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Multimedia Learning with a Collaborative Emergency Bag Packing Task for Volcanic Eruption Preparedness Among Primary School Students in Indonesia

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Abstract

Volcanic preparedness education for primary school students needs to connect factual knowledge with practical decisions. However, immediate written assessments may overlook difficulties in applying that knowledge, particularly when baseline scores are already high. This study aimed to describe immediate changes in volcanic eruption preparedness knowledge and identify practical difficulties following a multimedia learning intervention incorporating a collaborative emergency bag packing task. A preexperimental one-group pretest and posttest design involved 33 students from Grades IV and V at SD Negeri Wonogiri, Magelang Regency, Central Java, Indonesia. The 120-minute intervention combined slides, an educational video, an interactive quiz, and a practical task inspired by selected elements of project-based learning. Knowledge was assessed using the same 20-item true-or-false test before and after the session. Group means, relative change, and normalized gain were analyzed descriptively, complemented by facilitator field notes. The overall mean increased from 92.27% to 93.45%, representing a relative gain of 1.28% and a normalized gain of 0.15. Grade IV scores increased from 92.50% to 95.50%, whereas Grade V scores decreased from 92.00% to 91.00%. Some students had difficulty prioritizing essential evacuation supplies despite high written scores. Written knowledge assessments and practical tasks provided complementary information about preparedness learning needs. High baseline scores limited the measurable scope for improvement. The absence of a comparison group and delayed assessment prevented firm conclusions about intervention effectiveness or lasting preparedness.

Keywords: volcanic eruption preparedness, multimedia learning, emergency bag, disaster education, primary school students

Pembelajaran Multimedia dengan Tugas Kolaboratif Menyiapkan Tas Siaga Bencana untuk Kesiapsiagaan Erupsi Gunung Berapi pada Siswa Sekolah Dasar di Indonesia

Abstrak

Pendidikan kesiapsiagaan erupsi gunung berapi untuk siswa sekolah dasar perlu menghubungkan pengetahuan faktual dengan keputusan praktis. Namun, penilaian tertulis yang dilakukan secara langsung dapat mengabaikan kesulitan dalam menerapkan pengetahuan tersebut, terutama ketika skor awal sudah tinggi. Penelitian ini bertujuan untuk mendeskripsikan perubahan langsung pada pengetahuan kesiapsiagaan erupsi gunung berapi dan mengidentifikasi kesulitan praktis setelah intervensi pembelajaran multimedia yang menggabungkan tugas kolaboratif menyiapkan tas siaga bencana. Penelitian pra-eksperimental dengan desain one-group pretest and posttest ini melibatkan 33 siswa kelas IV dan V di SD Negeri Wonogiri, Kabupaten Magelang, Jawa Tengah, Indonesia. Intervensi berdurasi 120 menit tersebut menggabungkan salindia, video edukasi, kuis interaktif, dan tugas praktis yang diadaptasi dari elemen-elemen pilihan pembelajaran berbasis proyek (project-based learning). Pengetahuan diukur menggunakan tes benar-salah 20 butir soal yang sama sebelum dan sesudah sesi. Rata-rata kelompok, perubahan relatif, dan normalized gain dianalisis secara deskriptif, dilengkapi dengan catatan lapangan fasilitator. Rata-rata keseluruhan meningkat dari 92,27% menjadi 93,45%, yang menunjukkan peningkatan relatif sebesar 1,28% dan normalized gain sebesar 0,15. Skor kelas IV meningkat dari 92,50% menjadi 95,50%, sedangkan skor kelas V menurun dari 92,00% menjadi 91,00%. Beberapa siswa mengalami kesulitan dalam memprioritaskan

perlengkapan evakuasi yang esensial meskipun memiliki skor tertulis yang tinggi. Penilaian pengetahuan tertulis dan tugas praktis memberikan informasi yang saling melengkapi mengenai kebutuhan pembelajaran kesiapsiagaan. Skor awal yang tinggi membatasi ruang peningkatan yang dapat diukur. Tidak adanya kelompok pembanding dan penilaian tertunda mencegah penarikan kesimpulan yang pasti mengenai efektivitas intervensi atau kesiapsiagaan yang bertahan lama.
Kata kunci: *kesiapsiagaan erupsi gunung berapi, pembelajaran multimedia, tas siaga bencana, pendidikan bencana, siswa sekolah dasar*

