Bloom's Taxonomy Interpreted for Mathematics

Bloom's Taxonomy is an educational tool developed by Benjamin S. Bloom (1913-1999) that ranks the relative cognitive complexity of various educational objectives. This taxonomy is often used as an aid when creating test questions and assignments.

Bloom's Taxonomy of Cognitive Skills:

Knowledge - retention of terminology, facts, conventions, methodologies, structures, principles, etc.

Comprehension - grasping of meaning, translation, extrapolation, interpretation of facts, making comparisons, etc.

Application - problem solving, usage of information in a new way

Analysis - making inferences and supporting them with evidence, identification of patterns

Synthesis - derivation of abstract relations, prediction, generalization, creation of new ideas

Evaluation - judgement of validity, usage of a set of criteria to make conclusions, discrimination

Questions that encourage each of these skills often begin with:

Knowledge: List, define, describe, show, name, what, when, etc.

Comprehension: Summarize, compare and contrast, estimate, discuss, etc.

Application: Apply, calculate, complete, show, solve, modify, etc.

Analysis: Separate, arrange, classify, explain, etc.

Synthesis: Integrate, modify, substitute, design, create, What if..., formulate, generalize, prepare, etc.

Evaluation: Assess, rank, test, explain, discriminate, support, etc.

This taxonomy can be used to invent test or assignment questions. Here is an interpretation of each cognitive skill in a mathematical context. The example questions are aimed for introductory level, single-variable calculus students, but could be modified to apply to other courses.

Knowledge: Questions include "State the definition", "State the theorem", or "Use the specified method."

E.g., Take the derivative of the following rational function using quotient rule.

Comprehension: Questions ask the student to use definitions or methods to calculate something.

E.g., Find the slope of the tangent line to the following function at a given point.

Application: Questions which require the usage of more than one definition, theorem, and/or algorithm.

E.g., Find the derivative of the following implicitly defined function. (This question could be used to test logarithmic differentiation as well, for instance)

Analysis: Questions require the student to identify the appropriate theorem and use it to arrive at the given conclusion or classification. Alternatively, these questions can provide a scenario and ask the student to generate a certain type of conclusion.

E.g., Let f(x) be a fourth-degree polynomial. How many roots can f(x) have? Explain.

Synthesis: Questions are similar to Analysis questions, but the conclusion to be reached by the student is an algorithm for solving the given question. This also includes questions which ask the student to develop their own classification system.

E.g., optimization word problems where student generates the function to be differentiated.

Evaluation: Questions are similar to Synthesis questions, except the student is required to make judgements about which information should be used.

E.g., related rate word problem where student decides which formulae are to be used and which of the given numbers are constants or instantaneous values.