

Law of the Minimum in Learning

Moderator & Sumamrizer:

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Discussion Schedule:

Discussion: April 19-28, 2004

Summing-up: April 29-30, 2004

Pre-Discussion Paper

For a long time i am thinking about "Learning", what it is, how it occurs, what are the limitations, how can we improve its quality etc. eventually, i had a meaning for "learning" and named it "**Law of the Minimum in Learning**".

I have influenced greatly from Justus von Liebig's (For more information on Liebig, see:1,2,3) Law of the Minimum which states that **yield** is proportional to **the amount of the most limiting nutrient**, whichever nutrient it may be. From this, it may be inferred that if the deficient nutrient is supplied, yields may be improved to the point that some other nutrient is needed in greater quantity than the soil can provide, and the Law of the Minimum would apply in turn to that nutrient.

If we redefine "yield" as **learning** and "the most limiting nutrient" as **human readiness (either learner or helper)** then we can easily say that meaningful or active learning is directly proportional to any of the human's readiness. Unlike the plant system, just increasing any of the human readiness or increasing the quality nonliving constituents (instructional materials, methods) of the learning system may not improve the quality of learning process. At this point, we have to define learning system which is composed of living and nonliving constituents. Living constituents cover learner and the living helper of the learning process. Nonliving constituents cover all materials, methods and the environment where the learning process occurs.

Whatever high quality? Non-living constituents present in the environment has secondary effects on learning process. Let's say you have very effective? Instructional material which has tested for many years? The success of this material is directly proportional to the readiness of the any living constituents of the medium. This can be either learner or the learner helper. So, we can not increase the quality of learning process just increasing the quality of materials and/or methods. We have to focus on the living constituents of the learning environment.

Before going further, I want to describe what "learning" means; learning is an active (Bruner) and continuous process which occurs in any time and place and it has no negative value at all. Meaningful Learning is giving meaning and it occurs in a social context.

It is **continuous** and inherited to our offspring via "learnosomes"? which are the basic building blocks of the learning process. Unfortunately, there is no direct evidence for their molecular presence until now, but I am very optimistic for their presence and in near future.

Learning is a **continuous process** therefore we are learning whether consciously or unconsciously but continuously. We can not say that "I didn't learn" because we are learning less or wrong but we are learning something. Therefore, it has no negative value.

It is never lost but it is changed into new meanings by the help of the previous experiences and the social interactions. Learning is changed from one form to another (**Learning is conserved**).

In the light of those hypotheses; we can easily say that:

1. In order to increase the quality of learning we have to focus human constituents of the system. We have to consider both learner and the helper readiness because the less ready human will determine the overall yield of the learning process.

2. We have to find out good problems which have been defined by constructivists' i.e. real life problems.
3. Learning environment should be enriched to give change different type learning
4. The role of the helper should be moderator and/or facilitator
5. Group work should be used during learning process.

References

Gillispie, C. C. (1981-1990). *Dictionary of Scientific Biography*, 7, New York: Scribner.

Brown, C. A. (1942). "Justus von Liebig--Man and teacher." and "Liebig and the Law of the Minimum". In *Liebig and After Liebig: A century of progress in agricultural chemistry*, Lancaster, PA: The Science Press Printing Co.

van der Ploeg, R. R., Böhm, W., & Kirkham, M. B. (1999). On the origin of the theory of mineral nutrition of plants and the Law of the Minimum. *Soil Science Society of America Journal*, 63, 1055-1062.

Bruner, J. (1960). *The Process of Education*, Cambridge, MA: Harvard University Press.

Post-discussion Summary

"Learning is proportional to the readiness of the most limiting human factor (learner or helper) whichever human factor he/she may be. Because teaching and learning are best thought of, not as separate and independent activities, but rather as two sides of the same coin, interconnected and interrelated".

Michell Weisburgh stated "Before I plant my Spring garden, I test the soil to see what nutrients are necessary for the types of plants I intend to have, then I add the fertilizer, lime, etc. And it works. And he has asked a very good question;

Wouldn't it be great to have a similar diagnostic for learning? In my opinion, if we want to have better results we have to give more attention to the learning environment and find out different diagnostic tools for learning. Prof. Giorgio Casadei added his comments "Well. but what does it mean " ... test the soil to see what nutrients are necessary for the types of plants I intend to have", when the soil is the brain and types of plant are types of minds?" Similarly, Vikie Vance continued using the same analogy and stated "the current discussion by Dr Ozden is interesting, and unaccustomed as I am to the literature referred to regarding agricultural chemistry, I have interpreted this example to metaphor...the learner as a plant. I see merit in this; however I have some questions that perhaps Dr Ozden or others may help illuminate some understanding for me.

1. What role would mediation play in this... for instance if we use technology in the process, how does that fit with enhancing, limit or change nutrients for the learner?
2. What about the ecology in which the learner exists - things that don't directly impact upon nutrients but have an impact upon the learner in some fashion - predators, introduction of foreign species? (These are outside the learner and helper you describe, but are living.)
3. What about mutation? Lack of germination for various reasons e.g. virus? At what stage is the plant a learner?
4. What about environmental adaptation - is this Bourdieu's 'habitus'?

Forgive me if you think this frivolous, but I fail to see a plant without seeing the ecology within which it fits." I think, there is no need to find direct relation plants' growth/ecology and human learning. I have used it just an analogy. Human is not plant and/or human learning is not plant growth. But, if we omit any of the human factors in the system it also limits the level of learning. Those questions reminded me that in the real learning environment we are just focusing ecology or external factors (technology/methodology) but the limiting factor is the less ready human.