INTRODUCTION

Indonesia's location within the Pacific Ring of Fire exposes communities to volcanic hazards, including ashfall, pyroclastic flows, lahars, and hazardous gases (Kahfi et al., 2024). These hazards threaten public safety and can disrupt education, particularly in communities surrounding active volcanoes. Studies concerning Mount Semeru in East Java and volcanic hazards in East Flores illustrate the continuing importance of preparedness education for exposed populations (Bachri et al., 2023; Temu et al., 2025). For primary school students, such education needs to connect knowledge about volcanic hazards with practical actions that can be understood and performed under adult supervision.

Schools provide an important setting for developing preparedness because they offer structured instruction, teacher guidance, and opportunities for collective practice. The Sendai Framework for Disaster Risk Reduction 2015–2030 emphasises the integration of disaster risk knowledge into formal and nonformal education (United Nations Office for Disaster Risk Reduction [UNDRR], 2015). Nevertheless, a review of preparedness among children and families identified continuing challenges in translating educational activities into preparedness outcomes (Ronan et al., 2015). Indonesian studies also highlight the importance of school readiness, community participation, and institutional support in volcanic settings (Humaidie et al., 2025; Isnanto, 2025). These findings indicate a need for learning activities that develop factual understanding while providing opportunities to practise appropriate decisions.

Previous studies have explored multimedia instruction as a means of making preparedness information accessible to young learners. Animated videos have been used in volcanic preparedness education among primary school students near Mount Merapi, while practical educational activities and simulations have been conducted around Mount Semeru (Bachri et al., 2023; Kurniawan & Nirmalasari, 2023; Nuriman et al., 2022). These practices are supported theoretically by the cognitive theory of multimedia learning, which explains how learners select, organise, and integrate relevant verbal and visual information (Mayer, 2024). Research on instructional videos further emphasises directing attention to essential information and limiting unnecessary cognitive demands (Mayer, 2021). However, students' ability to recall information after multimedia instruction does not, by itself, demonstrate their ability to apply that information during an evacuation task.

Practical learning activities can provide complementary opportunities to examine this application. Serious games allow learners to rehearse decisions in a controlled environment, although evidence concerning their effectiveness varies across settings and evaluation designs (Solinska-Nowak et al., 2018). An emergency bag packing task, for example, requires students to distinguish essential supplies from optional belongings and explain their choices. Such activities can reveal difficulties in prioritisation that may remain unnoticed in a written knowledge assessment.

Project based learning (PjBL) offers a related framework for organising learning around authentic problems, collaboration, and tangible products (Kokotsaki et al., 2016). A meta analysis reported positive effects of PjBL on academic achievement, with variation across implementation conditions (Chen & Yang, 2019). In primary science, a study incorporating a volcano experiment into PjBL also reported improved learning outcomes (Sari et al., 2025). These findings support the educational rationale for connecting hazard information with practical tasks. Nevertheless, evidence from complete PjBL programmes cannot be directly extended to a brief activity that incorporates only selected elements of the model.

The local context further supports examining this form of preparedness education. SD Negeri Wonogiri is located in Kajoran District, Magelang Regency, Central Java, within the wider Sindoro and Sumbing volcanic region. Relevant studies have examined community risk around Sindoro and preparedness among hikers, while other studies have addressed schools and communities around

Merapi and Semeru (Hasib & Sumunar, 2016; Suharyadi & Fatmawati, 2025; Humaidie et al., 2025; Bachri et al., 2023). These studies provide useful contextual and educational evidence, but they do not directly explain how Grade IV and Grade V students at the participating school respond to a combined multimedia and emergency bag packing activity.

