

THE ROLE OF DIFFERENTIAL EQUATIONS IN DEVELOPING INTUITIVE COMPETENCE AMONG MILITARY CADETS

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Abstract

This article examines the importance of differential equations in developing intuitive competence among cadets of higher military educational institutions. Using a scientific-methodological approach, the study analyzes how differential-equation-based modeling supports rapid decision-making, situational assessment, forecasting, and the optimization of tactical and technical actions in complex military environments. The pedagogical mechanisms for enhancing intuitive thinking are explained, supported by real military modelling examples.

Keywords: Intuitive competence, differential equations, military education, modelling, decision-making, mathematical preparedness.

Introduction

In modern military education, the mathematical preparation of cadets encompasses not only a set of theoretical concepts but also the ability to make independent decisions in real combat conditions, rapidly analyze situations, and determine optimal actions. The specific characteristics of military operations – uncertainty, time constraints, varying levels of risk, and the complexity of external influencing factors – necessitate the development of intuitive competence.

Intuitive competence refers to a cadet's ability to make quick, accurate, and meaningful decisions in complex situations. It emerges from the interrelationship between structured knowledge, experience, psychological readiness, and skills of mathematical modelling. Differential equations constitute the theoretical and methodological foundation of these modelling processes.



1. The Essence of Intuitive Competence and Its Role in Military Education

Intuitive competence requires cadets to develop abilities such as:

- rapid structural analysis of a situation;
- sensing the internal dynamics of changing processes;
- making correct predictions under incomplete information;
- ensuring optimality in shooting, maneuvering, positional planning, and operating military equipment.

Many military processes – projectile trajectories, vehicle movement, fuel consumption, enemy force deployment, weather impacts, and logistic flows – change over time. Differential equations mathematically define the scientific basis of understanding such dynamic systems.

2. The Role of Differential Equations in Developing Intuitive Competence

2.1. As a Tool for Modelling Dynamic Processes

Differential equations enable cadets to:

- mathematically express time-dependent changes in physical, technical, and operational processes;
- identify influencing factors and predict trends;
- perform rapid calculations for optimal decision-making;
- connect mathematical reasoning with real military processes.

This fosters intuitive abilities such as:

- visualizing trajectory changes;
- sensing acceleration or deceleration patterns;
- predicting the enemy's potential movements;
- understanding operational rhythms of technical systems.

2.2. Military Example: Projectile Motion in Artillery

The projectile's flight trajectory can be modelled using the system:

$$\begin{cases} \frac{dx}{dt} = v \cos \alpha, \\ \frac{dy}{dt} = v \sin \alpha - gt, \end{cases}$$

where x, y are coordinates, v is the initial velocity, α is the launch angle, and g is gravitational acceleration.

Mastering this model helps cadets:

- anticipate changes in height and distance;
- understand the influence of wind, air pressure, and projectile mass;
- intuitively evaluate the probability of hitting the target.

2.3. Managing Dynamic Processes in Military Machinery

The motion of tanks, military vehicles, or drones is described by:

$$m \frac{dv}{dt} = F_t - F_q,$$



where F_t is traction force and F_q is resistance.

This model helps cadets intuitively sense:

- when technical acceleration will be at its maximum;
- under which conditions fuel consumption increases;
- how risk changes on uneven or unstable terrain.

3. Pedagogical Mechanisms for Developing Intuitive Competence

3.1. Model-Based Instruction

A sequence of mathematical model → dynamic simulation → comparison with real cases deepens cadets' rapid analytical skills.

3.2. Visualization of Time-Dependent Processes

Using MATLAB, Python, Simulink, and GeoGebra allows cadets to:

- visualize movement trajectories;
- modify parameters in real time;
- evaluate consequences quickly.

This significantly enhances intuitive sensitivity.

3.3. Scenario-Based Military Tasks

Examples:

- "How does the probability of hitting a target change when a projectile is launched at 60°?"
- "Determine the optimal speed of a tank column using a differential model."

Such tasks strengthen quick reasoning and prediction skills.

4. Practical Military Examples Strengthening Intuitive Competence

4.1. Radar Tracking of Moving Objects

A moving object's position satisfies:

$$\frac{dr}{dt} = v(t)$$

Tracking changes in t helps cadets form an internal "mental map" of object movement.

4.2. Movement of Troops and Logistic Flows

Logistic distribution dynamics can be expressed by:

$$\frac{dQ}{dt} = kQ \left(1 - \frac{Q}{Q_{\max}} \right)$$

This helps cadets intuitively identify:

- stages where shortages may occur,
- optimal strategies for resource allocation.

Conclusion

Differential equations are one of the key methodological tools for developing intuitive competence in military cadets. They allow the modelling of dynamic processes, accelerate



decision-making in real military situations, improve situational analysis, and cultivate the ability to foresee consequences. Integrating mathematical modelling with pedagogical technologies, visualization tools, and practical military scenarios effectively prepares cadets for professional military activity.

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