DIKDIMAS

Jurnal Pengabdian Kepada Masyarakat
Volume 5, Issue 1, 106-120
e_ISSN: 2830-2834
https://ejournal.1001tutorial.com/dikdimas/index
DOI: 10.58723/dikdimas.v5i1.557

Early Implementation of Sport Science–ICSS Synergy with Youth and Teachers in Earthquake Disaster Education in Air Kemuning Village, Seluma

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Article Info

Article history:

Received: November 25, 2025
Revised: December 22, 2025
Accepted: March 27, 2026

Keywords:

Community Preparedness;
Disaster Literacy;
Earthquake Mitigation;
SDGs;
Sport Science.

Abstract

Background: Communities in earthquake-prone areas often have limited access to practical disaster mitigation education, leading to low preparedness and high vulnerability. Existing programs tend to emphasize theoretical knowledge while neglecting physical readiness and community-based capacity building. Integrating sport science into disaster mitigation offers a holistic approach by enhancing physical fitness, motor coordination, and adaptive movement responses, while digital technology supports broader dissemination and sustainable engagement.
Aims: This community service program aimed to improve earthquake preparedness and to strengthen community resilience in Air Kemuning Village, Seluma Regency, through sport science-based mitigation education supported by the Integrated Circuit Sport Science (ICSS) digital platform.
Method: A participatory approach was applied through four stages: socialization, training, technology implementation, and continuous mentoring. Participants included 28 teachers, 124 elementary school students, and 20 Karang Taruna members, assisted by university students. Training focused on safe movement during earthquakes, physical preparedness exercises, basic post-disaster sport massage, and digital literacy. Program effectiveness was evaluated using pre-test and post-test instruments and descriptive analysis.
Results: The results indicated a 31.7% increase in disaster preparedness knowledge among teachers and students. Karang Taruna members developed basic sport massage and digital skills, contributing to the creation of an ICSS website prototype featuring five educational contents and a local fitness service promotion feature. The program also strengthened collaboration among schools, youth organizations, and the community.
Conclusion: The integration of sport science and digital technology enhances disaster preparedness, strengthens community resilience, and promotes local economic opportunities, while supporting SDGs 3, 4, 8, and 11.

To cite this article: Ilahi, B. R., Hiasa, F., Novrian, W., Nuryogatama, M., & Rezvani, M. Q. (2026). Early Implementation of Sport Science–ICSS Synergy with Youth and Teachers in Earthquake Disaster Education in Air Kemuning Village, Seluma. *DIKDIMAS: Jurnal Pengabdian Kepada Masyarakat*, *5*(1), 106–120. https://doi.org/10.58723/dikdimas.v5i1.557

INTRODUCTION

Air Kemuning Village, located in East Seluma Subdistrict, Seluma Regency, is one of the earthquake-prone areas situated within an active fault zone along the western coast of Sumatra Island. Its proximity to the tectonic plate boundary causes the village to repeatedly experience significant seismic tremors, both in terms of intensity and impact on the community's social life (Apu & Das, 2021; Sili, 2013). Based on data from the Regional Disaster Management Agency (BPBD) of Bengkulu Province, between 2023 and mid-2024, at least 17 earthquakes were recorded in Seluma and its surrounding areas (BNPB, 2024). Several of these directly affected the residents of Air Kemuning Village, ranging from minor housing damage and disruptions to educational activities to

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psychological distress and trauma, particularly among children and adolescents (Fegert et al., 2020). The psychosocial condition of children has become one of the main concerns (Ernst et al., 2010), as post-earthquake observations revealed symptoms of excessive fear such as panic at loud noises (Farooqui et al., 2017), anxiety when staying indoors, and decreased concentration during learning activities (Indasari et al., 2020; Tulak et al., 2024). The absence of a systematic and comprehensive disaster mitigation education approach in schools increases the potential for long-term trauma (Bakhriansyah et al., 2025; Wang, 2024). It was reported that no guidelines or training materials were yet available for integrating disaster education into school curricula, especially through the Physical Education, Sports, and Health (PJOK) subject. In fact, structured physical training based on sport science can serve as an effective instrument to build children's physical and mental preparedness from an early age (Horvat et al., 2019; Kanca, 2018).