A further gap concerns how educational outcomes are evaluated. Methodological reviews have identified limitations in evaluations of disaster education for children and highlighted the importance of examining outcomes beyond immediate knowledge acquisition (Johnson et al., 2014, 2016). Written assessments may offer limited information about students' practical choices, while scores close to the maximum leave little room to detect additional improvement. Consequently, a small increase in knowledge scores requires careful interpretation and cannot independently establish whether students are prepared to make appropriate decisions. Descriptive classroom observations can complement these scores by identifying difficulties encountered during a practical task, although they do not substitute for structured performance assessment.

The present study addresses these contextual and evaluative gaps through a single multimedia preparedness session incorporating a collaborative emergency bag packing task. The activity adopted selected PjBL elements: an authentic evacuation problem, a driving question, collaborative decision making, a tangible product, explanation of item choices, and shared reflection. Students addressed the question, "What should we do and bring when we have to evacuate because of an eruption?" However, the 120 minute session did not include an extended cycle of independent inquiry, product development, and revision. The intervention is therefore described as multimedia learning with a collaborative practical task inspired by PjBL.

The contribution of this study is contextual and descriptive. It brings together overall and grade specific knowledge changes with classroom observations of emergency supply selection to identify learning needs that may not be apparent from written scores alone. This combined perspective is relevant to interpreting brief preparedness activities, particularly when high baseline scores may constrain measurable improvement.

This study aimed to describe immediate changes in volcanic eruption preparedness knowledge, overall and by grade, among Grade IV and Grade V students at SD Negeri Wonogiri following the intervention. It also aimed to identify difficulties in applying preparedness knowledge during the collaborative emergency bag packing task through descriptive classroom observation.

METHOD

Research Design

This study used a preexperimental one group pretest and posttest design embedded in a school disaster education programme. The intervention was delivered to intact classes at a single school, without random assignment or a comparison group. The design was used to describe immediate changes in students' preparedness knowledge following the intervention rather than to establish a causal effect.

Setting and Participants

The study was conducted at SD Negeri Wonogiri, a public primary school in Kajoran District, Magelang Regency, Central Java, Indonesia, in September 2025. A total of 36 students were enrolled in the two participating grades: 20 in Grade IV and 16 in Grade V. All students in these grades were invited to participate.

The inclusion criteria were enrolment in Grade IV or Grade V, attendance on the day of the activity, and willingness to participate under the supervision of class teachers. Students who were absent were not included, and no additional exclusion criteria were applied.

Three students, comprising two from Grade IV and one from Grade V, were absent on the day of the activity. The final sample therefore consisted of 33 participants: 18 Grade IV students and 15 Grade V students. All participants completed both the pretest and the posttest. Participant characteristics are presented in Table 2 in the Results section.

Intervention

The intervention consisted of a single facilitated session lasting 120 minutes and combined multimedia instruction with a collaborative emergency bag packing task. It was organised around the driving question, "What should we do and bring when we have to evacuate because of an eruption?"

The elements of project based learning (PjBL) implemented during the session included an authentic preparedness problem, a driving question, collaborative decision making, production of a packed emergency bag, explanation of item choices, and shared reflection. Because the activity was

completed within one session rather than through an extended cycle of inquiry, planning, product development, and revision, it is described as a condensed intervention inspired by PjBL.

A slide presentation introduced the causes of volcanic eruptions, warning signs, self protection measures, and evacuation steps. An educational video presented information about the emergency bag. These activities were followed by an interactive quiz and the "What's in My Bag?" game. During the game, teams selected essential evacuation items from a mixture of essential and nonessential items, packed an emergency bag, and explained their choices.

