

Design of a Web-Based Hazardous Goods Information for the Dangerous Goods Course in the Air Transportation Management Study Program of Surabaya Aviation Polytechnic

Adrista Yafri Agraprana¹, Faoyan Agus Furyanto², Yudhis Thiro Kabul Yuniors³, Lady Silk Moonlight⁴
Politeknik Penerbangan Surabaya, Indonesia

Corresponding Author: Lady Silk Moonlight
Aeronautical Communication Department
Politeknik Penerbangan Surabaya, Indonesia
Email: lady@poltekbangsby.ac.id

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Abstract

Dangerous goods (DG) are hazardous materials that pose significant safety risks in aviation. This study aims to design and develop a web-based learning platform to support student understanding of Dangerous Goods materials in line with the IATA Dangerous Goods Regulations (DGR) 63rd Edition. The research applies a Research and Development (R&D) approach using the 4D model—Define, Design, Develop, and Disseminate—focused on the development phase. A needs analysis concerning functionality, academic benefit, performance, and user experience was conducted through questionnaires distributed to 46 students in the Air Transportation Management Study Program. The results indicate a strong need for structured, interactive, and accessible learning media. The resulting platform includes a Materials menu with summaries, illustrations, and tables, and a Practice menu featuring guided exercises and explanations. Feasibility testing involving media experts and subject matter experts showed high ratings with all key aspects rated above 85%. This web-based learning medium demonstrates potential as an effective educational tool to improve understanding of Dangerous Goods regulations and to promote independent learning beyond the classroom.



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1 INTRODUCTION

Dangerous goods (DG) are hazardous materials that pose significant safety risks in aviation, requiring aviation personnel to understand their classification, handling, packaging, labeling, and documentation in accordance with IATA Dangerous Goods Regulations (DGR) [1]. Improper handling of Dangerous Goods can lead to unintended consequences, such as cargo damage, in-flight fires, and even fatal accidents resulting in casualties [2], [3], [4]. Therefore, a solid understanding of Dangerous Goods by aviation personnel is a critical component of aviation education. This highlights the essential role of aviation training institutions, such as Politeknik Penerbangan Surabaya, in delivering quality instruction to prepare competent and qualified professionals in the field.

Several challenges faced by students include limited experience in using the IATA DGR manual, which often leads to difficulties in locating relevant materials, as well as a lack of understanding of key concepts and problem-solving methods. This issue is evident in the assessment results, where 43 out of 98 students (approximately 44%) failed to meet the minimum

passing criteria. Learner preferences increasingly support the shift to online Dangerous Goods training, as studies indicate that modern students highly value flexible and self-directed learning environments [5]. Valtonen et al. [6] report a clear demand for informal, anytime-anywhere learning modes that free students from rigid campus schedules. Conversely, empirical evidence indicates that learners often underutilize digital collaboration tools and rely on traditional methods [7]. In other words, students want engaging online resources (e.g. visuals, quizzes) but current materials are insufficient. This gap – between student needs and available instruction – suggests a web-based platform specifically for the Dangerous Goods course could significantly improve learning outcomes [8], [9]. To our knowledge, little published work exists on DG-specific e-learning tools in aviation education, so this study aims to fill that gap by designing and evaluating a DG web platform.

