The Learning Lab: Bridging the Gap Between Theory and Practice in Improving Teacher-Training Programs

As a rule, courses of study in the field of education are one-sided, namely, primarily focused on theoretical aspects. Because of the overemphasis on theory, opportunities to put theoretical concepts into practice are all too often insufficient and sometimes even non-existent. As a result, students in education often know a great deal about theoretical approaches to pedagogy but are unable to handle—or find it very difficult to integrate—teaching media and methods into their pedagogy. In order to provide future teachers with both theory and practice in integrating media and new instructional approaches into pedagogy, institutions training tomorrow's teachers need learning laboratories where student teachers have ample opportunities to experiment with instructional materials and methods in terms of the following: design/production, use, and research/evaluation.

As a place of practical research, the learning laboratory is an environment focusing on the practical applications of using the existing and emerging technologies in pedagogy as well as researching the effectiveness of their use. As such, the technologies of the learning laboratory have one overriding function: to be used by future teachers to design, produce, use, and evaluate the integration of instructional materials and methods into the learning process.

In operation for several years, the Learning Laboratories of the Pedagogical Faculty of the Federal Republic of Germany's Armed Forces have served students in education by bridging the gap between theory and practice. In the following discussion, the author—a member of the Pedagogical Faculty—uses his experiences, observations, and research to delineate both the educational objectives and the practical applications of the learning laboratory as a necessary pedagogical tool for improving the training of teachers.

Educational Value of Laboratory Work

By overemphasizing theory, courses of study in education create a gap between the theoretical and the practical: Although students end up knowing a great deal about theoretical concepts, they are not sufficiently trained to use instructional materials and methods in their pedagogy. The Learning Laboratories of the Pedagogical Faculty of the Federal Republic of Germany's Armed Forces have, for a number of years, enabled students to "turn theory into practice," and, thereby, have helped bridge the gap between educational theory and pedagogical practice—a gap any institution training tomorrow's teachers must bridge.

In general, there is little, if any, controversy about the educational value of laboratory work. Students, teachers, and the public at large agree that the opportunities for "hands on" learning provided by lab work is an indispensible ingredient in learning of any kind. Even more importantly, perhaps, experimental data point to the importance of "learning by doing" in the laboratory setting. Although the importance of lab work is most strongly proclaimed in fields like engineering by authors such as Rice (1975), researchers in diverse disciplines have shown that students and faculty are in essential agreement when it comes to learning from a lecture on the one hand and learning in a laboratory on the other (Ruff, 1977): The great importance attributed to and the preference for "hands on" laboratory work emerge time and time again.

Kath, Spötl & Zebisch (1985) define a learning laboratory as a place of empirical research, that is, a place of teaching and learning which is equipped with an array of technical devices which are suitable for the production and presentation of instructional materials. In addition, learning laboratories also serve as environments where relevant learning and pedagogical data can be collected and evaluated (Ulbricht, 1984).

Learning Laboratory Equipment

The array of technical devices and technologies in the modern learning laboratory allow future teachers to experiment with putting pedagogical theory into practice; the learning laboratory is an environment in which future teachers can experiment with the following: 1) techniques of instructional materials production; 2) relevant data collection and empirical research on the teaching/learning process; 3) use of instructional materials and pedagogical methods under various experimental conditions; and 4) comparisons and evaluations of instructional materials (commercially produced or self-made).

Training of future teachers in the learning laboratory will improve teacher-training programs because in the lab students are able to put into practice theoretical concepts of instructional design, production, use, and evaluation; in short, the learning laboratory allows future teachers to expand their understanding and "hone" their skills **before** stepping into the classroom.

Educational Objectives of the Learning Laboratory

The educational objectives of the learning laboratory are no different than the educational objectives found in the cognitive, affective, and psychomotor domains (Bloom, Hastings & Madaus, 1971). No one questions the crucial role of the lab both in research and teaching in the fields of the natural and the engineering sciences; the progress of these fields depends heavily on the work done in the laboratory. In education, specifically in the area of teacher training, the situation is obviously very different: Only a very small part of research— and an even smaller portion of teacher training—is done in a laboratory setting. This situation is—at least in part—due to the fact that the fundamental parameters of how the learning lab bridges the gap between educational theory and instructional applications has not yet been sufficiently understood, valued, and developed.

Teacher-Training Objectives in the Learning Laboratory

What specific outcomes or objectives for the training of future teachers can the learning laboratory help achieve? Although it is helpful to look toward the literature of Physics (Kruglak, 1951; Haefner, 1972; Nägerl, 1974) and Engineering (Rice, 1975; Haug, 1980) for information about the kinds of objectives and outcomes possible in the learning laboratory, it is well to keep in mind that the overall goal of all teacher training objectives in the learning laboratory is educating future teachers—educators who must be able to manipulate both a variety of instructional materials and methods to meet the needs of a variety of students with a variety of learning styles and educational backgrounds. If today's student of education is to become tomorrow's practitioner of pedagogy, he or she must be able to do the following: 1) qualify for lab work; 2) prepare for empirical research; 3) produce a variety of instructional materials; 4) perform empirical research in various aspects of the learning-teaching process; and 5) use the technologies of the learning laboratory to evaluate both instructional materials and pedagogy.

