Learning Definition

Learning is a change in behavior resulting from practice or other forms of experience. It occurs through interaction (stimulating environments causing "stimulus" and "response"). The 2-way process (teachers stimulating and learners responding) require both parties doing their part and receiving objective feedback. Active Learners seek, form, and modify their knowledge, skills, strategies, and beliefs rather than passively receive it [1].

Information Processing Theory

Figure 1: Human Neural Networks simulations

Learning theories understanding empowers teachers in enhancing the effectiveness of the material and activities they use **(UKPSF-A4).** Learning theories have three aspects: Philosophical, Psychological and Neurological [1].

Philosophers discuss rationalism vs empiricism, as the mind vs matter: Do we reflect and reason on our senses' input with consideration of the context and our existing beliefs? Or do we know what we sense (stimulus) only? Is it the combination of them that leads to learning?

Psychologists discuss Cognitive vs Behaviorism. Connecting to the philosophical perspective, we can formulate as: Is the internal reasoning (cognition) that takes the context and the order of events into consideration that is more important in the learning process? Or is it the stimulus in isolation as a discrete event that will certainly create the correct response each time?

Neuroscientists show relationships between brain functions and cognitive. The information processing theory defines Human mind as processors of information, in which cognition is a series of mental processes, and Learning is the acquisition of mental representations. Human Neural Networks are stimulated by millions of stimulus on daily basis. There exist noise, information that contradicts the beliefs or existing knowledge, information evaluated to be insignificant, which are all discarded. Only some are processed and learned. This redefines learning as the neural activity that forms brain neurons that classify new information sensed from the environment and connecting them to the existing ones that are formulated over a long period of time. With reinforcement (rewarding or punishing), neurons strengthen or weaken, and with practice they move from short term memory to long term memory.

In education simply assigning marks to any topic makes it significant, leaving teachers thinking about the gradual introduction of the material (order of events), connecting new information to context (connecting new concepts to previously learned concepts), and employ repetitions and practice to

strengthen learned topics **(UKPSF-A4)**. In operating system module, while introducing memory management concepts, I had to add more slides about student's previous knowledge of programming steps and declaration of variables and calling of functions and how that requires the operating systems to allocate memory to their code as it proceeds through the lines. Generally starting from the need, or the previously learned topic provide easy introduction to the new topic **(UKPSF-A1)**.

The above combines the rationalism (mind) and its cognitive consideration of order of events and context, while at the same time using the empirical (matter and senses) and the resulting behaviors as the experimentation setup to receive and standardize the stimulations and their responses.

Motivation is a main driving force in cognition that differ from one learner to another and can cause self-regulation **(UKPSF-V1).** Self-regulation is when an active learner regulates his pace independently, vs those requiring a governing body or authority to guide the process. Non-objective feedback from teachers can cause more students leaving university for more objective feedback elsewhere. Similarly, non-objective teaching effectiveness measures, might cause teachers to leave this practice to another more objective career, leaving this practice for actors and social scientists to do instead.

Cognitive learning theory has been observed to be more suitable for learning complex material such as STEM subjects, while behavioral theory is more suitable to learn simple skills [1]. From my practice, I have to introduce every new concept in relation to previously learned concepts to increases its chances of being processed by the learners brains.

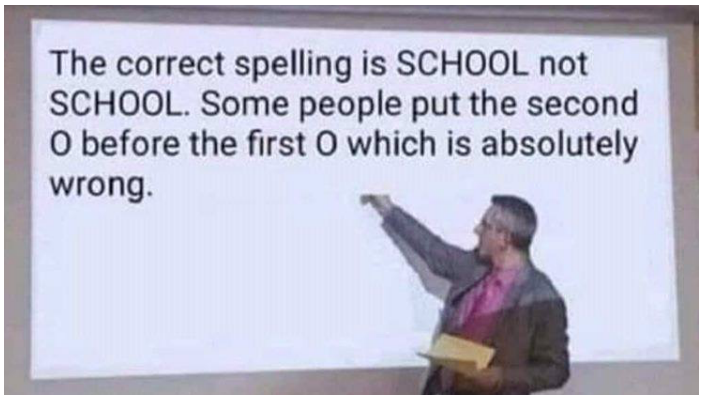

Figure 2: Non-objective feedback is illustrated in the figure.