2 METHOD

This study employed a Research and Development (R&D) approach aimed at designing and validating a web-based learning medium for the Dangerous Goods course. The development process adopted the 4D model introduced by Thiagarajan et al. [10] as a guiding framework. The 4D model provides a systematic sequence of phases for instructional product development, consisting of four systematic stages: Define, Design, Develop, and Disseminate [11], [12]. However, because this research was conducted as a pilot study, it was carried out only until the Develop stage. The next step would be a feasibility test by subject matter expert and media experts. During the Define stage, a needs analysis was conducted through questionnaires distributed to 46 students enrolled in the Air Transportation Management Study Program at Politeknik Penerbangan Surabaya. The needs analysis questionnaire was validated by a subject matter expert, with all items yielding a perfect score (100%) and confirming the instrument's validity for use, while its reliability, tested using Cronbach's Alpha, reached 0.944, indicating excellent internal consistency. In the Design stage, a website prototype was developed, featuring instructional content aligned with the IATA Dangerous Goods Regulations, along with visual elements, interactive modules, and practice questions. User interface wireframes, flowcharts, and database structures were prepared to ensure usability. The Develop stage utilized a combination of front-end and back-end programming technologies. HTML was used to structure the web pages, CSS to design the visual layout, and JavaScript to enable interactive functionalities such as button actions and data filtering. Local development and testing were supported by tools including XAMPP for running a local server environment (Apache, MySQL, PHP, and Perl), Visual Studio Code as the primary code editor, and Git as a version control system to manage code changes throughout the development process. In addition to conventional tools, Blackbox AI was utilized during the development process to assist with code generation, syntax suggestions, and implementation of specific functions. Its integration helped streamline development tasks and improve coding efficiency, particularly in implementing interactive features using JavaScript.

This study employed a quantitative descriptive analysis to process and interpret data collected through validated and reliable questionnaires. The developed web-based platform was subsequently tested by a subject matter expert and media experts to evaluate its content accuracy, functionality, interface design, and overall usability. Data were presented in the form of tables, percentages, and mean scores using a Likert scale to measure levels of agreement on key aspects such as information needs, content structure, accessibility, navigation, and visual readability. These combined evaluations served as the basis for assessing the feasibility of the learning system prior to broader implementation.

3 RESULTS

Define

Table 1. Needs Analysis Questionnaire Result

No	Statement	Index (%)
Funcionality		
1	The presentation of Dangerous Goods learning materials in web format is needed to support the learning process.	78,26
2	An exercise feature along with explanations is needed to help understand the Dangerous Goods material.	89,67
3	Illustrations or images explaining the types of dangerous goods are necessary to facilitate learning.	82,06
4	A simple and clear navigation system is necessary to allow users to easily switch between learning materials and exercises.	80,43
Overall		82,60
Academic benefit		
5	A web-based learning platform is needed to complement printed textbooks in understanding the Dangerous Goods course.	79,34
6	Anytime and anywhere access to course content is necessary to facilitate independent learning	89,13
7	Students need information that helps them understand the real-world application of dangerous goods transportation regulations	81,52
8	Learning media that supports exercise completion and exam preparation is necessary to enhance academic success.	89,13
Overall		84,78
Performance		
9	Optimal local computer performance of the website is essential for seamless learning processes	79,34
10	Fast loading speeds for instructional content and practice modules are essential to maximize the platform's effectiveness.	88,04

11	A stable website free from recurrent errors is essential to ensure uninterrupted learning.	80,97
12	Proper display of all elements, such as text, tables, and images, is necessary so that information can be conveyed completely.	77,17
Overall		77,17
User Experience		
13	An attractive and non-boring interface is needed to support comfortable learning.	90,21
14	A simple and easy-to-understand website design is necessary to ensure the media can be used without difficulty.	79,89
15	Clear menus and navigation buttons are necessary to allow users to easily access materials and exercises.	83,15
Overall		84,41

The findings of this study affirm both the importance and feasibility of developing a web-based learning platform for the Dangerous Goods course in aviation education. The needs analysis revealed high levels of student demand across four key dimensions—Functionality (82.60%), Academic Benefit (84.78%), Website Performance (81.38%), and User Experience (84.41%)—demonstrating a preference for interactive, flexible, and accessible digital learning solutions [5], [6]. This is further underscored by the fact that 44% of the students failed to meet the minimum passing criteria under traditional learning settings, indicating the urgent need for pedagogical innovation in technical and vocational education [7]. These results align with prior study that emphasize the role of technology-enhanced learning in improving student engagement and achievement in complex, regulation-based subjects [13].