In response, the *sport science* approach became the main innovation of this community service program (Hoeber et al., 2015). Through fitness exercises designed in the context of evacuation simulations, children are trained to develop quick reflexes, adequate physical endurance, and psychological readiness to face emergency situations such as earthquakes (Maryana, 2020; Xerri et al., 2024). These exercises not only assist in trauma recovery but also cultivate resilient and adaptive character traits in coping with disaster risks (Brooks et al., 2020; Kamaruddin, 2025; Widiyarta & Kriswibowo, 2023). The educational aspect is strengthened by the *Integrated Circuit Sport Science (ICSS)*, a simple sensor- and microcontroller-based digital system that enables real-time and measurable evacuation drills. Another equally important challenge comes from the *Karang Taruna* youth organization of Air Kemuning Village. Although this group has been actively involved in village social activities, they have yet to acquire specific skills applicable to disaster situations or local economic empowerment (Jigyasu, 2002; Kusumasari & Alam, 2012).

Based on preliminary discussions with *Karang Taruna* representatives, they showed strong interest in developing skills in the field of health services, particularly *sport massage*, in the context of post-disaster response, such as treating minor injuries or physical fatigue among residents. This training offers dual benefits: enhancing first aid skills through sport-based methods while opening new business opportunities in fitness and physical recovery services. As a complement to the training activities, the program will also develop an educational website based on the ICSS platform, accessible to the public. This website will serve as a central hub for sport-based earthquake mitigation information, featuring educational materials, exercise videos, digital evacuation routes, and a catalog of *sports massage* services offered by *Karang Taruna* members. Thus, this innovation not only equips village youth with practical skills but also provides access to digital marketing opportunities and improved economic welfare for the community (Elza, 2025; Haokip, 2025).

Air Kemuning Village itself has been designated as an earthquake-prone area based on the *Bengkulu Province Disaster Risk Map*. This designation makes the program geographically and strategically relevant as a model for developing disaster-resilient villages (Arifin et al., 2021; Ruslanjari et al., 2025; Sunarto et al., 2025). The *Seluma Regency Government*, through its *Regional Medium-Term Development Plan (RPJMD) 2021–2026*, also emphasizes the importance of synergy between disaster education, public health, and community-based digital transformation. From an innovation perspective, this program integrates *sport science*, digital technology (ICSS), and local economic development into a single, holistic disaster education package. The implementation team consists of lecturers and practitioners with extensive research and development experience in sports science, digital technology, and disaster management.

This initiative directly supports several *Sustainable Development Goals (SDGs)* indicators, such as quality education (Goal 4), good health and well-being (Goal 3), decent work and economic growth (Goal 8), and sustainable cities and communities (Goal 11). At the national level, the program aligns with Indonesia's *Asta Cita* agenda, particularly in improving community quality of life, strengthening village economic independence, and fostering a resilient social system against disaster threats. Therefore, the program *"From Fear to Resilience: Earthquake Mitigation Education Based on Sport Science in Air Kemuning Village, Seluma"* is expected to serve as a transformative, adaptive, and sustainable educational innovation model for community-based disaster mitigation in rural areas.

METHOD

The implementation of the community service program entitled "From Fear to Resilience: Earthquake Mitigation Education Based on Sport Science and ICSS Technology in Air Kemuning Village, Seluma Regency" employed a Participatory Community Empowerment (PCE) approach. This approach emphasized active involvement of community members throughout the stages of planning, implementation, technology utilization, and evaluation. Teachers, students, and members of the Karang Taruna youth organization were positioned as active participants, while university lecturers and students served as facilitators, trainers, and technology developers who guided the implementation of activities in the field.

