

# Research on the Application of Virtual Reality Technology in Practical Teaching in the Police Academy --With the Identification of Dangerous Goods as an Example

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**Abstract:** Practical teaching is essential for police academy students to master the knowledge of dangerous goods (DG). There are, however, deficiencies in the traditional practical teaching of DG, such as a single teaching style, insufficient learning aids, and difficulty combining with actual combat. Students cannot consolidate their knowledge of DG more effectively using traditional instructional methods and procedures. With the advancement of virtual reality technology, its unique and distinguishing characteristics will be increasingly applied to the field of police education, thereby compensating for the shortcomings of the conventional method of teaching. This study develops a dangerous goods identification teaching system, which includes observation projects, comparison projects and case studies, based on the application of VR to the practical teaching of DG. The system has remarkable characteristics such as repeatability, practicability and safety, allowing it to realize the combination of virtual and reality, theory and practice, effectively improve the practical teaching effect of DG, and meet the demands of actual combat and modernization of police education.

## 1 Introduction

"Everything must assist the actual combat" is the principle and objective of police education with the practical application of police education as the top priority. Police academies are the primary conduit for cultivating police reserves, conducting on-the-job police training, and researching police theory and actual combat. Police education is influenced by practical instruction, which is exclusive to teaching techniques and approaches. We can only meet the requirements of the times for the modernization of teaching and police education by combing those with teaching approaches. However, as an essential subject for police academies and universities, practical teaching typically presents insurmountable obstacles. It cannot excite students' interest in learning nor restore the status quo of the case, drastically lowering the efficacy of practical teaching and rendering it incapable of meeting the criteria and requirements of police education. Practical DG education must stay up with the times and enhance teaching strategies and procedures. Therefore, it is of the utmost importance to investigate practical teaching reform utilizing new technologies.

China's Education Modernization 2035 [1] and the Implementation Plan for Accelerating Education Modernization (2018-2022) [2] herald a new plan for the development of China's education in the future. Modernization of educational means and technology is the cornerstone of education modernization, which influences the direction of educational progress, the conduct of educa-

tors, and the learning efficiency of educated individuals. As a result of the ongoing demands and support of school modernization, widespread new technologies are entering classrooms gradually. VR technology provides a simulated world and objects, enabling real-time interaction through the use of sensor devices and virtual reality information. To accomplish human-computer interaction and achieve an immersive experience, the senses of touch, sight, and hearing connect with one another. Its distinctive characteristics of immersion, interaction, and conception will also serve as a new method and technology for the modernization of education, which will be gradually applied to police training. This also presents fresh directions and opportunities for DG's practical education reform. By consistently strengthening practical teaching, we can meet the demands of police education and provide society with more exceptional police officers [3].

Through research on the practical teaching reform of DG and the characteristics of VR technology, this paper concludes that VR technology can be used to avoid and overcome the original difficulties and create new teaching experiences and methods, thereby enhancing the teaching effectiveness and allowing for a more realistic application of textbook knowledge.

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## 2 The traditional method of practical education

### 2.1 The current status quo of conventional practical education

According to the curriculum system of National Standards for High-quality Police Teaching promulgated by the Ministry of Education: "Practical teaching credits account for at least 35 percent of the total credits" [4], the dangerous goods courses in police academies are required to incorporate practical teaching. This entails a variety of components, among which identification instruction is a crucial one, since it serves as the foundation and core of the other parts. In reality, the conventional method of instruction involves teachers continually explaining DG to students through the use of images and videos. Asking students to see and learn from the restricted number of copies of dangerous goods, or to simply describe these items, is another method for implementing this style. This method of education has existed for quite some time. From the standpoint of teaching methods and efficacy, there are the following primary issues:

One is the monotonous method of instruction. Traditional DG identification instruction consists of learning and explaining theoretical knowledge through the display and replay of necessary materials pertaining to DG. This flat, one-way method of instruction may allow students to comprehend some pertinent information, but it is incapable of displaying the appearance, components, and composition of each dangerous good in a comprehensive and three-dimensional manner, let alone providing training for deeper recognition. Students' understanding of DG is likely to be superficial and hazy. Teachers and students lack the initiative to communicate with one another; consequently, students passively assimilate knowledge, making it difficult to enhance instructional effectiveness [5];