Design

The design stage of this study demonstrates the strategic alignment between instructional content and the specific cognitive demands of the Dangerous Goods subject within aviation education. In this stage, the website’s information architecture and interface layout were systematically structured to match the learning needs of Air Transportation Management students. Artificial Intelligence tools—specifically Blackbox AI and ChatGPT—were integrated to assist in content generation, layout structuring, and overall development efficiency, reflecting a growing trend in educational technology applications [14], [15]. The learning materials were adapted from the IATA DGR manual and enriched with visual elements such as images and videos, along with sample practice questions to facilitate better comprehension and engagement.

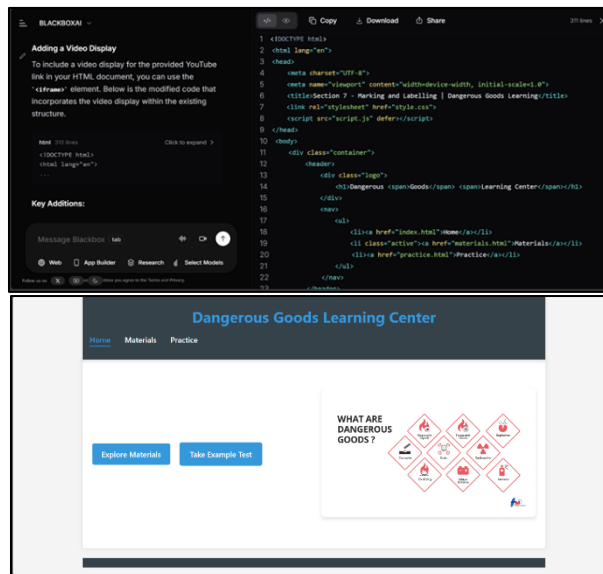


Figure 1. Website Design Process Using Blackbox AI

Development

The development stage of this project emphasized the practical transformation of a conceptual design into a fully functional web-based platform for Dangerous Goods instruction. During this phase, expert validation was conducted by both subject matter and media specialists to assess content accuracy, interface usability, and instructional clarity. The feedback gathered played a crucial role in improving the platform’s overall structure, ensuring it met both pedagogical and technical quality standards [13]. Through this iterative validation process, the researcher was able to identify and address content gaps, visual inconsistencies, and navigation issues that may have hindered user experience.