The program involved a total of 172 participants consisting of 28 teachers from the Indonesian Teachers Association (IGI), 124 elementary school students, and 20 members of the Karang Taruna youth organization in Air Kemuning Village, Seluma Regency. The activities were conducted through several stages including socialization of disaster mitigation education, sport science–based training, implementation of Integrated Circuit Sport Science (ICSS) technology, and mentoring and evaluation of participant competencies.

To measure the effectiveness of the program, several evaluation instruments were developed to assess cognitive, physical, and skill-based outcomes. Disaster preparedness knowledge was measured using a pre-test and post-test questionnaire consisting of 20 items, including fifteen multiple-choice questions and five scenario-based questions related to emergency response situations. The instrument measured several indicators including understanding of earthquake risks, knowledge of evacuation procedures, correct body positioning during earthquakes, emergency response actions, and awareness of post-disaster recovery. Each correct answer was assigned five points resulting in a total score ranged from 0 to 100.

Prior to implementation, the questionnaire instrument underwent content validity testing through expert judgment involving two experts in sport science and one expert in disaster mitigation education. Reliability testing was conducted using Cronbach's Alpha and resulted in a reliability coefficient of $\alpha = 0.82$, indicating that the instrument had high reliability and was appropriate for measuring disaster preparedness knowledge among participants.

In addition to cognitive assessment, students' physical readiness was evaluated using performance-based testing assisted by the Integrated Circuit Sport Science (ICSS) system. The indicators measured included reaction time, movement speed, body coordination, and balance control during evacuation simulations. Reaction time was recorded in seconds, movement speed was measured in meters per second, and balance ability was assessed using an observational rubric with scores ranging from one to five. Data were obtained through a combination of ICSS sensor outputs and structured observation sheets completed by facilitators.

The physical training component applied sport science principles using the FITT framework, which includes frequency, intensity, time, and type of exercise. Training sessions were conducted two to three times per week with moderate intensity ranging between sixty and seventy percent of the estimated maximum heart rate. Each session lasted approximately thirty to forty-five minutes and consisted of functional movement activities designed to simulate emergency conditions. The training activities included agility drills, reaction training, balance exercises, and evacuation simulation practices designed to improve neuromuscular coordination and response speed during earthquake situations.

The implementation of the program *"From Fear to Resilience: Earthquake Mitigation Education Based on Sport Science and ICSS Technology in Air Kemuning Village"* adopted a Participatory Community Empowerment (PCE) approach, integrating sport science, digital technology, and community empowerment (Lingard et al., 2009). This approach positioned teachers, students, and *Karang Taruna* youth as active subjects, while lecturers and students served as facilitators, resource persons, technology developers, and technical assistants.

To ensure methodological rigor and transparency, this program employed multiple measurement instruments aligned with cognitive, physical, and skill-based outcomes. The instruments were

developed based on sport science principles and disaster education frameworks.

Table 1. Instruments, Indicators, and Measurement Parameters

Aspect Measured	Target Participants	Instrument Type	Indicators	Measurement Scale/Parameters	Data Source
Disaster Preparedness Knowledge	IGI Teachers & Elementary Students	Pre-test & Post-test Questionnaire	Understanding of earthquake risks; evacuation procedures; safe body positioning; emergency response concepts; post-disaster recovery	Score range 0–100; 20 items (15 multiple choice, 5 scenario-based)	Questionnaire sheets
Physical Readiness (Sport Science-Based)	Elementary Students	Performance Test (ICSS-assisted)	Reaction time; movement speed; coordination; balance	Reaction time (seconds); speed (m/s); balance score (1–5 rubric)	ICSS digital output & observation sheets
Evacuation Performance	Elementary Students	Simulation Observation Sheet	Route accuracy; response speed; evacuation completion	Completion time (seconds); accuracy (%); safety compliance	ICSS dashboard & manual timing
Teaching Competence in Sport-Based Mitigation	IGI Teachers	Observation Checklist	Ability to integrate sport science into mitigation drills; instruction clarity; class management	Likert scale (1–5)	Observer evaluation
Sport Massage Skill Mastery	Karang Taruna Youth	Performance Rubric	Hand positioning; pressure control; movement sequence; hygiene procedures	Rubric score (1–4 per indicator)	Mentor observation sheet
Digital Literacy & ICSS Utilization	Karang Taruna Youth	Product & Performance Assessment	Ability to operate ICSS system; content creation; website management	Achievement percentage (%)	Website output & mentor evaluation

