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Learning Science and Mathematics

Piagetian Theory of Cognitive Development

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Cognitive Learning Process

- Piaget's three types of knowledge
  - Physical knowledge
  - Social knowledge

  } **EXTERNAL KNOWLEDGE**

  - Logicomathematical knowledge — **INTERNAL KNOWLEDGE**

Physical knowledge

- The basis of learning rests on the activities indulged in by children when they interact with the physical environment.
- This knowledge can be learnt through:
  - Observation
  - Action connected to an object

Logicomathematical knowledge

- More sophisticated type of knowledge
- Formed when students form associations between objects in their minds.
- Examples: changed the sape of a plasticine ball into silinder cannot changed their amount.
- Can firm up operational processes like conservation, classification, arrangement according to sequence and logical consistency.

Social knowledge

- Arises from the interaction of an individual with another.
- Through social experience, children learn the rules of social behavior.

How students learn

- Schemata
- Assimilation
- Accommodation
- Equilibration

Schemata

- External and internal knowledge – help students to form a mental structure called a schema.
- Schemata are mental images that are formed by organizing observation behavior or thinking in a certain pattern.
- Schemata are modified during learning and are used to identify, process and store knowledge received.

Assimilation

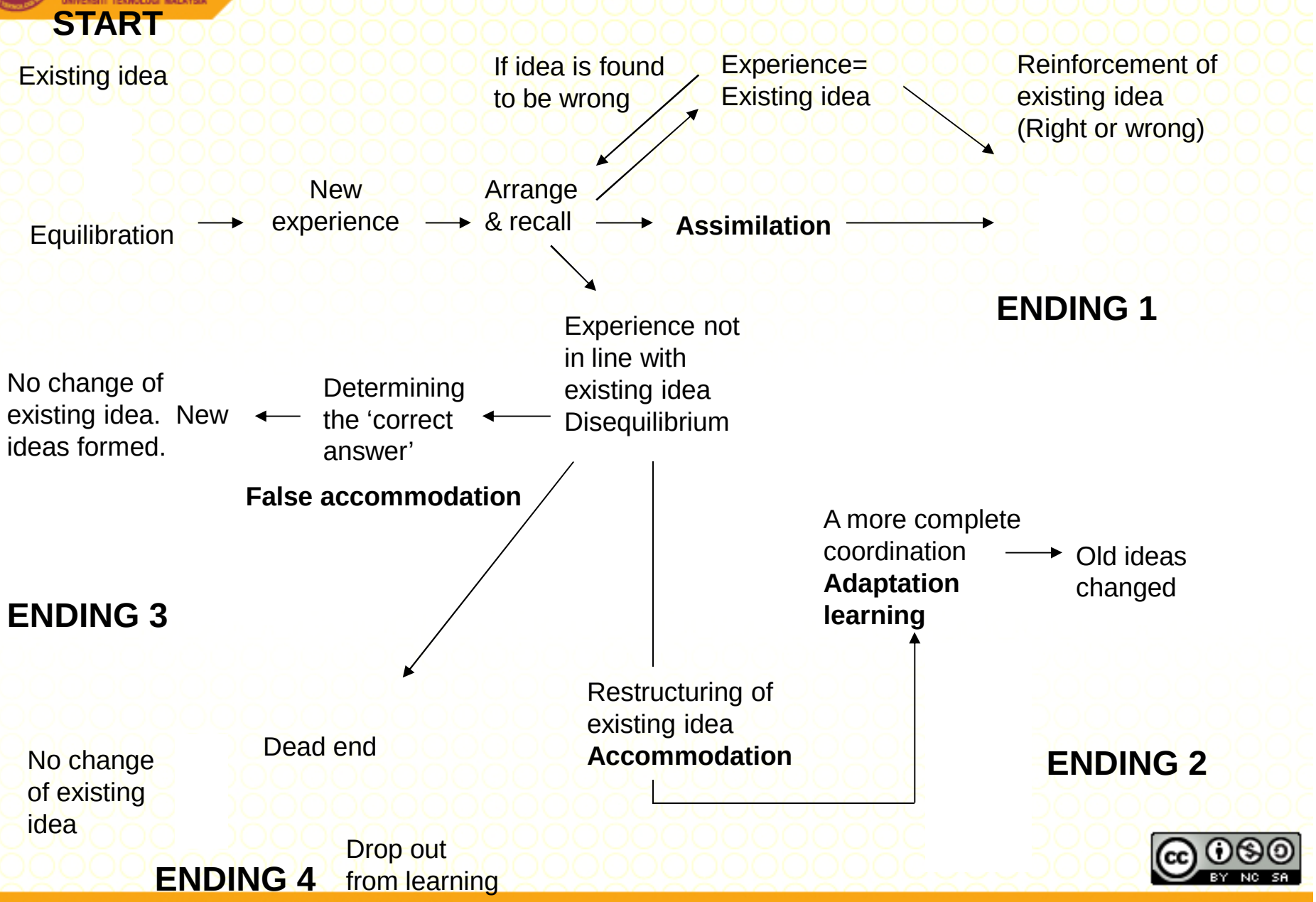
- The cognitive process of integrating experiences or new information (external knowledge) into an existing schema (internal knowledge).
- Assimilation results from the increase of experience. With each new experience, the schema expands in size and complexity but does not change its basic structure.

