USING APOS THEORY
In ABSTRACT ALGEBRA LEARNING
( A Class Action Research in UPI )

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PROBLEMS

- The students think abstract algebra is hard subject and very abstract.
- The students do not prepare themselves to attend the lecture.
- The students have many problems to understand some subjects such as; subgroup, normal subgroup, coset and quotient group, etc.
- The students get low value in Abstract Algebra examination
Collection and Analysis of Data

Design and Implementation of Instruction

Theoretical Analysis
Definition of APOS

Action

Action is a transformation of an object which perceived by the individual as being external.
Process is an internal construction that performs the same action, that is not necessarily directed by external stimuli. An individual who has constructed a process can describe, or even reverse the steps of the process without actually performing the steps.
An individual has an understanding at the level of an *object conception* of a mathematical concept when the individual’s depth of understanding of an idea or concept includes treating that idea or concept as an object.
A schema for certain piece of mathematics is an individual’s collection of actions, processes, objects and other schema which are linked consciously or unconsciously in a coherent framework in the individual’s mind and may be brought to bear upon a problem situation involving that area of Mathematics.
MENTAL CONSTRUCTION OF APOS THEORY

Interiorization

Actions

PROCESSES
  Coordination
  Inversion

OBJECTS

Encapsulation
De-encapsulation
ACTIVITY CYCLE

ACTIVITIES

EXERCISES

CLASS DISCUSSION
Examples of Lab. Activities

Write ISETL funcs with the given names according to each following specifications;

1. The func *is_closed* has two input parameters: a set G and a func o which is some operation on two variables. The action of *is_closed* is to determine whether the result of o, when applied to two element of G, is always an element of G. This indicated by returning the value true or false.

2. The func *identity* has two input parameters: a set G and a func o which is some operation on two variables from G. The action of *identity* is to search for an element e of G which has the property that for any element g of G, the result of the operation o applied to e and g is again g. This indicated by returning the value of e if it exists or om if it does not.
Expected Result;

1. > is_closed := func (G,o);
   >> return forall x, y in G | x.o y in G;
   >> end func;
   > is_closed(G,o);

2. > has_identity := func (G,o);
   >> return
   >> exists e in G | (forall x in G | x .o e = x);
   >> end func;
   > has_identity (G,o);
ISETL func to investigate group

- \( Z_{20} := [0..19] \);
- \( G := Z_{20} \);
- \( o := \text{func}(x, y) \);
- \( \text{if } (x \in G \text{ and } y \in G) \text{ then} \)
  - \( \text{return } (x+y) \mod 20 \);
- \( \text{end} \);
- \( \text{is_closed} := \text{func}(G, o) \);
  - \( \text{return } \forall x, y \in G \mid x \cdot o y \in G \);
  - \( \text{end func} \);
- \( \text{is_assoc} := \text{func}(G, o) \);
  - \( \text{return } \forall x, y, z \in G \mid (x \cdot o y) \cdot o z = x \cdot o (y \cdot o z) \);
  - \( \text{end func} \);
- \( \text{has_identity} := \text{func}(G, o) \);
  - \( \text{return} \)
  - \( \exists e \in G \mid (\forall x \in G \mid e \cdot o x = x \) \)
  - \( \text{and } x \cdot o e = x) \);
  - \( \text{end} \);
- \( \text{identity}(G, o) \);

- \( \text{has_inverses} := \text{func}(G, o) \);
  - \( \text{return} \) \( \forall x \in G \mid \exists x' \in G \mid x' \cdot o x = e \);
  - \( \text{end} \);
- \( \text{has_inverses}(G, o) \);

- \( \text{inverses} \) of element \( x \)
- \( \text{inverse} := \text{func}(G, o, x) \);
  - \( \text{local } e; e := \text{identity}(G, o) \);
  - \( \text{return} \)
  - \( \text{is_defined}(e) \) and \( (\forall x \in G \mid \exists x' \in G \mid x' \cdot o x = e) \);
  - \( \text{end} \);
- \( \text{inverse}(G, o, 5); \text{ inverse}(G, o, 12); \text{ inverse}(G, o, 15) \);
RESULT:

Based on the research in UPI;

• This model can be used in UPI, because this model can help students in preparing the subject matter, so that the students are mentally and physically more active to attend the lecture.

• This model can encourage the motivation to study abstract algebra.

• Almost of the students can construct the APOS (Action Process, Object, and Schema) for all subject of Abstract Algebra, but how deep the APOS can be constructed in the student’s mind needs the further research.
THANK YOU
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