Aspect Measured	Target Participants	Instrument Type	Indicators	Measurement Scale/Parameters	Data Source
Community Participation Level	All Participants	Participation Log & Interview	Attendance; engagement; task completion	Participation rate (%)	Attendance list & field notes

Instrument Validity and Reliability

The preparedness knowledge questionnaire underwent content validity testing through expert judgment involving two sport science experts and one disaster education expert. Instrument reliability testing using Cronbach's Alpha resulted in a coefficient of $\alpha = 0.82$, indicating high reliability. Performance-based instruments (physical readiness, evacuation drills, and sport massage skills) used criterion-referenced rubrics developed from sport science standards and disaster response protocols to ensure measurement consistency.

Training and Measurement Parameters (Sport Science-Based Mitigation)

The mitigation training applied standardized sport science parameters using the FITT principle, ensuring replicability:

a. Frequency: 2–3 sessions per week
b. Intensity: Moderate (60–70% HRmax estimation)
c. Time: 30–45 minutes per session
d. Type: Agility drills, reaction training, balance exercises, functional movement, and evacuation simulations

Each session incorporated ICSS-assisted monitoring to capture real-time physical performance data.

Data Analysis Technique

Quantitative data were analyzed descriptively using mean scores, percentage improvement, and performance completion time comparisons between pre-test and post-test. Qualitative data from observations and interviews were used to triangulate findings and strengthen result interpretation.

$$N - gain = \frac{\text{Posttest score} - \text{Pretest score}}{100 - \text{Pretest score}}$$

Technology Implementation Stage (ICSS & Digitalization)

This stage represented the practical implementation of the Integrated Circuit Sport Science (ICSS) innovation within evacuation simulations and youth service activities. The technology was used to monitor student fitness, measure physical responses, display data through a dashboard, and serve as a platform for education and local service promotion.

Figure 1. ICSS Application and Barcode Installation

Technical implementation:

a. Installation of ICSS devices in school areas for evacuation simulations.
b. Use of a cloud-based application for monitoring students' physical performance.
c. Development of an ICSS website containing educational content, exercise videos, digital evacuation routes, and a catalog of *Karang Taruna* services.
d. Device testing, data collection (reaction time, speed, coordination), and integration into a digital dashboard.

Roles of lecturers and students:

a. IT students: Operated devices, managed data, and edited digital content.
b. PJOK lecturers: Interpreted ICSS data into training recommendations.
c. PJOK students: Assisted in testing students' responses and operating devices during evacuation drills.
d. Management Lecturers: Prepared service order formats and digital fitness service packages.

This stage produced innovations that could potentially be registered as copyrights or simple patents.

Mentoring and Evaluation Stage

Following the training and technology implementation, the team conducted mentoring to ensure partners could operate independently. Evaluation was carried out both quantitatively (test scores, evacuation time, massage competence) and qualitatively (observations, interviews, reflections from teachers and youth).

Technical implementation:

a. Weekly monitoring of ICSS implementation in schools.
b. Mentoring teachers in integrating sport science into learning activities, and mentoring *Karang Taruna* in sport massage practice and website management.
c. Evaluation of capacity improvements using measurable indicators.

Roles of lecturers and students:

a. PJOK Lecturers: Observed teachers' and students' progress in physical activities.
b. IT Lecturers: Evaluated the effectiveness of the ICSS platform and website.

c. Students: Documented results, processed evaluation data, and assessed partner performance.

