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Cognitive Science and Teacher Education

During the past decade, research in cognitive neuroscience has documented a major educational principle: Individuals vary in the characteristic way they process information. Good teachers have always recognized individual differences in learners but have not understood the bases of these differences so as to approach them systematically. Cognitive neuroscience has uncovered the neural, developmental, and organizational bases of the differences and has demonstrated that they can be measured and studied in an organized way.

A beginning has been made in education to apply this information to learning style assessment, grouping, instruction and curriculum, cognitive strategies of students, and evaluation. Applying brain behavior relationships to education is not a simple or clear-cut procedure, however; it requires a holistic, informal diagnostic approach in the home, classroom, and workplace.

Because the teacher is the most important variable in influencing educational outcomes, we propose that the application of cognitive neuroscience to educational practice must emphasize pre-service and inservice education of classroom teachers. In this article we suggest a five-part plan for preservice teacher education focusing on the application of cognitive neuroscience and learning style research in the preparation of education personnel. We seek to prepare prospective teachers

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capable of effectively diagnosing and attending to individual learning needs and assisting students in adapting to the learning requirements of the school and workplace.

Phase One: Basic Education Background

The first phase of the teacher education program would include a basic course in cognitive neuroscience—a course on the brain, mind, and behavior to be offered at the freshman or sophomore level. This course would introduce students to the fundamental principles underlying brain organization, structure, and function. The biological basis for complex phenomena (i.e., memory, attention, thinking, learning, emotion, and consciousness) would be explored and evaluated, offering students new insights into those aspects of brain research which provide a rationale for human behavior.

A course titled "Brain, Mind and Behavior" was broadcast on PBS during the autumn of 1984. Based on the book of the same title by Bloom, Lazerson, and Hofstadter (1985), it provides an excellent model for a basic cognitive neuroscience course for preservice teachers.

Phase Two: Self-Awareness and Analysis of Learning Patterns

Lyons (1983) has documented the value in preservice teacher education of having each student develop an awareness of characteristic patterns in his/her own learning style. A focus on the self as

learner should begin during the first two years of university education. Prospective teachers should be identified and meet regularly in seminar sessions with a faculty teacher education coordinator. The study of self as learner serves a guidance function in the student's university course work as well as an introduction to educating for individual differences.

Formal assessment measures of key variables in the individual's learning processes would be administered, scored, and the results discussed. These variables include selective attention, motivation, memory, cognitive controls, personality components, and cognitive strategies (Languis, 1983). In addition, informal techniques to observe learning style patterns in self and others would be employed.

Prospective teachers would also respond to various questions about different aspects of the learning process. These introspective accounts would serve to develop individual awareness and thus lead to an understanding of their own and others' unique learning characteristics. The following sample questions are designed to stimulate self-analysis. Prospective teachers would be encouraged to provide concrete examples from their life experiences to support responses.

1. Discuss how you prefer to learn (i.e., direct observation, lecture, reading material, etc.).
2. Discuss if your learning preference varies. Do you use different approaches to more effectively learn specific things (i.e., athletic activities, sewing, math, science, etc.)?
3. What motivates you to learn?
4. What strategies do you use to memorize? Do the strategies vary? Why?
5. How do you prefer to be evaluated? Why?
6. Discuss how persistent you are in learning.
7. Do you prefer to learn alone, with a few peers, in a group?
8. What environmental conditions (i.e., sound, light, temperature, room design, etc.) facilitate learning for you? Why?
9. How important is it to know the reactions of others (i.e., peers, family, teachers, etc.) to your accomplishments or lack of accomplishments?
10. Discuss a rationale (based on your understanding of brain behavior relationships) for your processing strengths and weaknesses.
11. How do you believe your characteristic patterns of cognitive and learning processes differ from and/or are similar to those of other members of your gender group? the opposite gender group? (Languis & Naour, 1984)

Giving prospective teachers an opportunity to synthesize and share what they have learned about individual differences will assist them in beginning to know, understand, and accept their own learning strengths, while at the same time developing a healthy respect for the uniqueness of others' learning preferences.

Phase Three: Teaching Style Patterns

A major component of the third phase of the program would be an introductory course on models of teaching, held in conjunction with a field-based experience. This course would explore the repertoire of alternative teaching approaches presented by researchers such as Joyce and Weil (1980) and Hyman (1974) and provide prospective teachers an opportunity to investigate, evaluate, and experiment with a variety of teaching strategies. They would be expected to apply concepts learned in phases one and two of the program by observing and diagnosing the children's behaviors in various contexts (i.e., specific classroom subjects, play, lunchroom, etc.).

The course would emphasize the fact that there is no single method of teaching that accommodates all learning styles and that learning styles may change as the context changes. The primary job of the classroom teacher is to "read" the learning context and adapt instruction to create conditions which maximize learning.