Qualifying For Lab Work. In order to qualify for work in the learning laboratory, students of education must have facility in discussing and explaining the possibilities and limits of empirical research in the learning laboratory. In order to do this, students must understand the significance of the problems under study, delineate the most important factors which influence outcomes, apply the principles of experimental design, know the sources of systematic and random errors, including the principles of propagation of errors, and estimate the accuracy of empirical study, together with the possibilities for increasing accuracy.

Preparing For Empirical Research. In order to "set the stage" for empirical research, students need practice in applying the principles of planning empirical research. Such planning includes the following preparations: evaluating and incorporating the relevant literature in the field; developing an overall research design or approach, complete with schedules and flow charts configured with all experimental variables, including technology; and arranging and adjusting devices and variables correctly.

Producing Instructional Materials. The seminal issue in the production of instructional materials revolves around the question of which media is best matched with which type of student or learning style. In order to create the optimum media-student match, the student of education must understand relevant theories of learning psychology and be well-versed in how different media produce different learning outcomes, depending upon both the learning styles and educational backgrounds of the target learners. Above all, future teachers need "hands on" experience in producing and using instructional materials. The learning laboratory is the ideal learning-teaching environment in which to experiment with the production and presentation of instructional materials and methods.

Performing Empirical Research. Because the learning laboratory can serve as an information and technology rich learning-teaching environment, students of education can perform needed empirical research in education in the lab. In order to do empirical research, students must demonstrate that they are able to carry out, in logical steps, their own research plans. Not only must they be able to control the technologies useful in the conduct of empirical research, but they must also be able to direct co-workers to work as a cohesive team whenever necessary. The research procedures practiced in the learning laboratory must become routine and transfer to situations outside the laboratory.

Using the Learning Lab to Evaluate Instruction. In order to test and evaluate the effectiveness of instructional materials and methods, the student of education must be able to use the learning laboratory and its technologies to record experimental data, test experimental hypotheses, draw conclusions and make deductions, prepare experimental data for presentation, and propose future empirical studies.

Achieving Educational Objectives in the Learning Lab

Although a comparison of educational objectives of the teacher-training laboratory and that of the sciences and engineering, for example, show great similarity, the learning processes that lead to the achievement of such educational objectives in the teacher-training laboratory are particularly demanding.

A suitable system of learning which leads students of education toward achieving the educational objectives of the learning laboratory is the general unified and interactive model of teaching/learning processes recently developed by Butler (1985). Because learning in the laboratory is an adaptive, complex, and dynamic whole, this model is particularly well-suited to the teaching/learning processes of the laboratory since the perceptive, affective, cognitive, and psychomotor domains in the model are inseparably linked or blended. Neither learning in the laboratory nor the Butler model permit the dissection or separation of the learning process into independent, stand-alone parts. Although the learning process does not lend itself to separation into stand-alone parts, it is a process characterized by a sequence of stages through which learners progress. The main stages of this process—documented by writers such as Schiefele (1964) and Klauer (1983, 1986)—are as follows: 1) motivation, 2) orientation, 3) application, 4) evaluation, 5) repetition, and 6) generalization. These six stages of the learning process have particular relevance to the learning laboratory—an environment characterized by a learning climate which generally differs dramatically from other learning environments: In the learning laboratory, students learn how to learn more directly than in other learning situations; "hands on" experience in the learning laboratory inevitably helps students develop a systematic, intellectual, and pragmatic approach to learning how to learn that can only be achieved in learning by doing.

Motivation. Defined as the incentive for learning, motivation as a word has achieved "buzzword" status around the world. Educators the world over are looking for ways to motivate students to learn. In spite of the current interest in motivating students to learn, the existence of the motivation stage of students, that is, their wish and will to learn, has to be taken for granted or assumed. Because the activities of the learning laboratory are purposeful, that is, related to a product or outcome, such activities are inherently more motivational than those which have no apparent purpose. Furthermore, learning laboratory activities are also purposeful in a wider sense in that they are part of an overall educational goal or purpose, namely, the development of learning strategies and interactional skills. Although each student is, in large part, responsible for the motivation stage of learning, the learning laboratory builds on the existing incentives to learn and enhances motivation through meaningful activities.

Orientation. The activities performed by students in the learning laboratory become part of their knowledge, experience, capabilities, and skills; as such, they lead to deeper and increasingly more dimensional levels of understanding. Deeper levels of understanding are more easily achieved in a laboratory setting because in this environment students can illustrate and model complex problems, and thereby, take the orientation stage of learning far beyond what is possible in traditional learning environments. As Butler (1985) observes, the conceptualization of complex phenomena and problems is nearly impossible without models. Such illustrations and models may take the form of visual and audio representations, as well as schedules, diagrams, flow charts, etc. Conceptualization leading to understanding at this stage goes far beyond pure perception, namely, the processing and organization of information. Although a computer can organize, store, and process data, as a machine, it is not changed by this process. Human learners, unlike computing machines, will be changed by their learning and processing of information. Hence, the orientation stage of the learning process involving the conceptualization of complex problems is much more easily accomplished in the learning laboratory environment.