Five undergraduate anesthesiology nursing students facilitated the session, with class teachers present. Before implementation, the facilitators held a preparatory meeting to review the educational materials, learning objectives, activity sequence, pretest and posttest procedures, and instructions for the emergency bag packing game. The meeting also covered key messages on volcanic eruption preparedness, including warning information, self protection measures, evacuation procedures, and the selection of essential emergency supplies. This preparation aimed to establish a shared understanding of the intervention content and procedures and to support consistent delivery across activities. The stages and time allocation are presented in Table 1.

Table 1. Stages and Time Allocation of the Multimedia Intervention Inspired by PjBL

Stage	***Activity***	***Media or instructional element***	***Duration***
Opening and driving question	Introduction of the facilitators, session objectives, and the driving question about evacuation during a volcanic eruption	Authentic problem and driving question	10 minutes
Pretest	Students individually completed the preparedness knowledge test	Baseline assessment	10 minutes
Content presentation	Presentation of the causes of eruptions, warning signs, self protection measures, and evacuation steps	Slide presentation	20 minutes
Educational video	Presentation of an educational video on the emergency bag	Audiovisual learning material	10 minutes
Interactive quiz	A short oral quiz on key content, with small rewards for correct answers	Formative feedback	10 minutes
"What's in My Bag?" game	Teams selected essential evacuation items, packed an emergency bag, and explained their choices	Collaborative decision making, practical project, and tangible product	40 minutes
Posttest	Students individually completed the same knowledge test	Immediate outcome assessment	10 minutes
Reflection and closing	Joint reflection on the learning activities and appreciation of active participation	Shared reflection	10 minutes
Total			**120 minutes**

Source: Research procedure, 2025.

Instrument

Volcanic eruption preparedness knowledge was measured using a test developed by the research team based on the session content. The test covered the nature and causes of eruptions, warning signs of danger, self protection and evacuation steps, and the contents of an emergency bag.

The instrument consisted of 20 true or false items and was reviewed for content suitability by a nursing lecturer specialising in emergency and disaster nursing. Its psychometric properties were not formally established. The same instrument was administered before and after the session. Scores were calculated as the percentage of correct responses, ranging from 0 to 100.

Facilitators also recorded field notes on students' performance during the emergency bag packing game. These notes provided descriptive information about students' ability to select and prioritise essential evacuation items.

Data Analysis

Mean knowledge scores were calculated separately for each grade and for the whole sample. Overall means were weighted by the number of participants in each grade using the following formula:

$$Overall\ Mean = \frac{(18 \times Grade\ IV\ Mean) + (15 \times Grade\ V\ Mean)}{33}$$

Absolute change was calculated as:

$$Absolute\ Change = Posttest\ Mean - Pretest\ Mean$$

Relative gain was calculated as:

$$Relative\ Gain\ (\%) = \frac{Posttest\ Mean - Pretest\ Mean}{Pretest\ Mean} \times 100$$

Normalized gain was calculated using the formula proposed by Hake (1998):

$$g = \frac{Posttest\ Mean - Pretest\ Mean}{100 - Pretest\ Mean}$$

Nonnegative normalized gains were classified as high when ($g \geq 0.70$), medium when ($0.30 \leq g < 0.70$), and low when ($0 \leq g < 0.30$), following Hake (1998). Negative normalized gains were reported separately as decreases.

Only group mean scores were analysed; therefore, no inferential statistical tests were performed. Findings were interpreted descriptively, taking into account the high baseline scores and the limited room for improvement. Field notes were summarised descriptively to identify difficulties observed during the emergency bag packing task.

Ethical Considerations

This study was approved by the Health Research Ethics Committee of the Faculty of Medicine, Universitas Sebelas Maret, Surakarta, Indonesia (Approval No. 252/UN27.06.11/KEP/EC/2024). The activity was conducted with permission from the principal of SD Negeri Wonogiri, and students participated with the knowledge and supervision of their class teachers. No personally identifying data were collected, and no photographs of students are included in this article.

