Opportunities to Develop Students' Professional Competencies Based on the Integration of Disciplines

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Abstract: This article analyzes the opportunities for the development of students' professional competencies based on the integration of disciplines and explains the importance of the integration of disciplines in the development of the education system. How to use the integration of sciences is explained in the example of teaching the topic "Approximate and numerical solution of differential equations." In addition, the article provides a number of methodological recommendations for teachers on the use of science integration.

Keywords: integration, integration of sciences, competence, professional competence, differential equation, nonlinear differential equation, approximate solution of differential equations, approximate solution graph, Maple, Mathcad.

I. Introduction

It is known that the purpose of teaching mathematics in higher education is to acquaint students with the basic apparatus of mathematics and the elements necessary for solving theoretical and practical problems, as well as to develop students' logical thinking skills. In addition, it consists of teaching students to study innovations independently, to master their applications, to translate engineering problems into mathematical language. Striving to achieve these goals, in turn, raises the issue of improving the methodology of teaching mathematics.

Today, 70 percent of the world's countries use integrated curricula and textbooks in their education systems. Each country has developed and put into practice different levels of integration based on the objectives set for the education system. The methodology of applying integrated knowledge in the teaching of sciences has shown a positive effect on the study of program materials, the formation of students' skills and abilities to understand the world as a whole, as well as improve the quality and effectiveness of the lesson.

Today, students are very interested in high-tech, computer, information technology and their professions. The transfer of integrated knowledge in the teaching of sciences in the form of various graphs and tables using information technology, including computers, further increases the interest and enthusiasm of students for the lesson. If each teacher conducts the teaching process effectively, using the integration of disciplines, based on their own capabilities, students will develop relatively understandable, complete knowledge and skills. They will also continue to develop their professional activities.

II. Literature review

German scientist German Haken has discovered a synergetic method in the study of an object of science. According to the essence of this method, Haken criticizes the study of natural phenomena, technical and technological processes individually or in a short field in one direction. He recommends the use of the science community and the various methods in them in the scientific research of any object. For example, in the study of the structure and evolution of
the universe, meteorological conditions, the structure of matter, ecosystems and ecology, the sciences of physics, biology, ecology and chemistry, as well as their various principles are used. From this point of view, a synergistic approach is of great importance both methodologically and scientifically in the study of any process.

According to J.B. Ergashev, integration is a process that means that the different parts of the system, the whole organism, are interconnected and cause the same situation.

According to N.M. Akhmedova’s description, integration is the development of interconnectedness, unification as a whole, integration. Integration is the process of combining different parts and elements into one whole.

R.V. Salomova believes that integrated teaching of sciences allows to study their connected topics simultaneously and interconnected. Integration is a new approach to teaching science. Such lessons allow you to save time by complementing the teaching materials of different disciplines.

According to N.M. Akhmedova, integration is the ability to integrate the set of scattered knowledge that a professional needs, and to use the norms of time on the basis of creativity.

III. Analysis

As a result of the strengthening of the integration of mathematics and computer science in the eighties, a new fundamental scientific direction - "computer mathematics" has emerged, which is now widely used in scientific calculations and educational processes. At present, the rapid development of computer mathematics, computer industry and programming technologies is recognized as the basis for the automation of educational, scientific-methodical and scientific research. Currently, there are many software tools created as a result of the application of advances in the integration of mathematics and computer science, aimed at automating the solution of research, scientific-methodical, scientific-technical, engineering, financial and economic, chemical, biological problems. For example: Universal software environments such as Mathematica, Maple, Matlab, Mathcad, Derive, Scientific, Workplace, Femlab, FeexPDE. The use of Maple in mathematics education is one of the main criteria that ensures that the lesson is interesting and productive. The Maple program is the newest symbolic form of mathematics, in which all operations can be performed, from the simplest operations of elementary mathematics to the most complex operations used in special sections of higher mathematics.

IV. Discussion

For example, many types of differential equations cannot be solved precisely analytically. In such cases, they can be solved by approximate solution methods, in particular, by the method of spreading an unknown function to a hierarchical series. In this case, the type=series parameter is displayed after the variables in the dsolve command. The Order:=n command is issued before the dsolve command to specify the distribution order.

The following is the first-order nonlinear differential equation:

\[ \frac{d}{dx} y(x) - y(x)^5 \cos(y(x)) = \exp(y(x)) + y(x)^3; \]

we try to find an approximate solution of the differential equation according to a given initial condition:

\[ y(0) = 0 \]

for this:

\[ \text{restart; Order:=6;} \]

\[ Q:=\text{diff}(y(x),x) - y(x)^5 \cos(y(x)) = \exp(y(x)) + y(x)^3; \]
\[ Q := \left( \frac{\partial}{\partial x} y(x) \right) - y(x)^5 \cos(y(x)) = e^{y(x)} + y(x)^3 \]

\[ C := y(0) = 0; \]
\[ C \equiv y(0) = 0 \]

\[ N := \text{dsolve}\{Q,C\}, y(x), \text{type=series}\}; \]
\[ N \equiv y(x) = x + \frac{1}{2} x^2 + \frac{1}{3} x^3 + \frac{1}{2} x^4 + \frac{11}{20} x^5 + O(x^6) \]

we generate a graph of the approximate solution:

\[ \text{plot}\{\text{series}(1*x+1/2*x^2+1/3*x^3+1/2*x^4+11/20*x^5,x,6),x=-5..5\}; \]