Accommodation

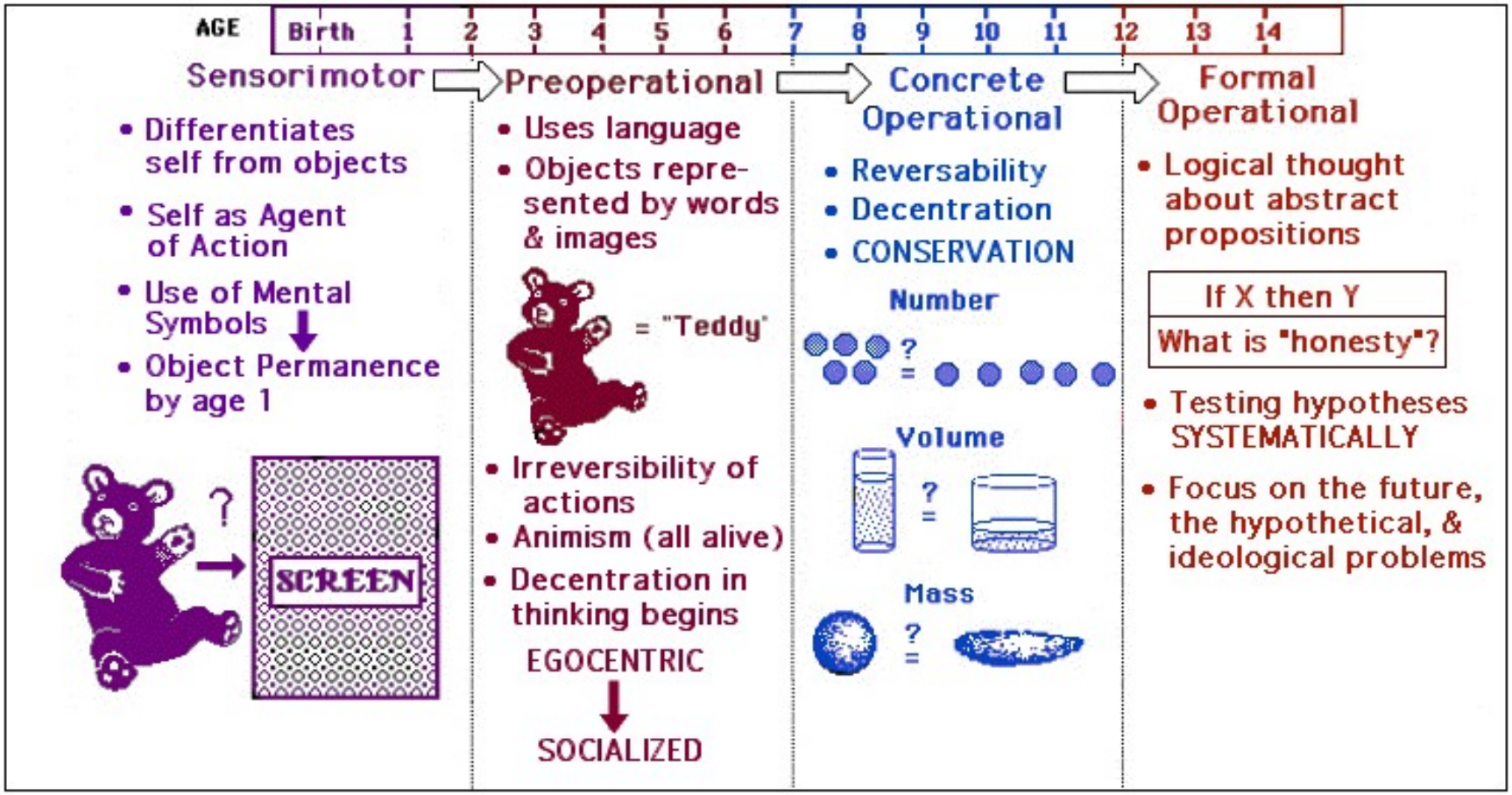
- If the new concept or experience that the student will try to assimilate is not compatible with the existing schema:
  - The student will form a new schema to hold the new stimulus
  - The existing schema will be modified so that the new stimulus can be observed.