RESULTS AND DISCUSSION

Participant Characteristics

Of the 36 students enrolled in Grades IV and V, 33 participated in the activity and completed both assessments. Grade IV students accounted for 54.5% of participants, while Grade V students accounted for 45.5% (Table 2).

Table 2. Characteristics of Participants by Grade

Grade	*Frequency (n)*	*Percentage (%)*
Grade IV	18	54.5
Grade V	15	45.5
Total	**33**	**100.0**

Source: Research data, 2025.

Changes in Preparedness Knowledge

The reported pretest and posttest means are presented in Table 3 and Figure 1. Baseline knowledge scores were high in both grades. The weighted overall pretest mean was 92.27%, leaving approximately 7.73 percentage points available for improvement.

Following the intervention, the weighted overall mean increased to 93.45%. This represented an increase of 1.18 percentage points, a relative gain of 1.28%, and a normalized gain of 0.15, classified as low.

The pattern differed between grades. The Grade IV mean increased from 92.50% to 95.50%, corresponding to an increase of 3.00 percentage points, a relative gain of 3.24%, and a normalized gain of 0.40, classified as medium. The Grade V mean decreased from 92.00% to 91.00%, corresponding to a decrease of 1.00 percentage point, a relative change of −1.09%, and a normalized gain of −0.13. These results describe changes in group means and do not establish statistically significant differences.

Table 3. Pretest and Posttest Knowledge Scores by Grade

Group	*n*	*Pretest (%)*	*Posttest (%)*	*Difference (percentage points)*	*Relative change (%)*	*Normalized gain*	*Category*
Grade IV	18	92.50	95.50	+3.00	+3.24	0.40	Medium

Grade V	15	92.00	91.00	−1.00	−1.09	−0.13	Decrease
Overall	33	92.27	93.45	+1.18	+1.28	0.15	Low

Source: Research data, 2025.

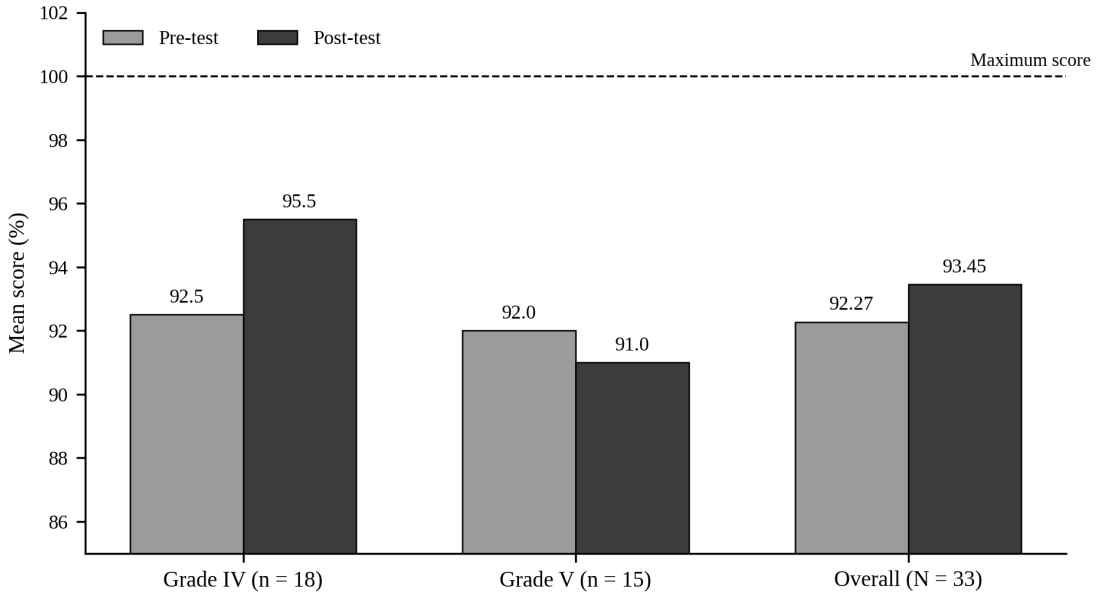


Figure 1. Mean Pretest and Posttest Knowledge Scores by Grade and Overall

Source: Research data, 2025.