Michael Barner-Rasmussen stated "Law of the Minimum in Learning" seems to me to be very problematic for the following reason:

It assumes a naturalistic, linear, parametric relationship between discrete and orthogonal parameters that may be shown to be significant to learning.

Much experimental experience seems to me to rather suggest that learning is an emergent phenomenon that cannot be adequately explained as a simple availability (transmission) -> assimilation -> understanding. Dewey, Kolb, Davydov Furthwer, it seems to me the law can not explain innovation, moments of insight where previously unrelated knowledge combine into a new, grander understanding, nor what Peirce called Abductive Reasoning, where knowledge from one domain is applied (successfully) to another. Li Zhou responded, "I think the "Law of the Minimum in Learning" only becomes problematic when we view learning in a very narrow sense such as planned or prescribed learning. However, the law seems to make sense if we do have a specific purpose in learning something for immediate use as Mitch argued. On the other hand, learning as a life long human productivity can not always be measured, such as life experience in early years or in a different situation might not be significant or meaningful then but years later as we mature and as the situation changes it often comes back to make much better sense of what we experience now as well as what we experienced then. It all depends on what we value. I do agree with Michael that one important property of learning is its recursive nature but the "Law of the Minimum in Learning" tends to measure each learning event only by itself while neglects the interconnection among different learning experiences without which all our separated experiences will not have any real significant meaning by themselves. I agree with Li Zhou, when we view learning in a very narrow sense. But Learning is a **continuous process** therefore we are learning whether consciously or unconsciously but continuously. We can not say that "I didn't learn" because we are learning less or wrong but we are always learning something. Therefore, it has no negative value. Whatever we learn is never lost but it is changed into new meanings by the help of the previous experiences and the social interactions. Learning is changed from one form to another (**Learning is conserved**).

Vickie Vance also commented on continuous nature of the learning and stated that, "I agree with much of what you say, (we constantly learn, learning is internally and socially constructed) however your 'human factor' is not a nutrient, or anything that we have in the history of mankind been able to accurately measure."

Would there be value in doing so? The environment can be manipulated to encourage maximum learning, or discourage it. We cannot control the histories or experiences that any learner brings to a situation. Any individual is unique, and while we may be able to administer IQ or any other means to provide a standard measurement, what is the point? To have a standard measurement is to take away the value of the individual. Why are you considering the 'human factor' as there is no learning without it?" I know, learning is giving meaning individually in a social context. Therefore, we can maximize or minimize learning up to a certain level just focusing environmental factors. So, we have to consider human factor and give more emphasis how we can make them ready for the desired learning activities. There is no need to administer IQ just let them ready for the learning activities.

Errol Thompson commented on the quality of learning process and stated that "I am sure that I have missed part of this discussion. However, it concerns me when it is said that "quality of learning process". We may not be able to influence what goes on inside a learner's head but we can teach "learning to learn" and I believe that we can assess and improve the learning process being used by the learner. If I have no influence over how a learner approaches learning then I should discard some learners from my classes because their memorisation learning processes or strategies are not going to help them develop creativity or critical reflection." Yes, we can not influence what goes on inside a learner's head but we can access and improve the learning process being used by the learner this means then, we are making them ready for the learning process.

Hellen Griffith stated "As a secondary teacher (grades 10-12), I found the following comment extremely thought provoking -- "So, we can not increase the quality of learning process just increasing the quality of materials and/or methods. We have to focus on the living constituents of the learning environment".

As a teacher, we are continually focused on increasing the quality of our materials, improving pedagogy, and meeting individual learner needs. What, in your opinion would constitute a "focus on the living constituents of the learning environment"? Does this transfer to what we consider in education to be a focus on the individual needs of each learner?" Sujeet Kumar responded "What you want to say, I do not agree with you. Our organization working in this direction and by adopting a proper methodology, learning quality can be improved without using any quality materials. I have met many teachers who try to improve the learning process by including body language in the teaching and not using technology. You can go to our website (<http://futureschools.org>) for details." Yes, just focusing on the human factor of the learning environment it is possible to obtain much better results.

At this point, Richard Dillman made some comments on human factor as follows “As I understand it, human factors analysis applies to specific situations with well defined goals and possible courses of action. Human factors analysis ... is the scientific discipline concerned with interactions among humans and other parts of a system in carrying out a purposeful activity. Human factors include leadership, teamwork, communication and decision-making.... Human factor analysts suggest that the errors, incidents, critical incidents and accidents that arise from human behaviour can best be addressed in a systematic fashion through programs of quality assurance and error and risk management (<http://www.pediatriccardiacinquest.mb.ca/ch10/humanfactors.html>).

One educational situation that might accommodate this method is the "first day of class" problem. On the first day of class the teacher faces a group of students, each of whom arrives with a different set of ideas, skills and attitudes. What is the most efficient way for the teacher to gain the attention of the class and focus it on the task at hand?

Another fruitful area of study might be "grading". The overall course grading process is quite complex, but some grading situations recur on a regular basis: the student who tries hard but does not quite succeed; the student who takes a long time to get acclimated but then does extremely well; the student whose efforts tail off towards the end of the course. I'm sure that there have been studies of grading methods, and of the effect of grading on student progress, but human factors analysis may be able to shed additional light on the problem.

A third possibility is the "what do you want" problem. Is there a most effective way to communicate an assignment to students with a minimum of misinterpretation?

I would like to conclude by saying that quality of learning/teaching is directly proportional human readiness (either learner or helper). In other words, the less ready human factor determines the overall quality of system. Whatever high quality? Non-living constituents (materials, methods etc.) present in the environment has secondary effect on this process. Therefore, human factor analysis would have a specific importance for obtaining better results.