Equilibration

- equilibration is the process that allows the individual to grow and develop mentally, but maintains stability.
- Piaget suggests, however, that equilibration is not an immobile state, but rather a dynamic process that continuously regulates behavior.


START
Existing idea
If idea is found to be wrong
Experience= Existing idea
Reinforcement of existing idea (Right or wrong)
Equilibration
New experience
Arrange & recall
Assimilation
ENDING 1
Experience not in line with existing idea Disequilibrium
No change of existing idea. New ideas formed.
Determining the 'correct answer'
False accommodation
ENDING 3
A more complete coordination
Adaptation learning
Old ideas changed
Restructuring of existing idea
Accommodation
ENDING 2
No change of existing idea
Dead end
Drop out from learning
ENDING 4

Stages of Cognitive Development



Stage 1: Sensorimotor period

Stage	Overview
Sensorimotor period (birth – 0-2 years)	This is the period is characterized as presymbolic and preverbal. Intellectual development is dependent on action of the child's senses and response external stimuli. Child is engaged in action schemes such as grasping and reaching for distant objects. Characteristics include: reflex actions, play, imitation, object permanence, nonverbal.

Stage 2: Preoperational period

Preoperational period (2-7 years)	Child's thought is based on perceptual cues and the child is unaware of contradictory statements. For example child would say that wood floats because it is small and a piece steel sinks because it is thin. Characteristics include: language development, egocentrism, classification on single feature, irreversibility.

Stage 3: Concrete operational period

Concrete operational period (7-11 years)	Logical ways of thinking begin as long as it is linked to concrete objects. Characteristics include: reversibility, seriation, classification, conservation (number, substance, area, weight, volume).

Stage 4: Formal operational period

Formal operational period (older than 11)	Students are able to deal logically with multifaceted situations. They can reason from hypothetical situations to the concrete. Characteristics include: theoretical reasoning, combinatorial reasoning, proportional reasoning, control of variables, probabilistic and correlation reasoning

Implication to Teaching and Learning Sciences: Secondary School Students

Implications on Teaching-Learning Science

- Inquiry-discovery
  - Hands-on activities that use concrete resource material
  - Through hands-on activities, children construct knowledge in their minds, minds-on.
  - Teacher acts as a facilitator who prepares the environment so that students increase their physical and logicomathematical knowledge.

Implications on Teaching-Learning Science

- Suitability of cognitive stages
  - Hands-on and minds -on activities are carried out should be compatible with the cognitive developmental stage
  - So that the students can understand and adapt the concepts learn into their schemata
    - Concrete to abstract
    - Near to far
    - Existed experience to new experience
    - Rough to soft

Implications on Teaching-Learning Science

- Exercise of the mental operation
  - Designing suitable activities, such as arranging according to a sequence, classification, and conservation.
- Intrinsic motivation
  - Prepare a lot of opportunities for the student to think about their learning process
  - To foster the spirit of wanting to know in their minds.

Implication to teaching and learning mathematics: secondary school students

Implications to teaching and learning mathematics

- Secondary school teachers are expected to be able to teach 13-19 year olds
- Teachers must be able to understand the intellectual level of students according to their ages
- For form 1 students: some are still in concrete operational stages and others are already in formal operation and others are in between
- From grade 6 to form 3: teachers should expect students to be in the concrete operational stage

Standard 6-form 3/4

- Students in this age group maybe be difficult to teach
- They may be rowdy, noisy, talkative, and undisciplined.
- However, at this level, students need to talk and be friends with other kids for their intellectual development
- They are trying out their own rules, and challenging the teachers' after discovering that rules are not absolute but are made

Standard 6-form 3/4

- Students need to relate abstract concepts with physical realities
- Enjoy working with diagram, models and physical devices
- New topics should be introduced with concrete examples
- Intuition and experimentation should play a larger part in solving problem strategies
- Have trouble with the concept of infinity and indefinite subdivisions

What are indefinite subdivisions?

- A frog is stuck in a hole that is 2 meters deep. Each day he hops 0.2 m. for every 0.2m, he has to hop 0.1m. How long does it take for him to climb out of the hole?
- answer?:

Standard 6-form 3/4

- Have trouble visualizing three dimensional shapes
- Geometry should be introduced informally and formal geometric proof should be introduced after students have entered stage of formal operational
- They may encounter problems in solving word problems and resort to memorizing patterns, and trial-error strategies

Standard 6-form 3/4

- Many formal operations involve symbols and manipulation
- They have trouble handling symbols
- So, they memorize certain formal operations
- What's wrong with these operations?
- $(x+y)^2=x^2+y^2$,

$$\frac{a+b}{a}=b, \sqrt{x^2+y^2}=x+y$$