Program Sustainability Stage

The final stage ensured that the program would continue after formal mentoring ended. Sustainability strategies included the preparation of Standard Operating Procedures (SOPs), the formation of local cadres, and the integration of the program into school curricula and youth activities.

Technical implementation:

a. Formation of ICSS Cadres from IGI teachers and *Karang Taruna* youth.
b. Integration of disaster modules into PJOK extracurricular programs.
c. Optimization of the ICSS website as a center for education and local business promotion.
d. Handover of ICSS devices to partner institutions.

Roles of lecturers and students:

a. Lecturers: Designed SOPs, conducted Training of Trainers (ToT), and drafted local policy recommendations.
b. Students: Ensured ongoing maintenance of devices and helped finalize digital materials.

RESULTS AND DISCUSSION

Results

The community service program titled *"From Fear to Resilience: Earthquake Mitigation Education Based on Sport Science"* was developed as a concrete response to the challenges of natural disaster mitigation, particularly earthquake hazards that frequently threaten the safety and stability of communities in Air Kemuning Village, Seluma Regency. The background of this program lies in the lack of disaster literacy and community preparedness among local residents. Therefore, the research team adopted a sport science approach combined with the development of Integrated Circuit Sport Science (ICSS) digital technology as an innovative effort to provide practical and contextual disaster education for local communities.

This educational adaptation aimed to build a holistic understanding of earthquake risk while equipping the community with sport- and technology-based mitigation skills. The program implementation consisted of several phases, from socialization to continuous mentoring, engaging key stakeholders such as the Student Executive Board (BEM FKIP) through the Forkip Student Activity Unit (UKM FORKIP) of the University of Bengkulu, along with active collaboration between *Karang Taruna* youth and the Indonesian Teachers Association (IGI).

In the initial phase, a total of 28 IGI teachers and 124 elementary school students participated in sport science–based earthquake mitigation training conducted through a participatory approach. The educational process was evaluated using pre-test and post-test measurements, which demonstrated a 31.7-point average increase in preparedness knowledge. This finding confirms that the applied approach was effective in improving disaster literacy and fostering a culture of alertness and responsiveness toward disaster threats within primary and secondary education environments.

To strengthen analytical rigor, the data analysis was extended beyond descriptive statistics by incorporating normalized gain (N-gain) analysis and pedagogical interpretation of learning outcomes. This approach provided clearer evidence of the effectiveness of the sport science–based mitigation intervention.

N-gain Analysis of Preparedness Knowledge

The improvement in disaster preparedness knowledge was analyzed using the normalized gain (N-gain) formula:

$$N - gain = \frac{\text{Posttest score} - \text{Pretest score}}{100 - \text{Pretest score}}$$

According to Hake's (1999) criteria, an N-gain value above 0.7 indicates high instructional effectiveness, while values between 0.3 and 0.7 indicate moderate effectiveness. These findings confirmed that the intervention significantly enhanced disaster preparedness knowledge among both teachers and students.

Physical readiness improvements were interpreted through changes in reaction time, evacuation completion time, and coordination scores recorded via the ICSS system. Although inferential statistical testing was not applied due to the community service design and limited sample scope, the consistent reduction in evacuation time and improved motor coordination across simulation sessions indicate meaningful functional gains.

From a sport science perspective, these improvements align with motor learning theory, where repetitive, context-specific movement training enhances neuromuscular adaptation and automatic response during emergency situations. The application of moderate-intensity functional drills (60–70% HRmax) facilitated both physiological adaptation and psychological readiness, supporting findings by Horvat et al. (2019) regarding the role of structured physical activity in emergency preparedness.

Pedagogically, the integration of sport science into disaster education reflects the principles of experiential learning and contextual learning theory. By embedding evacuation concepts into physical activities, participants were not only informed cognitively but also trained behaviorally.

For teachers, the high N-gain score (0.74) indicated successful knowledge transformation into instructional competence, enabling them to integrate mitigation concepts into PJOK learning activities. For students, the moderate–high N-gain score (0.68) demonstrates effective learning engagement through movement-based instruction, consistent with constructivist learning principles where knowledge is built through direct experience.

