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(71) Name of Applicant(s):
1. Archana Satish Shirsat,
2. Dr. Vinod Shravan Khairnar,
3. Dr.pradnya Sunil Raut,
4. Dr.rajendra Shaligram Dhake,
5. Mrs.seema Kisanrao Nikam,
6. Mrs.jyotsana Shukracharya Gore (jagtap,
7. Mrs.sneha Arun Shinde,
8. Mr. Rajkumar Digambar Rajkuvar,
9. Ms. Mahekar Komal Ravindra,
10. Mrs. Shilpa Suresh Shinde,
11. Mr. Ghanahshyam Haribhau Borate,
12. Mr. Sunil Prabhakar Sonavani,

(72) Name of Inventor(s):
1. Mrs.archana Satish Shirsat
2. Dr. Vinod Shravan Khairnar
3. Dr.pradnya Sunil Raut
4. Dr.rajendra Shaligram Dhake
5. Mrs.seema Kisanrao Nikam
6. Mrs.jyotsana Shukracharya Gore (jagtap
7. Mrs.sneha Arun Shinde
8. Mr. Rajkumar Digambar Rajkuvar
9. Ms. Mahekar Komal Ravindra
10. Mrs. Shilpa Suresh Shinde
11. Mr. Ghanahshyam Haribhau Borate
12. Mr. Sunil Prabhakar Sonavani

(57) Abstract:

The present invention relates to a digital educational framework configured to automatically generate and solve academic problems based on the analysis of physical and chemical processes. The proposed system integrates data acquisition, mathematical modelling, and intelligent computation to observe real-world physical and chemical phenomena and translate them into structured educational problems in disciplines such as engineering mathematics, physics, and chemistry. The framework comprises modules for data collection, process interpretation, problem formulation, solution computation, and visualization. By analysing parameters including temperature, pressure, velocity, concentration, and reaction rates, the system generates theoretical and numerical problems along with step-by-step solutions. The invention assists students, educators, and researchers in improving conceptual understanding and problem-solving skills. The framework further enables adaptive difficulty levels and

real-time problem generation from experimental or simulated systems, thereby enhancing digital learning environments in science and engineering education.

Title of the Invention

A Digital Framework for Generating and Solving Educational Problems through Analysis of Physical and Chemical Processes

Abstract:

The present invention relates to a digital educational framework configured to automatically generate and solve academic problems based on the analysis of physical and chemical processes. The proposed system integrates data acquisition, mathematical modeling, and intelligent computation to observe real-world physical and chemical phenomena and translate them into structured educational problems in disciplines such as engineering mathematics, physics, and chemistry.

The framework comprises modules for data collection, process interpretation, problem formulation, solution computation, and visualization. By analyzing parameters including temperature, pressure, velocity, concentration, and reaction rates, the system generates theoretical and numerical problems along with step-by-step solutions.

The invention assists students, educators, and researchers in improving conceptual understanding and problem-solving skills. The framework further enables adaptive difficulty levels and real-time problem generation from experimental or simulated systems, thereby enhancing digital learning environments in science and engineering education.

Field of the Invention

The present invention generally relates to digital education technologies and intelligent learning systems. More particularly, the invention relates to a computer-implemented framework for automatic generation and solution of educational problems derived from the analysis of physical and chemical processes.

Background of the Invention

Problem-solving is a fundamental component of education in scientific and engineering disciplines, including mathematics, physics, and chemistry. Conventional educational methods typically rely on static problem sets provided in textbooks, examination materials, or instructional resources. While these problems serve educational purposes, they often fail to represent dynamic real-world phenomena and rarely adapt to the learner's level of understanding.

In physical and chemical sciences, numerous academic problems originate from observation of natural phenomena such as heat transfer, motion dynamics, diffusion processes, chemical reactions, and energy transformations. However, converting real-world observations into structured academic problems generally requires manual effort by instructors or researchers.

With the advancement of digital technologies and intelligent educational platforms, there is a growing need for automated systems capable of generating educational content dynamically. Such systems can bridge the gap between theoretical learning and observable scientific phenomena.

Existing digital learning platforms mainly provide pre-defined problem banks or automated grading systems, but they lack the ability to generate problems directly from physical or chemical observations.

Accordingly, there exists a need for a digital framework capable of analyzing real-world physical and chemical processes and automatically generating educational problems along with corresponding solutions. Such a system would significantly enhance interactive learning and scientific understanding.