Second, there are insufficient teaching tools. Dangerous goods in the restricted sense relate to the products managed by the state's public security agencies in line with the applicable laws and regulations. Even dangerous items in the narrow sense are abundant in variety and number, so from a practical standpoint, it is vital to develop learning aids selectively. Only risky, easy-to-manufacture goods in a certain category may be used as teaching aids for practical instruction. It is difficult for pupils to establish an interest in learning, and they lack motivation for active and in-depth study. Ineffectiveness, lack of confidence, and failure to achieve the desired educational effect also characterize teachers' use of learning aids for identification instruction. With only learning aids, it is difficult to conduct other, more practical teaching activities.

Thirdly, the actual battle is difficult to integrate with. In the traditional method of learning the theoretical knowledge of DG, reference images or films always adhere to a particular "identification standard." In this context, the teacher will demonstrate to the pupils, one by one, the identifying features of DG, including its look, substance, component, and size. Over time, the students only

know the DG through the reference images and films they have learned, which increases the likelihood that they will build a stereotype. It is impossible to implement what you have learned in actual combat [6]. Based on recent incidents, DG is also in constant flux. It is evident that DG's knowledge cannot be habitually constrained by the current knowledge system and identification criteria, nor diverted from the actual battle.

### 2.2 Evaluation of conventional practical teaching method

Traditional DG practical instruction is confined by reality, which is inescapable and, to some extent, surmountable. From the source of the issue, the following are the primary causes.

Firstly, it is difficult to obtain DG. Every coin has two sides, and so does DG. On the one hand, they have hazardous properties like explosion, flammability, toxicity, infection, corrosion, and radiation. It is simple to inflict physical harm, property damage, or environmental pollution during transport, storage, production, operation, use, and disposal. On the other hand, it is an essential element of economic development and social life, and it plays a crucial part in daily production and life. Therefore, the management of dangerous items is quite stringent in all nations. Before they can be obtained in the real world, DG must satisfy a number of legal requirements. It is significantly more difficult to get DG for educational purposes.

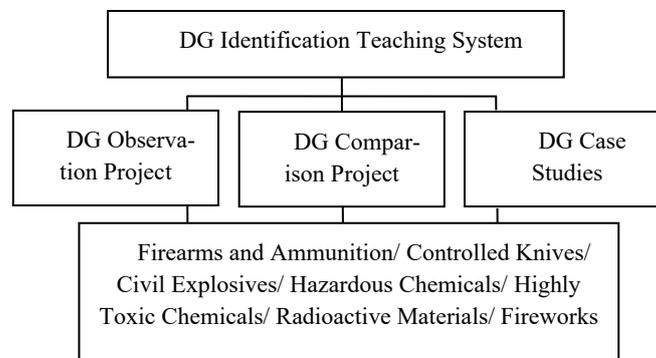
Second, it is challenging to create teaching tools. The production of instructional aids for DG necessitates not only a similar appearance to the actual object, but also a rigorous and accurate structure. Some DG must also be deconstructed to permit internal observation and learning. These criteria will ultimately result in production difficulties and expensive production costs. As a result, the number of learning aids that may be employed in instruction is limited, the repetition rate is high, and the simulation impact is weak. Even if there were no issues with economic cost and production, the created teaching aids would still be subject to future changes in standards and regulations. The original dangerous goods may no longer qualify as dangerous goods; hence, the current DG teaching aids lose their initial purpose, resulting in significant cost losses.

Lastly, the expense of maintenance is substantial. To safeguard social and public safety, all types of flammables, explosive, toxic, and other DG must be carefully stored in compliance with relevant legislation, standards, and other stringent requirements. The stringent criteria necessitate substantial investment in personnel, financial, and physical costs in order to simultaneously implement the three facets of human, physical, and technical protection. The investment in labor, financial, and physical expenditures for the production of a complete spectrum of DG is much more difficult to assess. Moreover, for ensuring the normal usage of DG, good performance and stable harmful features, the related DG must be routinely maintained, which will require a considerable financial investment; otherwise, poor maintenance will result in serious safety risks.