STEM/CS Effective Teaching

Science, Technology, Engineering and Medicine (STEM), are lab-based teaching environments. Teachers measure the required response while designing the stimulations before the delivery starts **(UKPSF-A1).** Assess and measure the quality of feedback to students aligned with announced learning objectives **(UKPSF-A3).** A final measure on the student outcome at the end of the session is required for teaching efficiency evaluation **(UKPSF-A4).** ABET Student Outcome Equation is a suitable objective function. The Reinforcement Learning (RL) equation used in Machine Learning algorithms provides an alternative iterative measure shown in Figure 3 (https://en.wikipedia.org/wiki/Q-learning):

$$Q(s_t, a_t) \leftarrow (1-\alpha) \cdot \underbrace{Q(s_t, a_t)}_{\text{old value}} + \underbrace{\alpha}_{\text{learning rate}} \cdot \overbrace{\left(\underbrace{r_t}_{\text{reward}} + \underbrace{\gamma}_{\text{discount factor}} \cdot \underbrace{\max_a Q(s_{t+1}, a)}_{\text{estimate of optimal future value}} \right)}^{\text{learned value}}$$

Figure 3: Reinforcement Learning Equation

Assign suitable expected rewards ***r***; select the ***Q*** function mapping the state-action (s_t, a_t) pair with the highest ***Q*** value, where ***t*** is the time step / iteration. If it is student's feedback, the time step is each teaching activity, its learning state, reward (marks and motivations), and action (increase/decrease the challenge, or repeat failed material). If it is teacher's feedback, the time step is the teaching session, the state is the student outcomes from the examinations statistics, rewards is whether to keep the content or redesign it and the actions are the implementation of new or updated plans. These equations provide evidence informed approaches to measuring teaching effectiveness and student outcomes **(UKPSF-V3).**

Computer Science (CS) is a fast evolving discipline require continuous development from the teachers perspective **(UKPSF-A5) (UKPSF-V4).** E-learning moves education from the teacher- centered towards the student-centered. Generative learning objects (GLOs), modelling at the higher level of abstraction using feature-based modelling and the use of educational robots in teaching CS topics aim at integrating different technologies with the known pedagogical approaches [2].

My Reflections / Evaluation Criteria

The teacher's role is designing the stimulus to the learners' senses to create the learning response. Teachers evaluate students learning outcomes to evaluate their choices of material and activities to enable better outcome in following sessions. This 2-way learning process are managed by objective measures of assessments and feedback. Non-Objective assessments or feedback provide anti-learning environment to both sides of the learning process (the teacher and the learner).

Enhancing the learning environment is achieved by applying an objective measure of the quality of the feedback provided to students corresponding to the announced learning objectives to rely on to enhance their performance. This also provide a measure of effectiveness from the student perspective. On the other side the teaching effectiveness is measured by student outcomes providing teachers feedback to enhance their future offerings.

The evidence for the student outcomes is the assessment statistics and the verification of the quality of the testing and marking criteria by internal and external checkers.

The challenge is aligning the curricular structure and instructional design (stimulus and activities) to the learner neural activity to a large cohorts of students from different backgrounds and have different beliefs. What motivates a learner can be demotivating to another. The STEM curricular structure requires the teacher to align his neural activity to that by researchers and industry leaders maintaining a multi-model neural networks system. It is challenging being an expert learner to teach, and require continuous tuning of all the parameters of a well-defined equation [2].

Studies in [3] emphasize the student outcome as the objective measure of teaching efficiency and provide various resources to design feedback forms and collect information required to evaluate teaching efficiency.

UKPSF and Teaching Values

The assessment activities of both the student performance (UKPSF – A3), and the teaching efficiency (UKPSF – A1 & A5) are my focus. The learning environment is implied so A4 is indirectly discussed.

In the core knowledge, UKPSF - K5 is the main focus of this report.

My focus in values is on UKPSF- V3 (importance of evidence-informed approaches to effective teaching by measuring). I provided 2 objective equations to substitute the subjective MEQs and SSLC meetings. My second focus is on V4 (aligning research outcome and industry trends with learning objective) by using generative learning objects (GLOs).

References

[1] D. H. Schunk, *Learning theories: an educational perspective*, 6th ed. Boston: Pearson, 2012.
[2] V. Štuikys, *Smart Learning Objects for Smart Education in Computer Science*. Cham: Springer International Publishing, 2015.
[3] M. A. Fox, N. Hackerman, and National Research Council (U.S.), Eds., *Evaluating and improving undergraduate teaching in science, technology, engineering, and mathematics*. Washington, D.C: National Academy Press, 2003.