Objectives of the Invention

The primary objectives of the present invention include:

1. To develop a digital framework capable of generating educational problems from observed physical and chemical processes.
2. To provide an automated mechanism for solving the generated problems using mathematical and computational models.
3. To integrate analysis of physical and chemical parameters including temperature, pressure, velocity, and concentration.
4. To create an intelligent educational platform that connects real-world scientific phenomena with academic problem-solving.
5. To provide adaptive difficulty levels for generated problems based on the user's educational level or performance.
6. To enable graphical visualization and step-by-step explanation of generated problems and solutions.

Claims:

1. A digital framework for generating and solving educational problems based on analysis of physical and chemical processes, comprising:
   a data acquisition module configured to collect observational data;
   a process analysis module configured to interpret scientific relationships among observed variables;
   a problem generation module configured to automatically generate educational problems;
   a computational solution engine configured to compute solutions for the generated problems; and
   a visualization interface configured to present generated problems and solutions to users.
2. The framework according to claim 1, wherein the data acquisition module collects data from sensors, laboratory experiments, simulations, or user inputs.
3. The framework according to claim 1, wherein the process analysis module applies mathematical models and scientific laws to interpret physical and chemical parameters.

4. The framework according to claim 1, wherein the problem generation module automatically formulates conceptual, numerical, or analytical problems.
5. The framework according to claim 1, wherein the solution engine generates step-by-step explanations for computed solutions.
6. The framework according to claim 1, wherein the visualization interface displays graphs, diagrams, and scientific representations.
7. The framework according to claim 1, wherein the system supports adaptive problem difficulty levels based on user performance.

Drawings:

Figure 1: System Architecture of Digital Framework

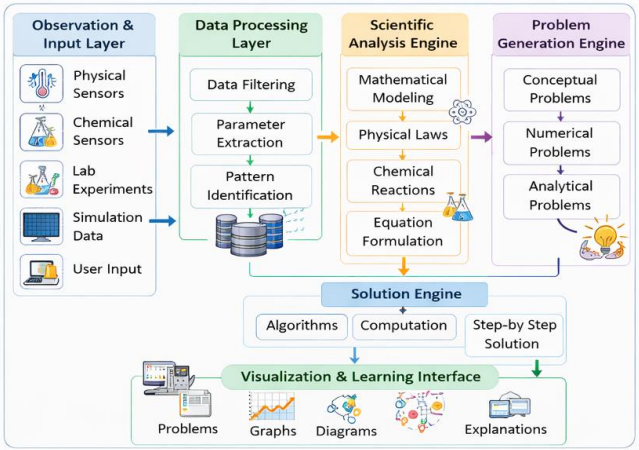


Figure 2: Flowchart – Problem Generation Process

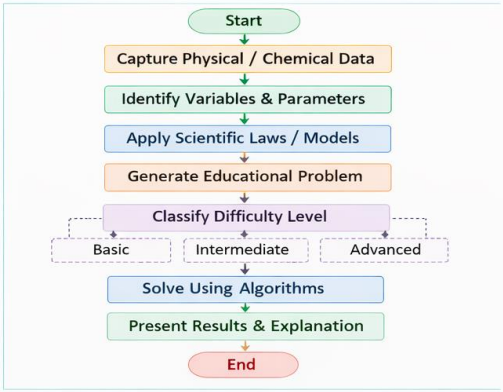


Figure 3: Functional Modules of Problem Generation & Solution System

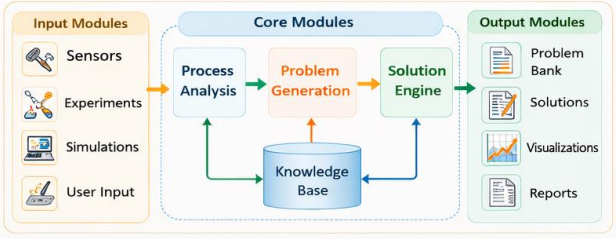
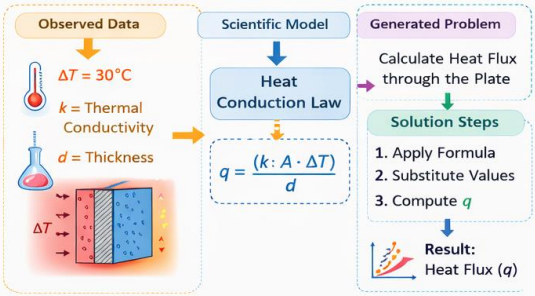


Figure 4: Example Workflow – Heat Transfer Problem Generation & Solution



The accompanying drawings illustrate embodiments of the invention and are intended to facilitate understanding of the system architecture and operational processes.