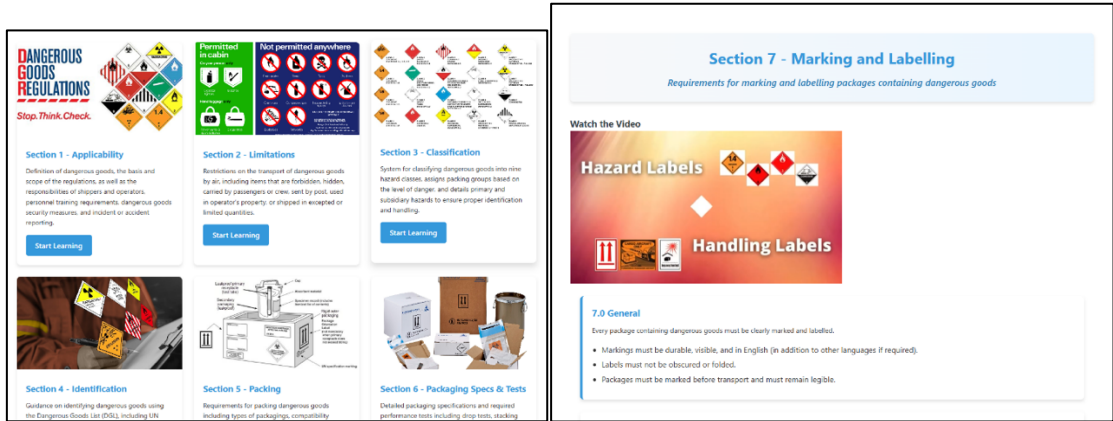


Figure 2. Website Testing Process

Final Look

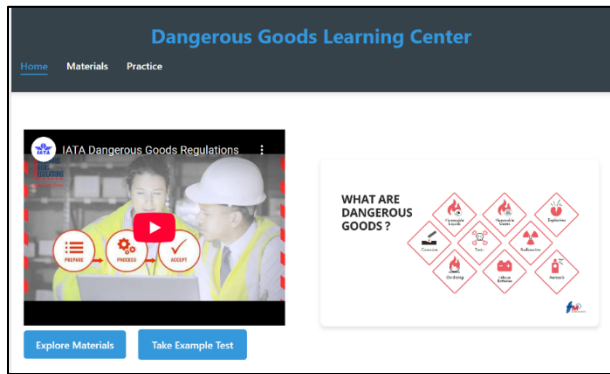


Figure 3. Start Screen

The homepage displays the title “Dangerous Goods Learning Center” along with two primary navigation buttons: “Explore Materials” and “Take Example Test”. This design provides users with quick access to both learning content and practice exercises.

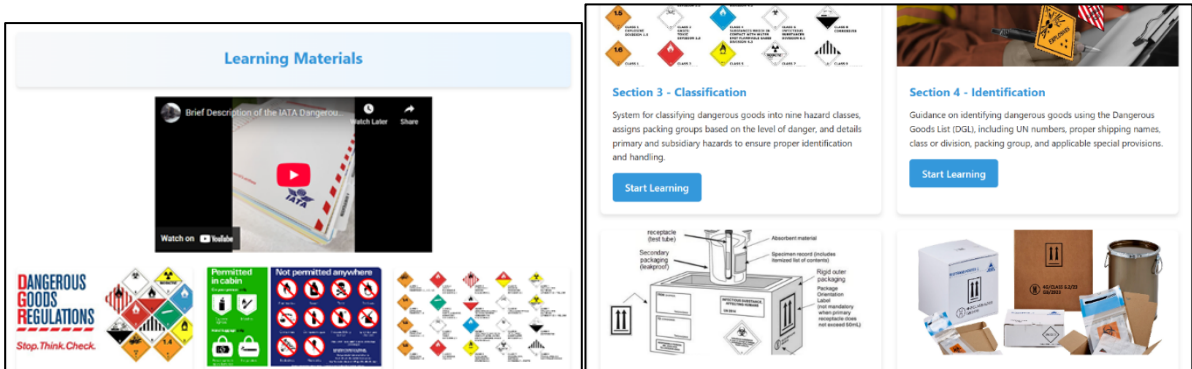


Figure 4. Material Display

This menu contains the main learning pages, organized into sections such as Section 1 – Applicability, Section 2 – Limitations, and so on. Each section is supplemented with text, images, tables, and Dangerous Goods labels and symbols in accordance with IATA DGR standards.

Small, Non-Removable Gas Cartridges

Table 2.3.A Provisions for Dangerous Goods Carried by Passengers or Crew

Items	The approval of the operator is required	Permitted in or as checked baggage	Permitted in or as carry-on baggage	The pilot-in-command must be informed of the location
Alcoholic beverages, when in retail packaging, containing more than 24% but not more than 70% alcohol by volume, in receptacles not exceeding 5 L, with a total net quantity per person of 5 L.	NO	YES	YES	NO
Ammunition, securely packaged (in Div. 1.4S, UN 0012 or UN 0014 only), in quantities not exceeding 5 kg gross weight per person for that person's own use. Allowances for more than one person must not be combined into one or more packages	YES	YES	NO	NO

Dangerous Goods Forbidden in Aircraft Under Any Circumstances

Any article or substance which, as presented for transport, is liable to explode, dangerously react, produce a flame or dangerous evolution of heat or dangerous emission of toxic, corrosive or flammable gases or vapours under conditions normally encountered in transport must not be carried on aircraft under any circumstance.

