

Technology in teaching of mathematics

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To paraphrase English scientist, philosopher, and educator Alfred Whitehead, the purpose of education is not to fill a vessel but to kindle a fire. We encourage students to be creative and imaginative in their learning. This desirable goal is not an easy one to realize in mathematics with students whose primary interests are in areas other than mathematics. Even with students majoring in programming at our Globe Institute of Technology, a four-year New York City college specializing in information technology and business.

To serve the needs of these students especially returning adults students whose mathematical proficiencies may have declined during years away from education, we set up course projects to create simple programs such as calculation of a distance in Cartesian coordinate plane, finding the slope of linear function, solving quadratic equations and systems of linear equations using graphing calculators and computers. One of the programs is orientation lines in coordinate plane. We have designed an assignment for one of the remedial classes to construct a program consisting of inputs X and Y-coordinates of a given set of points, slope formula, and displaying the final results by a graphing calculator. The process of constructing and executing this program let the students to understand clearly the relationship between inputs and outputs and how orientation of the lines changes with different sets of given points. The students have understood that the change of a rule of correspondence between inputs and outputs in their programs gives calculation of a distance in rectangular coordinate plane, solutions of linear and quadratic equations. Steps for these programs are :

Step 1. Enter inputs (input A, input B, input C ...).

Step 2. Enter formulas, connecting inputs with outputs, and store the outputs (for example, slope formula : $(B - D) / (A - C) \rightarrow E$.

Step 3. Display the results.

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Step 4. Stop the program.

After two years of pilot experiments using technology in teaching of remedial mathematics an assessment of the grades has showed an increase of the sample mean by 15 % with 95% confidence interval for sample of 200 students. Based on these results we have started to use programming in teaching of remedial mathematics for all classes.

In discrete mathematics classes we use technology in teaching of the probability theory and the graph theory. We have designed the project for finding the optimal Hamilton circuit between cities of the USA using brute-force algorithm, nearest-neighbor algorithm, and cheapest-link algorithm. We have developed the computer program including different methods of searching and sorting out such as A* search, greedy search algorithm, Prim's and Kruskal's algorithms. The process of finding the optimal solution shows the students advantages and flaws of the searching methods and how to combine accuracy of the brute-force algorithm with time saving nearest-neighbor strategy. For example, application of clustering, which means replacement of a group of similar elements by one virtual object. This assemblage of entities makes up a unit located in the "center of gravity of the system". Clustering converts unstructured system in multilevel like tree system. Clustering decreases the number of calculation dramatically. For example, the number of permutation for N elements (the brute-force algorithm) in unstructured system is equal to:

$$P = N!$$

If a number of elements in one cluster are equal to M, number of clusters is equal to N/M, then a number of permutations of clusters are equal to :

$$P1 = (N/M)!$$

And a number of permutations inside of one cluster are equal to:

$$P2 = M!$$

Final number of permutations in the clustered system is equal to:

$$Pf = (M!) * (N/M) + (N/M)!$$

Efficiency of just one level of clustering is equal to:

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$$E = N! / [(M!) * (N/M) + (N/M)!] \quad \text{or}$$

$$E = N! / \{[(M - 1)!] * N + (N/M)!\}$$

If $N = 10$, $M = 5$ then $E = 14,995$ which means that number of calculations decreases almost in 15,000 times.

To use technology in teaching of the probability theory we have designed the project based on the law of large numbers. Using random number generator to automatically generate the random sample the students conduct repeated experiment (toss a coin, roll a die). For programming we used Microsoft Excel. The students have observed how empirical probability approaches theoretical probability when the number of experiments increases dramatically. To find the binomial, normal, Poisson probability distribution the students used a graphing calculator. In every math class we have workshop for teaching how to use different types of a graphing calculator (TI – 82, 83, 83plus, 85, 89).

To involve students in the learning process we have developed course projects in statistics for finding the measures of central tendency and variability of a data. The variable of interest in database was determined by the different characteristics of the Globe Institute of Technology student body such as age, height, weight, SAT, placement test score, updated GPA, points scored by Globe's basketball players etc. One of the important parts of the project was regression analysis and finding fitting correlation models by a graphing calculator. For descriptive and inferential statistics the students use various statistical software (Microsoft Excel, SAS, and MINITAB). Technology engages the students and enables them to gain greater insight into statistics.