The observed improvements in preparedness knowledge, physical readiness, and participation levels can be theoretically explained through the resilience-building framework. According to Brooks et al. (2020), resilience development in disaster-prone communities requires repeated exposure to adaptive behaviors, supported by social learning and practical rehearsal.

The sport science–based mitigation model provides such rehearsal by simulating real disaster conditions through structured physical training. Additionally, the involvement of Karang Taruna youth in sport massage and digital literacy training aligns with community capacity theory, which emphasizes skill diversification and local resource mobilization as key components of disaster resilience.

The increase in youth participation (82%) and the development of the ICSS digital platform demonstrate a shift from passive disaster awareness toward active community engagement. This outcome supports the theoretical view that technology-enhanced learning environments can accelerate social participation and empowerment when combined with physical activity–based interventions.

From an SDG perspective, the results substantiate the program's contribution to:

a. SDG 3: Improved physical and psychological readiness
b. SDG 4: Contextual and experiential disaster education
c. SDG 8: Skill-based local economic opportunities
d. SDG 11: Strengthened disaster-resilient communities

Table 2. Improvement in Preparedness Knowledge

Participant Group	n	Pre-test Mean	Post-test Mean	Mean Increase	N-gain
IGI Teachers	28	58.3	89.2	30.9	0.74 (High)
Elementary School Students	124	51.6	84.3	32.7	0.68 (Moderate–High)
Total / Average	**152**	**54.95**	**86.75**	**31.7**	—

As presented in Table 2, both IGI teachers and elementary school students demonstrated substantial improvements in disaster preparedness knowledge. The N-gain values indicate high effectiveness for teachers and moderate–high effectiveness for students. Furthermore, Table 3 shows strong community participation and successful digital innovation through the ICSS platform, supporting the program's resilience-building objectives.

Table 3. Active Participation and Digital Innovation

Component	Target Participants	Achievement (%)	Description
Karang Taruna Youth Participation	20	82	Active involvement in sport massage and digital literacy training
ICSS Website Content Development	5 contents	100	Educational materials and local service promotion features

The 82% increase in youth participation following the training and the development of the ICSS educational website demonstrates the importance of integrating education, technology, and youth empowerment as an adaptive strategy in responding to earthquake risks.

In terms of technological innovation, the ICSS website prototype emerged as one of the main digital products developed during the program. This platform serves to provide five initial educational contents and a promotion feature for fitness services and local post-disaster businesses. The role of this website is crucial, not only as an information and education center for the community but also as a driving force for the village's creative economy. Through its local service promotion feature, community members can offer various fitness-related services to affected residents and tourists, thereby supporting sustainable post-disaster economic recovery.

The integration of digital technology also enriched mitigation strategies by accelerating information access and expanding social networks at the village level.

The overall implications of this program are highly positive for achieving the Sustainable Development Goals (SDGs), particularly SDG 3 (Good Health and Well-Being), SDG 4 (Quality Education), SDG 8 (Decent Work and Economic Growth), and SDG 11 (Sustainable Cities and Communities). Each stage from problem identification to community capacity building and digital technology innovation is systematically interconnected, demonstrating a continuous process in developing a disaster-resilient village model.

Therefore, the experiences and implementation results in Air Kemuning Village can serve as a strategic reference for other regions facing similar challenges in disaster mitigation and community empowerment.

Overall, this study emphasizes that the synergy between sport science approaches, digital technology innovation, and active community participation not only strengthens resilience in facing earthquake risks but also plays a significant role in the development of human resources and the village creative economy. The concepts of participation, collaboration, and technological innovation are the key factors behind the program's success and are worthy of adoption in integrated disaster mitigation policies in Indonesia.