Application. No stage in the learning process is as "at home" in the learning laboratory as the application stage. The outstanding benefit of using the learning laboratory is the opportunity to apply laws, rules, approaches, ideas, etc. What makes the application of ideas in the laboratory so uniquely beneficial, namely, unlike that in other learning environments, is in the **way that learning occurs:** In attendance at lectures and seminars, students learn by way of storing new information heard or seen; in the learning laboratory, however, students learn by way of doing (experiential learning) or by way of discovery for themselves what needs to be done in order to cope with or understand a particular problem or phenomenon. Moreover, in learning by way of doing, students try out numerous possibilities, strategies, and processes and thereby exert control over outcomes or consequences.

In addition, students who learn by doing in the learning laboratory can enlist the aid of existing and emerging technologies to help them produce and use instructional materials and methods. Once produced, instructional media and methods—and the results of their integration into pedagogy—can be confronted and evaluated; in no other learning environment do students have opportunities to confront and experience the consequences of their particular pedagogical models and teaching strategies.

Evaluation. It is commonly known that feedback quickly given is instrumental in determining the efficiency of the learning process. Easy problems and incorrect approaches to problems on the part of students are instances in which feedback can be quickly and relatively easily given. But, if problems are complex or there are many variables and dimensions involved, feedback—on which efficiency of learning and evaluation of products or performance depend—is not always readily nor quickly available. When there are no criteria on which to base feedback, it is necessary to make an integrated evaluation in order to make proper and appropriate choices. Such integrated evaluation is ideally suited to the environment of the learning laboratory because in the learning laboratory it is possible to experiment, interview experts in the field, try out instructional materials in pilot studies or samples of intended learners, and discuss findings and observations with colleagues or students.

Repetition. Educational psychologists have long insisted that immediate and continuing and selective reinforcement is crucial for efficient learning. The reinforcement or repetition stage of learning in the learning laboratory differs from classroom drilling—a widely used and practiced type of rote learning used in the memorization of dates, figures, vocabulary, etc. Reinforcement in the learning laboratory takes the form of remembering the evaluations of instructional productions and outcomes, recalling of strategies and processes that were successful and those that were not, and transferring successful problem solving approaches to new problems. Reinforcement in the learning laboratory leads to the formation of an associative cognitive network (Ball-Staedt, et al., 1981), consisting of highly organized hierarchies of meaning that encompass certain clusters of information and the relationships that connect them. Because it is unlike rote memorization, learning in the learning laboratory can be meaningful.

It is the cognitive network that enables students to solve new problems; in all experience, it is meaningful information that is remembered and transferred to new situations, while surface or decorative details are forgotten within a short period of time. Students who reach the level of associative cognitive network formation built on a solid foundation of meaningful learning (learning by doing) will remain on this level for the long term and maintain interest and motivation, while at the same time stabilizing their cognitive networks.

Generalization. The highest stage of learning, generalization integrates the learning processes of all the aforementioned stages into an associative network. Because rote learning is only reproductive—aimed at reproducing responses or actions exactly—its applicability is limited. On the other hand, generalization is productive and creative in the highest degree. "Comprehensiveness, breadth of meaning and application, and the ability to translate and to transfer concepts, principles, and processes to the widest possible range of contexts and tasks," says Butler, "are the desired outcomes for generalized learning." It is most important, therefore, that students learn under conditions appropriate for the transfer and translation of generalized knowledge and skills to new tasks. In order to accomplish such transfer successfully, students need to develop the divergent thinking that generalization involves.

Students going through the stages of learning in the environment of the learning laboratory gain an awareness of their own learning and, thereby, the ability of how to learn. Because all learning in all stages of the learning process is undertaken in the learning lab in an atmosphere of "learning by doing," students are much more likely to reach the stage of generalization which encompasses the ability to participate in deutero-learning ("deuteropraxis"). This ability can be defined as the need of human beings to always surpass their own experiences and reorganize their knowledge in a generalized form of metaprocessing (Bruner & Olson, 1974).

The learning process begins with motivation and ends with generalization. Once having progressed through this learning cycle, learners are forever changed. More importantly,perhaps, is the fact that at the end of the cycle, learners are ready to begin the process all over again, only this time, beginning at a higher level.

Because the learning laboratory provides students of education with opportunities to "learn by doing," it is a necessary ingredient in any program concerned with the training of future teachers. If today's students of education are to become tomorrow's practitioners of pedagogy, they need to be able to design, produce, and evaluate instructional materials and methods. If courses in the field of education continue to overemphasis theory at the expense of practice, the gap between a theoretical understanding of pedagogy and its practical and pragmatic applications will widen, and today's education students will become tomorrow's educational casualties. Learning laboratories, with their modern technologies, can bridge the gap between educational theory and pedagogical practice by giving students unprecedented and unequalled opportunities to learn in the most effective and long-lasting way possible, that is, learning by doing.

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