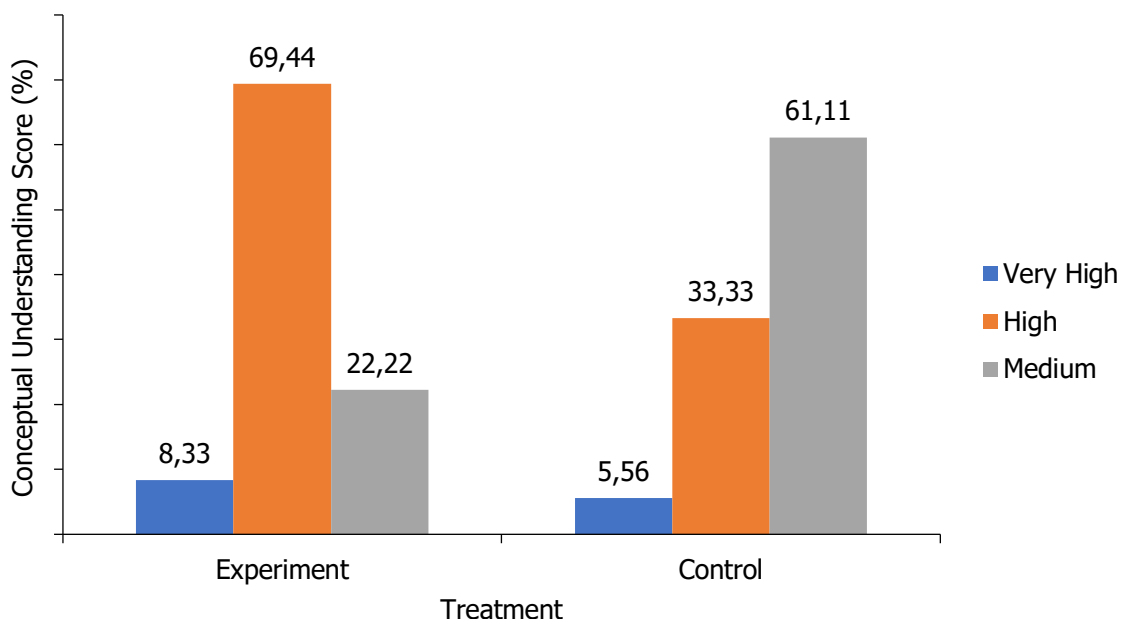


Figure 2. Comparison of conceptual understanding test results

According to the data derived from Figure 2 above, the experimental class was able to achieve a posttest of concept understanding of 64.44% high criteria using the bulletin media in the form of a pocketbook on green chemistry material, whereas the control class used the textbook, which obtained 61.11% medium criteria. Since green chemistry is frequently encountered in daily life, students are enthusiastic and encouraged to respond to inquiries from the teacher and other friends when they discuss the evaluations that are available in the bulletin media in the form of pocketbooks. Pocket books that serve as bulletin media promote awareness of environmental pollution incidents. This demonstrates how the usage of pocketbooks as bulletin media affects learning activities. According to the explanation above, it is evident from the criteria met that the experimental class performed better on the posttest when it came to concept understanding than the control group.

Students who actively participate in learning activities have a better understanding (Rahayu et al., 2023). Individual differences in conceptual understanding depend on their intelligence; there is no particular intelligence as a measure of success as long as students are active in the learning process (Kurniawan et al., 2023). The research findings confirm that the appropriate use of learning media gives a positive appearance to school subjects, requiring teachers to be innovative in every learning process (Choirudin et al., 2021). Parawangsa and Listari (2023) show that using bulletin media in the form of pocketbooks increases the value of student learning outcomes by 81.67%. Table 4 shows the findings of the homogeneity and normalcy tests.