### 3 VR technology in practical teaching mode

In recent years, numerous police colleges and universities have incorporated virtual reality (VR) technology to accomplish practical outcomes in a particular major or

course. These accomplishments are primarily applicable to majors or courses with high risk, high cost, and challenging repetition, as well as those that are cross-border. However, the use of VR technology in the practical instruction of hazardous materials has not been researched or designed.



**Fig. 1.** DG Identification Teaching System

In view of the problems in the traditional teaching mode stated in this article, we have employed VR technology in the practical teaching of recognizing DG and constructed a DG identification teaching system with the characteristics of police academies. The system covers all kinds of common DG. As illustrated in Figure 1, this system incorporates three practical teaching projects, namely, the DG observation project, the DG comparison project, and the DG case studies. These instructional programs are organized around the common dangerous goods handled by public security organizations in compliance with national laws and regulations. The following outlines the precise contents of these projects:

#### 3.1 DG Observation Project

Only by comprehensively and systematically observing and comprehending dangerous goods and by mastering the important components such as appearance, material, components, dimensions and standards for identifying DG, can a solid foundation be established for teaching other dangerous goods in a more practical manner. Consequently, we utilized 3Dmax software to individually sketch and model a variety of frequent dangerous goods. We conducted texture mapping and lighting effects on the produced 3D model to create realistic VR goods, and then loaded the 3D model or panoramas into the Unity3d software development platform. In addition, we created human-computer interaction that can be exhibited on VR headsets such as the HTC Vive. In the virtual reality environment, each student has more security, more time, and more diverse DG to observe and learn, so as to avoid missing information or learning too quickly owing to the constraints of reality. This system includes all popular DG types. By picking the catalog, you may begin to study and observe various DG. The dangerous goods listed in each catalog are accompanied by a description of their qualitative significance.

In the virtual reality environment, students are not only able to freely hold and observe dangerous goods as they

would in reality, but they can also transcend the limitations of reality by zooming in or spinning the objects to observe them from multiple angles. Therefore, pupils can comprehend their unique shape, material composition, and dimensions, enhancing their learning experience. Different components make up dangerous goods, and in reality, there are detachable and nondetachable (nonrequired) dangerous goods. For the detachable ones, they can be disassembled into components in the virtual reality environment, where operating lights can be placed on various components and a pop-up text box can provide the component's name and function. This can make up for the loss of not being able to observe the primary component in its entirety in the past, thus improving students' enthusiasm for learning.

For nondetachable (nonrequired) items, the main components are frequently placed externally and are easy to observe. When observing nondetachable (nonrequired) items in a virtual reality environment, the object's operating lights can display all the main components and their names, enhancing learning efficacy. In the dangerous goods observation project, virtual and actual reality are blended, allowing for repeated observations. Students are able to continually solidify their knowledge of dangerous goods that must be mastered as they are no longer constrained by reality.

#### 3.2 DG Comparison Project

A second goal of learning about dangerous goods is to enable students to rapidly and reliably identify real dangerous goods amid complicated objects. Without the ability to compare and distinguish DG, it will be impossible to avoid, stop, and manage DG. Due to misidentification and omission, it is highly likely that hazardous materials are misunderstood and overlooked in the workplace. Still dispersed throughout society are DGs that have not been disposed of in a timely manner, leaving them in an "uncontrollable" state and posing a grave hazard to the safety of people's lives and property.

The varieties and amounts of dangerous goods in the virtual reality environment are constantly increasing. The sample library for the DG comparison project contains a broad assortment of DG and real-world goods with similar appearances. Therefore, DGs are mixed and crossed with other items in the comparison project, which subtly increases the identification complexity and stimulates students' interest and thirst for knowledge. The management terminal allows instructors to modify the learning difficulty at any moment by setting criteria such as the specified number of DG, the random number of total items, and the specified completion time. This project consists of two learning modes in order to boost learning motivation and effectiveness.

One is the single-player learning mode. In this mode, students compare and assess items through a succession of self-judgments, such as appearance, size, composition, etc., based on prior knowledge. They must identify the specified number of DG and submit them before the deadline. The completion time and correct rate will be displayed on the interface and logged, which is handy for future reference, error correction, and academic performance monitoring;

The second mode is multiplayer learning. Using numerous VR devices, students can engage in competition. Teachers can also alter the learning difficulty at any time by using the administration terminal to pick various settings. In order to achieve higher scores in such a short amount of time, students must optimize and streamline the comparison procedure in order to make quick and accurate assessments. In a bid to save time during catalog selection, the multi-person learning mode is configured to put items on the desktop. Students can compare and evaluate by grabbing and observing, so exercising their application skills and responsiveness. This initiative has drastically altered the process of enhancing practical education and resolved issues that could not be addressed in the past. Not only may students properly use their knowledge in this project, but they can also engage in the process with tremendous enthusiasm.