Using numeric, symbolic, and graphic representations gives us multiple avenues for investigating and analyzing complicated functions in calculus. We have developed assignments for finding limits where a function does not exist, plotting graphs with maximum and minimum and determining zeros. We have designed projects using technology in the course “ Artificial Intelligence”. These projects based on proposition and predicate logic which develops students' skills for creating 'smart' software. This software has the ability to reason as a tool for problem solving. For

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example, use software for solving problem : Goodman and Batman hold two different jobs : a teacher, a nurse. The job of nurse is held by a male. Goodman is a female. Who holds which job?

Formal logical description of the problem :

1. Has a job (Goodman) \wedge has a job (Batman)
2. Female (Goodman)
3. Male (Batman)
4. \neg Has a job (x, nurse) \vee Male (x) (the job of nurse is held by a male)
5. Has a job (Batman, nurse) \vee has a job (Batman, teacher)
6. Has a job (Goodman, nurse) \vee has a job (Goodman, teacher)
7. \neg Female (x) \vee \neg Male (x)

Machine Reasoning :

8. Applying Unit – Resolution to (7) and (3): \neg Female (Goodman)
9. Applying Unit – Resolution to (4) and (2) and Existential Elimination x/Goodman to (4) : \neg Has a job (Goodman, nurse)
10. Applying Unit – Resolution to (4) and (3) and Existential Elimination x/Batman to (4) : $\neg(\neg$ Has a job (Batman, nurse)) or Has a job (Batman, nurse)
11. Applying Unit – Resolution to (6) and (9): Has a job (Goodman, teacher)

We have proposed for the Senior project constructing programs based on different mathematical ideas such as the emulation of intuition in artificial systems, the method of clustering for genetic algorithm, the creation of the utility function representing multidimensional vector of intelligence. For example, our definition of artificial intuition is an non-intentional extraction of the knowledge from the data and information in the memory and transferring this knowledge into solution. In artificial system genetic information is stored in the hardware and partly in software and contributes to the artificial intuition. All knowledge about objects and processes has to be presented as models designed from the different points of view. Our presentation of the artificial intuition system structure is shown in the fig.

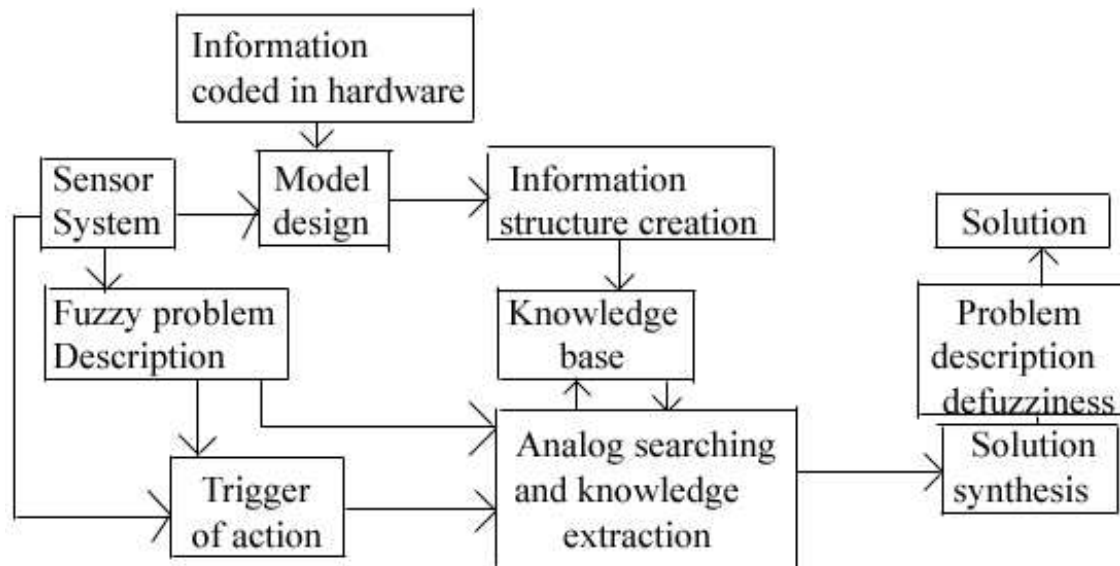


Fig. The Artificial Intuition System Structure.

The students construct programs, do research which arises more questions about possibility using technology in discrete mathematics, statistics, calculus and artificial systems. Optimistic approach to the problem gives reliable hope for the future research.