During this phase students would be required to keep journal accounts focusing on varied aspects of the teaching process. The journal questions would be designed to examine the students' own and others' preferred teaching styles. Questions to stimulate self-analysis of teaching style might include the following:

1. Describe the teaching style(s) of the classroom teacher with whom you are working.
2. Describe how the classroom teacher's teaching methodologies change throughout the day.
3. How does the classroom teacher adapt her/his teaching style to accommodate individual learning needs?
4. Discuss how you would organize the curriculum for a day.
5. Discuss how you would prefer to introduce new concepts in math, science, social studies, reading, etc.
6. Discuss how you would reinforce these new concepts.
7. Discuss how you motivate children to learn and how you evaluate their progress.

8. Discuss how you would help the slower child.
9. Discuss how you would foster growth in the gifted child.
10. Develop a lesson plan for each subject utilizing a variety of teaching techniques. (Prospective teachers would teach the lessons they developed.)
11. Discuss the strengths and weaknesses of each lesson and make recommendations for improvement.

The experiences of this phase will help participants realize the variety of teaching strategies they can employ. They will become knowledgeable and skillful in interpreting their own teaching behaviors—what they do, why they are doing it, and what effect their actions produce.

Phase Four: Adapting Teaching Style to Learning Style/Preference

Phase four would include a full-time, one quarter, pre-student teaching experience following instruction in methods of teaching content specialties (i.e., math, science, social studies, language arts, reading). Prospective teachers would be required to observe, identify, and diagnose cognitive, affective, and physiological patterns of learning behavior in the children they are instructing, design instructional strategies to meet individual learning styles, and adapt their teaching methodologies to accommodate these learning needs. The following journal questions are designed to accomplish this goal.

1. Identify two pupils you suspect have opposite learning styles/preferences. Observe and discuss these two children in various learning situations (i.e., math, reading, science, social studies, physical education, art, music, lunchroom, recess, socializing with others, etc.).
2. Classify specific learning behaviors of the two children in various learning situations and the teaching methodology used.
3. Discuss if there was a match or mismatch between learning style and teaching style for each learning situation.
4. Discuss and describe how the learning behaviors of the two children changed as the learning situation changed.
5. Provide a rationale for why the learning patterns changed or did not change.
6. Classify and group each child in the classroom according to observed learning patterns of behavior.

7. Discuss the relationship between your learning style/preference and teaching style/preference.

Through weekly seminars, prospective teachers would examine the problems teachers face in designing curriculum. The sharing process will help them develop a practical theory of learning based on the cognitive sciences—a theory rooted in what the learner does, rather than how proficient he/she is in performing the task.

Participants would be guided in developing a practical theory of instruction which addresses how the teacher can facilitate a child's ability to gain proficiency. This approach to instruction suggests adjusting the curriculum to the child, not the child to the curriculum. Prospective teachers would also learn skills to deal with the idiosyncratic dimensions of children's learning behavior.

Phase Five: Internship

Student teaching would be replaced with a full year internship (fifth year of the teacher education program). During this year, prospective teachers would receive guidance, direction, and feedback in applying cognitive science and learning style research.

Conclusion

The prototype neuroscience/learning style pre-service teacher education program described in this article was designed and experimentally implemented at The Ohio State University (Lyons, 1983). Two follow-up studies have been conducted (Lyons, 1984a). Results suggest:

1. Awareness of one's learning style/preference is a necessary prerequisite to identifying others' learning styles/preferences.
2. Learning style and teaching style are related (Lyons, 1984b).
3. Understanding one's own learning processes improves teaching (Lyons & Languis, 1984).
4. By creating a greater diversity of curricula, instructional methods, and educational goals and values, prospective teachers will make it possible for students with a wide range of abilities and proclivities to meet with success in the classroom.

We believe one way to stop the serious erosion of public confidence in educational practices is by developing prospective teachers' ability to become professional decision makers. A program of study rooted in cognitive neuroscience is a step in that direction.

It is no secret that teaching is not considered a "true" profession (Ornstein, 1981). Other professions (i.e., physician, attorney, engineer, etc.) train their undergraduates to become experts in their respective fields. A cognitive neuroscience/learning style program of teacher education would provide students a foundation for developing an expertise in the learning/teaching process, which is the core of education.

True professionals have the knowledge and expertise to make sound judgments concerning the educational process. The key to good instruction is what the teacher knows, not the text or the test (Shuy, 1981). The program of study outlined in this article may start a trend toward increased professionalism for classroom teachers. Such a program would create an atmosphere of inquiry leading to an awareness of self and others functioning as everyday scientists in a quest for appropriate teaching strategies.

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