

great significance of the law in daily life. We are slowly beginning to realize that triviality and importance of events are not measured by the absolute magnitudes of the events but by the more specific relationships they bear to our appreciation of them. Satisfaction with wages, hours, working conditions within the middle ranges, to paraphrase the limitations set to Weber's law, are more dependent on what the other fellow gets, how long he works, and where he works than upon any direct understanding of the actual differences in amount of or method of payment.

In 1795, the astronomer in charge of the Greenwich Observatory noticed that an assistant whose error in recording stellar transits had previously been a half second, had now increased that error to almost a whole second. The error became the topic of much discussion and almost one hundred years later became the leading problem of psychological investigation. The refinements of method, the insight gained into behavior, and the importance of the results where minute time periods are a factor need not detain us here. We may nevertheless note in passing that one hundred and thirty years later we have come full cycle and the problem of the "personal equation" is once more a practical one. The driver of an automobile who cannot shift his foot from accelerator to brake in fifty-two hundredths of a second or thereabouts will be denied his license as was the assistant astronomer years ago. He is offered one alternative unknown in earlier days, to improve by practice where he will not endanger others, according to a learning curve that bristles with mathematics sufficiently detailed to satisfy the most fastidious.⁸ This "personal equation" has been the factor in thousands of cases of turnover and the cause of unmeasured amounts of unhappiness and friction.

If time permitted it would be interesting to trace historically the growing significance of mental testing, of the psychologist's studies of the emotions, and of the still more recent attempts at quantification in the field of human personalities. We are not only confident that the ghost of the fallacy that psychology cannot become a practical science is rapidly being laid; but also that its shadow is materializing into real substance and form for those who still call knowledge intuition and experience. We have tried to

show above that "intuition and experience" are but elementary and crude efforts at artistic explanation.

III

In 1897, Bryan and Harter published their studies of learning. In this report they showed what are now generally known features of the learning curve, such as the early steepness of the curve, its flatter portion, and the later steep portion where skill becomes expertness. Since then many studies have appeared on different types of learning, of learning by different processes, of learning with or without knowledge, and of the effects of different incentives, distractions, etc. My attention has recently been called to these facts again by a statement made in a series of articles on "Management in the Wood-working Industry," by Carle M. Bigelow. He seems to have rediscovered these earlier facts in his studies of acquirement of skill in this industry. He has sought to apply this rediscovery by a special modification of his method of paying wages. The modification consists primarily in a steadier rise in the wage scale than is warranted by the shape of the learning curve.

We believe that we have discovered an absolute fact that with the average worker when he or she has covered about one-half normal training period, there must be expected a period of time, depending upon nature of work, when progress or increase in skill practically ceases. Then, after a short while, he attains balance of average proficiency very rapidly. Especially in plants employing female labor, the loss of operatives before they become fairly efficient workers is a serious problem and we believe largely due to the fact that their remuneration is based upon a required constant increase in proficiency which is practically impossible for the average worker to maintain.⁹

Noting as a general preliminary reservation that the acquirement of skill depends on the materials and operations involved, let us look at some of the implications in the above observation. In the first place we may note that later studies do not seem to indicate the plateau as an essential part of the learning curve.¹⁰ "As long as a learner maintains a high degree of attention and puts forth maximum effort, he continues to improve until he reaches his limit. . . . The ordinary learner usually does his best for a time, then because of fatigue, or lack of attention, or loss of interest, he

⁸Quoted by Roe and Lytle in *Management's Handbook*, Ronald, 1924, pages 962-963.

⁹Book, W. F., "The Psychology of Skill with Special Reference to Its Acquisition in Typewriting," The University of Montana, Missoula, 1908.

⁸F. A. Moss and H. H. Allen. "Personal Equation in Automobile Driving," *Journal of the Society of Automotive Engineers*, Vol. 16, April, 1925, pages 415-420.

relaxes and works at a lower point of efficiency."¹¹ Again assuming for the moment that in the wood-working industry we are dealing with types of acquirement of skill that follow the simpler laws of learning, we see that an increase in wages, at the plateau stage, theoretically at least, is more likely to fixate the sensations of fatigue, or habits of lack of attention than to stimulate toward an elimination or shortening of the plateau. If examination should show that loss of interest is the factor, we are again confronted with a similar question. Should payment continue to increase while the interest of the worker is temporarily busied with surroundings not yet adjusted to?

The application of another type of incentive should be considered at the beginning of the plateau of the curve. "There is in every workroom a fashion, a habit of work, and the new worker follows that fashion, for it isn't respectable not to. . . . Our chart shows that the stronger the sentiment in favor of industry is, the harder the new member tries and the sooner he succeeds."¹² After a certain familiarity and degree of mastery are attained the worker begins to look about him, to observe how others are working, how they act, and who they are. According to this view the wage phase of the incentive if used should be applied to those in the department who are most skilled and the beginners who are in the plateau stage should then be furnished with data showing how profitable it is to reach high skill. Previous to this stage to know about highest possible production might conceivably be a discouragement rather than an incentive. For those who prefer to keep all incentives in terms of wages, it is, therefore, the wages paid others, not the direct wage, that is the incentive.

We are not, however, directly concerned with wage incentives. Let us take the case quoted by Douglas. The management found their product was losing in consumer demand. They laid off one-half the force. Production remained the same or better. Again they laid off men. Still the production failed to fall. In another instance, where special effort over a two year period had reduced waste and spoiled parts one-half, the management announced that until times were better they would shut down the plant as soon as the present stock of raw materials was worked up.

¹¹Pyle, W. H., "The Psychology of Learning," Warwick and York, 1921, page 32.

¹²Gantt, H. L., "Work, Wages, and Profits," The Engineering Magazine Co., 1919, page 186.

Waste fell 75 per cent below the existing level. Mere mention need be made of Wolf's experiences with non-financial incentives in this connection.

What about the learning curve? Both of these illustrations seriously modify that curve, if production be the measure. Neither of the changes in the curve just cited was produced by task and bonus, or premium or piece rate, or any other method of payment. You may say, these illustrations do not apply to the first plateau. Perhaps so, perhaps not. They certainly apply to later plateaus which are equally important.

Let me recall at this point some further data on the learning curve. We have not drawn the complete curve until we know the relation between speed of reaction and the limits of the machine, if it be a machine operation. If the machine can be operated more rapidly than the most rapid human reaction necessary to tend it, we can then find the human limits of speed and skill. Under other conditions, we cannot. Turning to the human side of the equation, Fernald's endurance or will test illustrates vividly the possible congeries of factors operating. The test is simple; to stand on one's toes until it is impossible to stand in that manner any longer. Though not a natural position, there seems to be no short physiological limit beyond which one cannot go. The subjects when they quit usually said, "Oh, I just quit," or "I decided I had stood long enough," or merely, "What's the use?"

Here is where a rough generalization of Weber's law recurs to us. The decreasing value of the stimulus due to adaptation, habituation, fatigue, or change of interest reaches a point where the ratio between stimulus and mental process no longer gives the just noticeable difference necessary for a rising or even level learning curve. The introduction of other stimuli, incentives if you will, or decreasing effect of these may again raise this ratio to its standard fraction.

Note that I am not advocating continuous work at the peak. Stephen Leacock tells of the calculation whereby the addition of two, four, etc., ounces of food would cause a hen finally to lay 20 eggs per week. His partner, enthusiastic over the possibilities, suggested they start at once feeding the hen 16 ounces per day. He adds: "I had to remind her laughingly that at 8 ounces a day the fellow would probably be working up to capacity, and carrying what we call in business his peak load. The essential factor in business is to load up to the peak and stay there."