### 3.3 DG case studies

Numerous situations involving DG in the real world reveal that some non-standard goods have distinctive shapes and components that are plainly distinct from the theoretical DG described in books. In terms of injuries, property losses, and societal risks, the responsible departments have determined that it belongs to a certain category of dangerous goods. In addition to gaining theoretical information, students should deepen their understanding of past case studies to increase their practical experience, enabling them to better apply what they have learned in the real world.

The case items cannot be restored for observation and identification learning, given the actual circumstances and technical means. They can only be viewed and explained via multimedia by the instructor, whose unique details cannot be displayed. The inability of students to recognize these elements renders actual combat training rudimentary and nonspecific. In DG case studies, all types of actual

dangerous goods are simulated in a virtual world using VR technology, and a text box is utilized to describe the case's context. Students can observe the intricacies of the dangerous objects involved in the case, including the objects themselves, outside packaging, and soft packaging used for camouflage, concealment, and covering.

In the same manner as judging suspected dangerous goods in reality, in addition to observing the unique appearance of the dangerous goods in the case, it is also necessary to analyze internal structural components, chemical composition, experiments for identifying DG, observe the combustion and explosion form of dangerous goods, and in some cases, the scope of influence.

This can assist students in comprehending the function and rationale of the aforementioned steps in the judgment process, as well as each judgment step and conclusion of actual cases, thereby enhancing their sense of participation and realism in actual combat and identifying their own blind spots for future learning. The DG case studies can circumvent the restrictions of reality, include students in the decision-making process of a virtual case, evaluate their learning efficacy, and realize the effective integration of theory and practice.

### 3.4 Teaching quality

The experimental group consisted of 39 students majoring in Science of Public Order from Class 1 of the 19th grade, while the control group consisted of 40 students from Class 2. In the course of Dangerous Goods Management, the experimental group utilized virtual reality technology, whilst the control group was instructed using the conventional method of practical instruction. After the course, a teaching quality evaluation survey was distributed to both student groups. Table 1 demonstrates that, with the exception of question 5, the experimental group outperforms the control group. In the first place, we feel it is indisputable that the traditional method of teaching through the practical application may still achieve the intended learning outcomes. In contrast, students believe they are more effective at learning (92.3%>82.5%) and happier with the teaching technique (92.3%>75%) when taught utilizing VR technology. Second, a greater proportion of students believe that they are attracted to innovative learning approaches and that active engagement helps them concentrate better on learning (89.7%>62.5%). Students feel more inspired so that they can identify their own weaknesses, encouraging self-study and review outside of class (94.8%>85%). Finally, when integrated with VR technology, students are able to better notice the features of dangerous goods and gain a deeper grasp of DG (87.2%>75%). Through DG identification and comparison projects and GD case studies, students can have a deeper comprehension of the curriculum (97.4%>72.5%). For issue 5, based on the feedback and observations of the experimental group's pupils, it was determined that in the traditional method, a single teacher instructs a large number of students, allowing for a discussion break when students become confused. The manner of practical instruction for VR technology is one-on-one. In this procedure, instruction begins simultaneously, but pupils have

distinct learning and comprehension abilities, resulting in disparate progressions. When multiple students seek assistance from a teacher, the teacher is so overburdened that he or she cannot respond to the inquiries in a timely

manner (84.6–90%). In the future, this will be optimized by incorporating a concentrated discussion session, more teachers, and a dialogue system into the process.