Note. The vertical axis begins at 85%. The dashed line indicates the maximum possible score of 100%. The truncated axis makes small differences more visually prominent; interpretation should therefore refer to the numerical values.

Observations During the Emergency Bag Packing Game

Field notes indicated that students participated actively in the "What's in My Bag?" game and collaborated to complete the packing task. However, some students had difficulty distinguishing essential evacuation items from nonessential items.

This observation suggests a possible gap between factual knowledge and its application in a practical preparedness task. High written test scores did not necessarily correspond to consistent prioritisation of emergency supplies. Because no structured performance scores or counts of specific selection errors were available, the observations cannot establish the frequency or extent of these difficulties.

Interpretation of Knowledge Changes

The high baseline scores are central to interpreting the results. With an overall pretest mean above 92%, the assessment offered limited room to detect further improvement. The small overall increase is therefore compatible with a ceiling effect. However, the available data cannot determine whether this primarily reflected strong prior knowledge, relatively easy test items, or both.

The findings should not be interpreted as conclusive evidence that the intervention was effective or ineffective. Previous methodological work has highlighted limitations in evaluations of disaster education for children, particularly when effectiveness is judged mainly through immediate changes in knowledge scores (Johnson et al., 2014). Normalized gain expresses improvement relative to the remaining possible increase, but it does not remove limitations arising from an easy instrument, repeated testing, or the absence of a comparison group.

The medium normalized gain in Grade IV indicates that the reported mean increase represented a substantial proportion of the remaining possible improvement for that group. The direction of this change is consistent with previous Indonesian studies examining audiovisual instruction and practical activities in volcanic preparedness education (Bachri et al., 2023; Kurniawan & Nirmalasari, 2023; Nuriman et al., 2022). Nevertheless, differences in participants, instruments, and programme delivery limit direct comparison.

The Grade V mean decreased by one percentage point. Without individual paired scores or information about score variability, it is not possible to determine whether this represented a consistent pattern among students or a small fluctuation in aggregate performance. Fatigue,

differences in attention, and limited test sensitivity are possible explanations, but none was measured in this study.

Multimedia Learning and Practical Preparedness

The combination of slides, video, quiz questions, and a collaborative task provided several opportunities to encounter and apply preparedness information. The cognitive theory of multimedia learning offers a theoretical basis for combining relevant verbal and visual information to support understanding (Mayer, 2024). Guidance on instructional video design also emphasises directing attention to essential content and limiting unnecessary information (Mayer, 2021).

However, this study did not assess the separate contribution of each instructional component. Consequently, the observed changes cannot be attributed specifically to the video, slide presentation, quiz, or packing game.

The packing task incorporated selected PjBL elements through an authentic problem, collaboration, a tangible product, and explanation of decisions. These features are consistent with descriptions of PjBL in the educational literature (Kokotsaki et al., 2016). Nevertheless, the single session did not include an extended cycle of inquiry and product revision. The findings therefore concern a multimedia intervention inspired by PjBL rather than a complete implementation of the model.

The practical difficulties observed during the game support including performance assessment alongside written tests. A structured checklist could assess whether students select essential supplies, explain their choices, and recognise which preparations require adult assistance. This would broaden evaluation beyond factual recall, consistent with calls to examine how disaster education contributes to preparedness behaviour (Johnson et al., 2016).

Official Guidance for Preparedness Content

Official guidance provides an important reference for interpreting the practical task and strengthening future delivery. The Indonesian National Disaster Management Agency, Badan Nasional Penanggulangan Bencana (BNPB), advises communities exposed to volcanic hazards to follow information from the Centre for Volcanology and Geological Hazard Mitigation (PVMBG), identify evacuation routes and shelters, and prepare protection against volcanic ash. Its guidance includes masks, protective eyewear, emergency food and drinking water, lighting, and personal medication (BNPB, n.d.). These recommendations provide a reference for discussing warning information, protective actions, and evacuation decisions.