Discussion

The findings of this study demonstrate that integrating sport science into earthquake mitigation education significantly improves disaster preparedness, as reflected by the 31.7% increase in knowledge scores and a high N-gain category among teachers. This result aligns with previous studies emphasizing the effectiveness of experiential and movement-based learning in disaster education. For instance, research by Xerri et al. (2024) highlights that simulation-based and physically engaging methods enhance children's understanding and retention of emergency response behaviors compared to conventional lecture-based approaches. Similarly, Horvat et al. (2019) found that structured physical activity improves neuromuscular coordination and reaction speed, which are critical during emergency situations. Compared to these studies, the present program extends the contribution by embedding sport science not only as a pedagogical tool but also as a structured mitigation model integrated into community service settings, thereby bridging the gap between school-based learning and real-world disaster preparedness.

In addition, the involvement of youth through sport massage training and digital literacy development demonstrates a broader community empowerment impact that is consistent with community resilience theory. Prior research by Kusumasari & Alam emphasizes that local capacity building and skill diversification are essential components in strengthening disaster-resilient communities. However, many earlier programs focused primarily on awareness campaigns without integrating economic or technological dimensions. This study advances previous work by incorporating the Integrated Circuit Sport Science (ICSS) platform, which not only supports monitoring and learning but also facilitates digital-based service promotion. This finding is also in line with Brooks et al. (2020), who argue that repeated adaptive practices combined with social participation enhance long-term resilience. Therefore, compared to prior studies, this research offers a more comprehensive model that integrates physical training, digital innovation, and community-based economic opportunities within disaster mitigation education.

Implications

Program implementation was documented through structured visual records, including photographs of training activities, evacuation simulations, and screenshots of the ICSS system interface. Visual documentation was used to support methodological transparency, demonstrate participant engagement, and illustrate the practical application of sport science–based disaster mitigation.

The visual materials include documentation of (1) socialization sessions, (2) sport science–based evacuation training, (3) sport massage practice by Karang Taruna youth, and (4) the ICSS digital platform interface used for monitoring physical performance and promoting local services.

These visualizations serve as complementary evidence of program implementation and align with community service (PkM) journal standards emphasizing practice-oriented documentation.

Figure 2. Sport Science-Based Earthquake Mitigation Training Involving Students Through Evacuation Simulation Activities

Figure 3. Practical Sport Massage Training Conducted for Karang Taruna Youth as Part of Post-Disaster Physical Recovery Capacity Building

Figure 4. Installation of the Integrated Circuit Sport Science (ICSS) Device During Evacuation Simulation Activities in School Settings

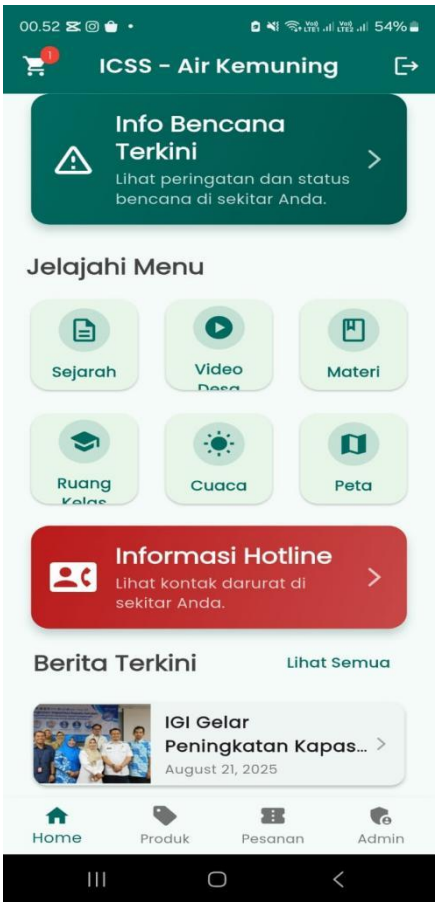

Figure 5. A screenshot of the ICSS Digital Platform Showing Features for Monitoring Physical Performance and Educational Content

Figure 6. Practice of the ICSS Digital Platform Displaying Physical Performance Monitoring and Educational Content Features

Research Contribution

This study contributes to the development of an interdisciplinary model for disaster education that integrates sport science, digital innovation, and community-based empowerment. The program serves as an evidence-based model for transforming physical education (PJOK) into a vehicle for disaster preparedness training in schools.