**Table 1.** Teaching Quality Evaluation Survey

Questions	Experimental Group	Control Group
1. This way of teaching makes learning more efficient	92.3%	82.5%
2. It is able to increase understanding of DG	87.2%	75%
3. It is able to grasp concentration for learning	89.7%	62.5%
4. It is able to help deepen understanding of the knowledge taught	97.4%	72.5%
5. It is able to discuss with the teacher timely	84.6%	90%
6. It is able to be inspired and motivated to study	94.8%	85%
7. It is able to be satisfied with this way of teaching	92.3%	75%

The criterion for evaluating practical teaching is grade. A written test on DG identification was administered one week after the course was finished (the Ebbinghaus' Forgetting Curve demonstrates that the memory preserved is only around one-fourth of what was first acquired after six days). The scores of the two groups were entered into the SPSS statistical analysis software for independent sample t-test analysis. According to Table 2, the experimental group's score of 87.3846 was approximately 10 points higher than the score of the control group, which was 78.6. The results in Table 3 show that the observed value of the F statistic is 20.567, and the corresponding probability p-value of 0.000 is less than 0.005, so we should look at

the column assuming that the variances are not equal. The t-statistic is 5,324, and the two-tailed p-value of 0.000 is less than 0.005. There is a statistically significant difference between the mean values, indicating that the experimental group and the control group have substantially different written test results. In addition, the 95% confidence interval of the mean difference between the two groups does not exceed 0, confirming the aforementioned conclusion from a different angle. In conclusion, the practical teaching mode with VR technology will continue to be employed as a way of instruction to help students better comprehend the features of dangerous objects and improve their performance.

**Table 2.** Group Statistics

Group	N	Mean	Standard Deviation	Standard Error of Mean
Experimental Group	39	87.3846	5.18406	.83011
Control Group	40	78.6000	9.01793	1.42586

**Table 3.** Independent Sample T-Test

		Equal Variances Assumed	Equal Variances Not Assumed	
Levene Test for Equality of Variances	F	20.567		
	Sig.	0.000		
T-Test for the Mean Formula	t	5.290	5.324	
	df	77	62.544	
	Sig. (two-tailed)	0.000	0.000	
	The 95% Confidence Interval of the Mean Difference	Lower Limit	5.478	5.487
		Upper Limit	12.091	12.082

#### 4 Prospects for Application of the Dangerous Goods Identification Teaching System

Repetition, usability, and security are just a few of the exceptional qualities of the DG identification teaching system. It overcomes numerous limits of reality, deepens the relationship between students and teachers, realizes the combination of theory and practice, and improves the

efficacy of identification instruction. In order to make the most of this system, it can also be applied to the training of site employees and police officers, in addition to police academy courses.

First, application in course training. Throughout their probationary, internship, and post-graduation work in cross-examination, checkpoint inspection, and site inspection, students majoring in police at police colleges and universities will surely come across dangerous goods. Therefore, students should be provided with DG identi-

fication courses to further pique their interest and excitement for learning. In addition to the theoretical knowledge acquired in the classroom, this training approach can be implemented in practical teaching sessions to continuously strengthen students' ability to identify DG in the real world and their future professional competence.

Second, the application of on-site personnel training. There are checkpoints for security inspections at the entrances and exits of public venues and critical locations in order to prevent the unauthorized entry of dangerous goods, which could cause unneeded panic and unanticipated dangerous circumstances. In the event of malfunction, insufficiency, or incompatibility of electronic equipment, it is vital for this staff to increase their training in DG-related knowledge and cultivate their identifying capability of DG.

Finally, application in police training. The public security organizations, which are responsible for maintaining social security and safeguarding public safety and order, should keep up with the evolution and changes of the times and enhance the professional training of police in order to handle a variety of situations. Dangerous goods are likely to be one of the most common forbidden items detected during routine police inspections and patrols. Consequently, this training approach is utilized in police training to continually expand their understanding of DG and acquaint themselves with the appearance and features of DG, so that they may detect and seize dangerous goods and protect social security.

## 5 Conclusion

The dangerous goods identification education system utilizing VR technology is able to transcend the limitations of reality, achieve the merging of virtual and reality, theory and actual combat, excite students' great interest in learning, and increase teaching efficiency. This system is merely a microcosm of VR technology in the practical education of police academies, with much more to come. This necessitates collaboration between police academies and responsible agencies in the development of more platforms and technologies suited for practical instruction in police academies [9-10]. By thoroughly comprehending the era requirements of education modernization and police work modernization and emphasizing the advancement of police education modernization, we will reinforce the connotation building, create police characteristics, and encourage the growth of high-quality education.

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