Table 4. Result of Normality and Homogeneity

Normality Shapiro-Wilk				
Class Group	Normality	α	Description	
Experiment	0.065	0.05	Normal	
Control	1.101	0.05	Normal	

Homogeneity Levene				
	F	Sig.	α	Description
Equal variances assumed	2.581	0.113	0.05	Homogenous

Table 4 shows that the normality test uses Shapiro-Wilk because the sample size is below 100 (Permana & Ikasari, 2023). The posttest scores of the experimental and control groups were used to determine the homogeneity and normality of the data. The Shapiro-Wilk test $> \text{sig. } \alpha$ 0.05 indicated that both classes' data was homogeneous, as did the Levene homogeneity test. The t-test is based on sig (2-tailed) < 0.05 , which means that H_0 is rejected (Domu et al., 2023). The experimental class is $0.065 > 0.05$, and the control is $1.101 > 0.05$, according to the normality test in Table 4, which is performed with the SPSS 22 software. It is concluded that both sets of data are normally distributed. If the homogeneity test yielded a result of $0.113 > 0.05$, then both classes' data are homogeneous. The independent sample t-test is used by researchers to support their findings and demonstrate significant differences in students' conceptual understanding between experimental and control classes (data meets normal assumptions). The following hypothesis (H_0): Concept understanding among students taught through pocketbooks or bulletin boards is not superior to students taught through textbooks. The Environmental Protection Agency (EPA) has acknowledged the significance of introducing green chemistry materials, including textbooks that are not commonly available (Tejas et al., 2023). However, learning green chemistry requires applying the 12 principles to help understand the concepts in solving the problems given by the teacher (Mohammed et al., 2020). According to the study's findings, some students are still unsure how to apply the 12 green chemistry principles to the problems the teacher assigns. Table 5 shows the independent sample t-test results.

Table 5. Independent Sample t-test

		t	df	Sig (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
Score	Equal Variances assumed	3.631	70	.001	7.083	1.951	3.193	10.974
	Equal variances not assumed	3.631	62.535	.001	7.083	1.951	3.185	10.982

Based on the findings, H_0 is rejected because both classes received a significant posttest sig (2-tailed)

value of $0.001 < 0.05$. The idea that students should be taught using bulletin media in the form of pocketbooks is acknowledged by H_1 as better than understanding the concepts taught with textbooks. Bulletin media in the form of pocketbooks can be a condensed channel of information in presenting subject matter and increasing students' understanding in learning activities compared to textbooks whose material content is incomplete or not by what is taught, large, thick, and heavy so it is difficult to use anywhere (Erawati et al., 2023; Rizkiyah & Albadri, 2023). Bulletin media in the form of a pocketbook can encourage students to think. However, it is not as interactive as sophisticated online learning, and compared to complex web-based technology, selecting bulletins in the form of a pocketbook is more accessible in situations where resources are limited and provide material information in an organized sequence so that allows readers to understand concepts gradually (Ahmar & Azzajjad, 2024). The bulletin media in the form of a green chemistry pocketbook has been adapted to the emancipated curriculum to encourage critical and cooperative thinking, and the success factor is influenced by students' emancipated learning using the help of learning media (Purnomo et al., 2023).

The results of this research have implications for chemistry teachers regarding the emancipated curriculum, which contains green chemistry material. The application of bulletin media in the form of a pocketbook is very interesting to use as a reference when students have a low understanding of concepts or interest in reading. By understanding the concept of green chemistry during learning activities, teachers can help students gain the proper understanding. This can positively influence students because green chemistry is generally theoretical and conceptual. Apart from that, it encourages the development of students' thinking abilities through problem-solving available in bulletin media in the form of pocketbooks so as to provide a helpful contribution to teachers in implementing effective learning media to obtain material information in schools that use the emancipated curriculum.

CONCLUSION

Organizational Citizenship behavior among university employees in Indonesia shows that the dimensions of altruism and sportsmanship dominate it, while the influence of the dimensions of organizational compliance and loyalty is only in the medium category. Meanwhile, organizational citizenship behavior among university employees in Malaysia shows that altruism, sportsmanship, organizational compliance, and loyalty have a strong influence. This research implies that the application of OCB to employees at universities in Indonesia is more focused on individual citizenship behavior and the need to internalize organizational regulations so that employees consciously comply with them, even under supervision, and can put the organization above themselves. Educational organizations in Malaysia can develop OCB to understand their employees better so that OCB performance increases. Employee behavior in helping colleagues who are having difficulties and providing assistance and support for new employees is a clear indication of the work environment that it can increase a positive climate among employees. Employees will be more polite and cooperate with others, which will create a more pleasant work environment.

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