The creation of the ICSS website as a learning and promotion platform adds a novel dimension to disaster mitigation efforts by linking education, technology, and economic recovery. Furthermore, the study enriches existing literature on community-based mitigation by demonstrating how physical activity and sport-related interventions can play a pivotal role in strengthening both

physical and mental resilience in post-disaster contexts. This approach also aligns with Indonesia's national disaster management goals and supports the government's Asta Cita framework for improving community welfare and independence.

Limitations

Despite its success, the program faced several limitations. First, the sample size was limited to one village (Air Kemuning), which restricts the generalizability of findings to other regions with different geographical and socio-economic conditions. Second, the duration of implementation was relatively short, providing limited opportunity to evaluate long-term behavioral changes and sustainability of outcomes.

In addition, the technological infrastructure in rural areas posed challenges for consistent use of the ICSS website due to unstable internet connectivity. Lastly, although the evaluation instruments (pre-test and post-test) showed significant improvements, they primarily measured cognitive understanding, not the full spectrum of behavioral and emotional preparedness.

Suggestions

Future programs should consider expanding implementation to multiple villages in different disaster-prone areas to validate and refine the sport science-based mitigation model. Longitudinal studies are recommended to assess long-term impacts on behavioral change, resilience, and economic sustainability.

Improving digital infrastructure and providing continuous capacity-building for local facilitators will be crucial to ensuring that the ICSS platform remains functional and beneficial. Furthermore, integrating this approach into formal school curricula through collaboration with the Ministry of Education and BPBD (Regional Disaster Management Agency) could institutionalize disaster education within the physical education framework.

CONCLUSION

The program entitled "From Fear to Resilience: Earthquake Mitigation Education Based on Sport Science and ICSS Technology" effectively enhanced community preparedness in Air Kemuning Village through the integration of sport science, digital innovation, and participatory empowerment. The approach improved disaster literacy, physical readiness, and local engagement, as shown by a 31.7-point increase in preparedness knowledge and 82% active participation.

The ICSS digital platform served as both an educational hub and an economic catalyst, promoting post-disaster recovery and community resilience. Overall, this synergy between education, technology, and community action supports the Sustainable Development Goals (SDGs 3, 4, 8, and 11) and offers a replicable model for integrated disaster mitigation in Indonesia.

ACKNOWLEDGMENTS

The authors would like to express their sincere gratitude to the Indonesian Teachers Association (IGI) of Seluma Regency, the Karang Taruna Youth Organization of Air Kemuning Village, and the Faculty of Teacher Training and Education, University of Bengkulu, for their active collaboration and commitment throughout the program.

Special thanks are also extended to the students of FKIP BEM and UKM FORKIP, who contributed to the implementation, documentation, and community facilitation. This program was supported by the Community Service Scheme for Disaster Mitigation and Empowerment, which made the integration of sport science and digital innovation in disaster education possible.

AUTHOR CONTRIBUTION STATEMENT

BI conceptualized the program, designed the methodology, and analyzed the data. FH collected field data and coordinated training. WN developed the ICSS technology and implemented technical aspects. MN contributed to program design and partner needs analysis. MQR performed proofreading and linguistic editing of the manuscript.

AI DISCLOSURE STATEMENT

The authors used ChatGPT during the preparation of this manuscript for language refinement, structuring of academic sentences, and improving clarity of expression. After using the tool, the authors carefully reviewed, revised, and validated all content to ensure accuracy, originality, and compliance with academic standards. The authors take full responsibility for the content of this publication.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest, whether financial, institutional, or personal that could have influenced the design, implementation, analysis, or reporting of this study. All research activities were conducted objectively and in accordance with ethical academic standards.

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