Example:

- Explosives that are extremely sensitive



Boosters, Class 1 Dangerous Goods

- Substances with uncontrolled reactions




Figure 5. Sub-Menu Sections

Each section on this page provides detailed explanations. For example, Section 3 – Classification presents the principles of classifying dangerous goods, types of hazard classes, and packing groups. The content is designed to support a step-by-step learning experience for students.


Dangerous Goods Learning Center

Home Materials Practice

Example Questions



Question 1 | Substance Identification
Identify the Proper Shipping Name of a substance based on the stated characteristics.



Question 2 | Segregation of Dangerous Goods Packages
Identify if two dangerous goods materials can be packed in a

Classification of Hexamitate Oxide

Case Study

You are tasked with determining the correct Dangerous Goods classification for a chemical substance named **Hexamitate oxide**.

UN Number	Proper Shipping Name	Class / Division	Packing Group	Packing Instruction	Max Qty	Net Qty
UN 2802	Copper chloride	Class 8 Corrosive	PG III	860	25 kg	10 kg
UN 1341	Phosphorus sesquisulphide	Div 4.1 Flammable Solid	PG II	445	15 kg	5 kg
UN 2730	Nitroanisoles, liquid	Div 6.1 Toxic	PG III	655	60 L	20 L

Figure 6. Practice Display

This menu contains Example Questions divided into several topics, such as Question 1 – Substance Identification and Question 2 – Segregation of Dangerous Goods Packages. Each practice question is accompanied by a case study, relevant tables, and explanatory notes to help students practice and deepen their understanding of the classification and handling of dangerous goods.

Website Feasibility

Table 2. Feasibility Test by Subject Matter Expert

Aspect	Score	Max Score
Material	30	32
Language	8	8
Total	38	40
Aspect	Score	Accumulated Score Percentage
Total	95	95%

Table 3. Feasibility Test by Media Expert

Aspect	Score		Max Score
	Expert 1	Expert 2	
Interface	22	24	24
Functionality	15	16	16
Total	37	40	40
Aspect	Score		Accumulated Score Percentage
Total	92,5	100	96,25%

The feasibility evaluation results indicate that the developed web-based learning platform for Dangerous Goods is highly viable for educational implementation. The assessment by a subject matter expert resulted in a total score of 38 out of a maximum 40, reflecting a 95% feasibility rate. This suggests that the instructional content and language components are accurate, relevant, and appropriate for supporting student learning in compliance with established aviation safety standards. Furthermore, validation by media experts yielded scores of 92.5% and 100%, averaging a combined feasibility score of 96.25%. These high percentages reflect the platform's effectiveness in terms of interface usability, navigational structure, and functional responsiveness—key elements in digital learning environments. Feasibility percentages exceeding 85% typically indicate that an educational product can be considered highly valid and ready for deployment without substantial revision [16]. These findings align with existing literature demonstrating that well-designed web-based learning tools—offering intuitive interfaces and high-quality instructional content—can significantly enhance student engagement and learning outcomes. For instance, a systematic review found that online learning platforms can improve academic performance and engagement when they include interactive elements and multimedia resources [17]. The high feasibility scores from both subject matter and media experts underscore that the platform not only delivers pedagogically accurate content but also incorporates user-friendly and engaging design. This suggests strong potential for the platform to support self-directed, flexible learning, particularly in highly technical domains such as aviation Dangerous Goods education.

4 CONCLUSION

This study confirms the feasibility and relevance of a web-based learning platform for the Dangerous Goods course in aviation education. Developed using the 4D model, the platform received strong validation from experts, with all key aspects rated above 85%. The results highlight the platform's potential to enhance independent learning, especially in complex regulatory subjects. Future development may focus on expanding content depth, implementing real-time assessments, and integrating user analytics to further enhance instructional effectiveness and learning outcomes.

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