For the packing task, BNPB's emergency bag guidance identifies supplies including drinking water, durable food, clothing, first aid materials, personal medication, communication equipment, masks, a whistle, lighting, cash, and important documents (BNPB, 2019). This provides a practical reference for distinguishing essential supplies from optional belongings. In primary school activities, the household guidance should be adapted to children's abilities, with adults retaining responsibility for medication, important documents, and the overall evacuation arrangements. This adaptation is an educational implication rather than an outcome measured in the present study.

Local information is also necessary because recommendations depend on the volcano and its activity. A PVMBG report for Mount Sumbing dated 24 September 2025, reproduced on the Temanggung government portal, identified hazards associated with unstable crater rocks and possible toxic gas accumulation at the crater floor. This illustrates the importance of using volcano specific advice rather than relying solely on general descriptions of eruption warning signs (Smart City Temanggung, 2025). The report is contextual evidence and does not establish the conditions on the exact intervention date.

Future delivery should therefore align classroom materials with relevant PVMBG information and evacuation arrangements confirmed by BPBD Kabupaten Magelang and the school. The present study did not document a formal review of its materials by these authorities. Accordingly, the official sources discussed here serve as references for interpretation and programme improvement, rather than evidence of external validation before implementation.

Practical Implications and Limitations

The findings suggest that future programmes should place greater emphasis on applying knowledge through realistic decisions. Tasks could include selecting supplies under a carrying limit, explaining why particular items are necessary, identifying a designated assembly point, and practising responses to official instructions.

Activities conducted over several meetings would allow students to plan, present, receive feedback, and revise their preparedness products. Teacher and family involvement could also connect classroom

activities with household preparation, consistent with the broader emphasis on children and families in disaster preparedness education (Ronan et al., 2015).

Several limitations restrict interpretation. The study involved a small sample from one school and had no comparison group. Knowledge was assessed immediately after a single session using the same instrument, so familiarity with the questions may have influenced performance. High baseline scores limited the measurable scope for improvement, and the instrument's psychometric properties were not formally established. Analysis relied on group means without individual paired score analysis or inferential testing. Classroom observations were descriptive and did not use a structured scoring rubric. No delayed assessment or real evacuation performance was measured.

CONCLUSION

Following the multimedia learning intervention incorporating a collaborative emergency bag packing task, students' overall preparedness knowledge scores increased slightly, with improvement in Grade IV and a small decrease in Grade V. High baseline scores limited the measurable scope for further improvement. Classroom observations also identified difficulties in prioritising essential evacuation supplies, suggesting that high written knowledge scores alone do not establish practical preparedness.

The findings highlight the value of complementing written assessments with structured practical tasks to identify preparedness learning needs. However, the study design does not establish intervention effectiveness or lasting behavioural change. Future research should incorporate validated knowledge instruments, structured performance assessments, a comparison group, and delayed follow up. Extending the activity across several sessions could also provide opportunities for inquiry, feedback, and product revision, with teacher and family involvement.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AI USE STATEMENT

The authors used Claude (Anthropic) to assist with English-language drafting, restructuring the manuscript according to the journal template, and checking bibliographic details of the references. All content, data, and interpretations were reviewed and verified by the authors, who take full responsibility for the manuscript.

AUTHOR CONTRIBUTIONS

I.S.W.: Conceptualization, methodology, supervision, validation, and manuscript review and editing. M.R.: Investigation, data curation, and preparation of the original draft. O.I.S.: Investigation, resources, and preparation of the original draft. U.B.P.S.: Investigation, formal analysis, and visualization. M.S.Z.H.: Investigation, project administration, and preparation of the original draft. O.K.: Investigation, data curation, and manuscript review and editing. All authors have read and approved the final manuscript.

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