Figure 1 illustrates the overall system architecture of the digital framework designed for generating and solving educational problems derived from physical and chemical processes.

Figure 2 illustrates a flowchart representing the sequential process involved in converting real-world physical and chemical observations into structured educational problems.

Figure 3 illustrates the functional modules of the automated problem generation and solution system.

Figure 4 illustrates an example workflow demonstrating how a real physical or chemical phenomenon is translated into a mathematical or scientific problem and subsequently solved.

Detailed Description of the Invention:

Figure 1 – System Architecture of the Digital Framework

Referring to Figure 1, the overall architecture of the digital framework is illustrated. The framework comprises interconnected modules configured to collect observational data, analyze scientific relationships, generate educational problems, and compute corresponding solutions.

The system includes a data source layer, data processing module, scientific analysis engine, problem generation engine, solution engine, and visualization interface.

The data source layer receives observational data from multiple sources including physical sensors, chemical sensors, laboratory experiment datasets, and simulation data.

The collected data are transmitted to the data processing module, which performs preprocessing operations including noise filtering, parameter extraction, and pattern identification.

The processed data are subsequently analyzed by the scientific analysis engine, which applies mathematical modeling techniques and scientific laws to construct a model representing the observed phenomenon.

The derived scientific model is then provided to the problem generation engine, which converts the model into structured educational problems.

The generated problems are processed by the solution engine, which applies computational algorithms and mathematical methods to compute solutions.

Finally, the visualization interface presents the generated problems, graphical representations, and step-by-step solutions to users.

Figure 2 – Flowchart of the Problem Generation Process

Referring to Figure 2, a flowchart illustrates the sequential process through which observational data are transformed into educational problems and solutions.

The process begins with capturing observational data from physical or chemical systems.

Next, the system performs identification of relevant variables and parameters, including temperature, pressure, concentration, and velocity.

The system then applies scientific laws or mathematical models to describe the observed phenomenon.

Based on the established model, the system generates an educational problem statement representing the scientific process.

The system subsequently classifies the problem difficulty level, which may include basic, intermediate, or advanced categories.

The generated problem is then solved using computational algorithms, and the results are calculated.

Finally, the system presents the results with explanatory steps and visual representations.

Figure 3 – Functional Modules of the System

Referring to Figure 3, the system architecture is divided into input modules, core processing modules, and output modules.

The input modules include components responsible for collecting data from sensors, laboratory experiments, simulations, and user inputs.

The collected data are analyzed by the process analysis module, which identifies relationships among variables and determines applicable scientific principles.

The analyzed information is transmitted to a modeling engine, which constructs mathematical models representing the observed processes.

A problem generation module then formulates educational problems derived from the constructed model.

The generated problems are processed by a solution engine, which performs computational analysis and determines accurate solutions.

Finally, the results are displayed through a learning interface, providing graphical outputs, diagrams, reports, and interactive educational content.

Figure 4 – Example Workflow for Heat Transfer Problem Generation

Referring to Figure 4, an example embodiment of the invention is illustrated through a heat transfer observation scenario.

In this embodiment, the system receives observational data indicating a temperature difference of 30°C between two regions separated by a material layer.

Additional parameters include thermal conductivity of the material and thickness of the plate.

The scientific analysis engine identifies the governing physical principle as the heat conduction law.

Based on this identification, the problem generation module automatically generates an educational problem requiring the calculation of heat flux through the material.

The generated problem may be expressed as:

A metal plate having thermal conductivity k and thickness d separates two regions with a temperature difference of 30°C. Determine the heat flux passing through the plate.

The solution engine then applies the appropriate heat transfer equation and computes the heat flux.

Summary of the Invention

The present invention provides a digital computational framework that integrates observation, scientific analysis, problem generation, and solution modules for educational applications.

The system is configured to collect data related to physical and chemical processes through sensors, simulations, laboratory datasets, or manual inputs. The collected data are analyzed using mathematical models and scientific principles to identify relationships among variables.

Based on the analyzed relationships, the system automatically formulates educational problems related to subjects including engineering mathematics, physics, and chemistry.

The generated problems may include numerical calculations, conceptual reasoning problems, or analytical questions derived from real-world scientific scenarios such as motion dynamics, thermodynamic processes, diffusion phenomena, or chemical reactions.

Subsequently, the system applies computational algorithms to solve the generated problems and produce detailed explanations. The framework further provides visualization tools including graphs, diagrams, and interactive representations of scientific processes.

The invention therefore provides an intelligent educational platform that bridges theoretical knowledge with real-world scientific observations.