We now consider a differential equation with a definite solution and find its exact analytical and approximate solutions:

\[ \frac{\partial}{\partial x} y(x) = y(x) + x^3 \]

clear analytical solution:

\[ \text{restart; Order:=5:} \]
\[ \text{dsolve}\{\text{diff}(y(x),x)=y(x)+x^3,y(0)=0}\}, y(x)); \]
\[ y(x) = -x^3 - 3 x^2 - 6 x - 6 + 6 e^x \]

approximate solution:

\[ \text{restart; Order:=5:} \]
\[ \text{dsolve}\{\text{diff}(y(x),x)=y(x)+x^3*y(x),y(0)=0\}, y(x), \text{type=series}\}; \]
\[ y(x) = \frac{1}{2} x^2 + \frac{1}{6} x^3 + \frac{1}{6} x^4 + O(x^5) \]

We generate analytical solution and approximate solution graphs:

\[ \text{diff}(y(x),x)=y(x)+x^3*y(x); \]
\[ \frac{\partial}{\partial x} y(x) = y(x) + x^3 \]

\[ \text{restart; Order:=6:} \]
In the graph, the green line represents the exact analytical solution and the red line represents the approximate solution. As can be seen from the graph, the difference between the analytical and approximate solution increased after \( x=2 \). By increasing the level of accuracy in the calculation of the approximate solution, it is possible to approach the exact analytical solution. But in finding an approximate solution, the error increases after a certain value, this can also be seen when solving the above nonlinear differential equation numerically. Therefore, it is preferable to solve nonlinear differential equations numerically.

To numerically solve differential equations (Cauchy problem or boundary value problem), the \texttt{dsolve} command must specify the parameter \texttt{type=numeric} (simple \texttt{numeric}). In this case, the command to solve the differential equations will have the following appearance:

\[
\texttt{dsolve(eq,vars, type=numeric, options)}
\]

here, \texttt{eq} – equations, \texttt{vars} – unknown functions, \texttt{options} – methods.

In MAPLE, the following methods are implemented: \texttt{method=rkf45} – 4,5-order Runge-Kutta-Felberga method; \texttt{method=dverk78} – 7,8-order Runge-Kutta method; \texttt{method=classical} – 3-order Runge-Kutta classical method; \texttt{method=gear} – one-step Gira method; \texttt{method=mgear} – multi-step Gira method.

A graph of a numerical solution of differential equations can be constructed using the \texttt{odeplot(dd,[x,y(x)], x=x1..x2)} command. The following is a numerical solution of the Cauchy problem, the values of the solution and its product at points \( x=0.5 \) and \( x=1 \) are calculated, and the graph of the numerical solution is formed in the interval \(-5 < x < 5\):

\[
\texttt{> restart;}
\]
\[
\texttt{> Q:=diff(y(x),x)-y(x)^5*cos(y(x))=exp(y(x))+y(x)^3;}
\]
\[
\texttt{Q := \left( \frac{\partial}{\partial x} y(x) \right) - y(x)^5 \cos(y(x)) = e^{y(x)} + y(x)^3}
\]
\[
\texttt{> C:=y(0)=0;}
\]
\[
\texttt{C \equiv y(0) = 0}
\]
Below is a numerical solution of the Cauchy problem for the second-order differential equation and a graph is generated:

```maple
> N := dsolve({Q, C}, y(x), numeric);
N := proc(rkf45_x) ... end proc
> N(0.5);
[x = .5, y(x) = .749093938799862968]
```

```maple
> with(plots);

> odeplot(N, [x, y(x)], -5..5);
```

Below is a numerical solution of the Cauchy problem for the second-order differential equation and a graph is generated:

```maple
> eq := diff(y(x), x$2) - x*x*sin(y(x)) = sin(2*x);
```

```maple
> cond := y(0) = 0, D(y)(0) = 1;
cond := y(0) = 0, D(y)(0) = 1
```

```maple
> sol_num := dsolve({eq, cond}, y(x), numeric);
sol_num := proc(rkf45_x) ... end proc
> sol_num(0.5);

```

```maple

```

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```

```

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```

```

```

```maple
> sol_num(1);
```

```

```maple
```

```maple
```

```maple
```

```maple
```
odeplot(sol_num,[x,y(x)],-5..5);

Now we present the process of numerical solution of a system of differential equations and create a graph:

```maple
cond := x(0) = 1, y(0) = 2;
sys := diff(x(t), t) = 2*y(t)*sin(t) - x(t) - t,
diff(y(t), t) = x(t);
F := dsolve({sys, cond}, [x(t), y(t)], numeric);
with(plots);

p1 := odeplot(F, [t, x(t)], -3..7, color=black, thickness=2, linestyle=3, legend="x(t)"); x(t) solution numeric values:

p1 := PLOT CURVES([...])
```

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\[ p2 := \text{odeplot}(\text{F}, [t, y(t)], -3..7, \text{color}=\text{green}, \text{thickness}=2, \text{legend}="y(t)") \]

solution numeric values:

\[
p2 = \text{PLOT}([\text{CURVES}([[-3.75, 2.102040821], [2.0273215052344464, 2.102040821], [2.102040821, 7.53501132953088693], [7.53501132953088693, 2.918367537, 0.18450005612399113, 0.18450005612399113]])\]
\]

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V. Conclusion

The use of the Maple program in the learning process allows the solution function graph to be seen in practice, and students fully understand how accurate the solution is found by looking at the function graph. The use of Maple, which is based on the integration of mathematics and computer science in the teaching of mathematics, serves, firstly, to improve the methodology of teaching mathematics, and secondly, to increase students' interest in information technology. They realize that an in-depth study of both mathematics and modern information technology is a requirement of the times, and they themselves, independently, begin to study the latest advances in mathematics.

In the education system of Uzbekistan it is necessary to increase the number of educational materials and textbooks of an integrated nature. This, firstly, increases the effectiveness of the lesson, and secondly, leads to the development of teacher and student activities. In addition, as a result of increasing the number of integrated teaching materials and textbooks, the volume of textbooks will be reduced, and their cost will be reduced.

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