# CRITICAL THINKING AS INFLUENCED BY LEARNING STYLE

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## Abstract

*The development of critical thinking skills in students at all age levels has long been a national concern. As such, teaching faculty in all disciplines and at all levels of education shared a common goal: to develop in students in the complex mental operations that will allow them to be successful in the classroom as well as their future careers. A review of education literature reveals several factors that have been found to influence cognitive development. Learning style was one such factor. This study sought to investigate the influence learning style had on critical thinking abilities of students enrolled in a college of agriculture. A random sample of senior students was selected for the study. The Developing Cognitive Abilities Test and the Group Embedded Figures Test were used to gather data on students critical thinking abilities and learning style. Using multiple linear regression, 9 percent of the variance in students' critical thinking was uniquely accounted for by learning style after controlling personal characteristics. Recommendations are offered based on the results and for future research.*

The education literature overwhelmingly conveys the value for the development of critical thinking abilities in students. Most rationales convey arguments for the importance of thinking abilities: they lead to getting a better job, to the nation being able to compete better economically, to people being able to fit better within a changing and complex environment, to improve the quality of life (Thomas, 1992).

Addressing the postsecondary faculty, Weiss (1993) indicated that teaching faculty in all disciplines and at all levels of education shared a common goal: to develop in students in the complex mental operations that will allow them to be successful in the classroom as well as their future careers. How do we develop complex mental operations in student?

## Theoretical/Literature Base

In a comprehensive literature review, Torres (1993) developed a conceptual framework that grouped variables identified into five major factors that contributed to developing complex mental operations or cognitive abilities: 1) teacher-related variables; 2) student-related variables; 3) personal characteristics; 4) learning styles; and, 5) other factors (Figure 1).

Teacher-related factors included such variables as philosophical beliefs (Bane, 1969), preparation (Young, 1982; Gall, 1970), cognitive expectation (Pickford, 1988), tests and assignments (Miller, 1989), and instructional delivery (Pascarella, 1975; McMillan; 1987). While teacher-related factors hold to be very important influential factors in cognitive development, student-related factors may be more profound.

Student-related factors included such variables as involvement (McKeachie, 1980; Flander, 1970), motivation (Miller, 1989; Pickford, 1988), and student interest in and value of the course enrolled (Pickford, 1988). Similarly, McKeachie (1980) maintained that students' personal characteristics

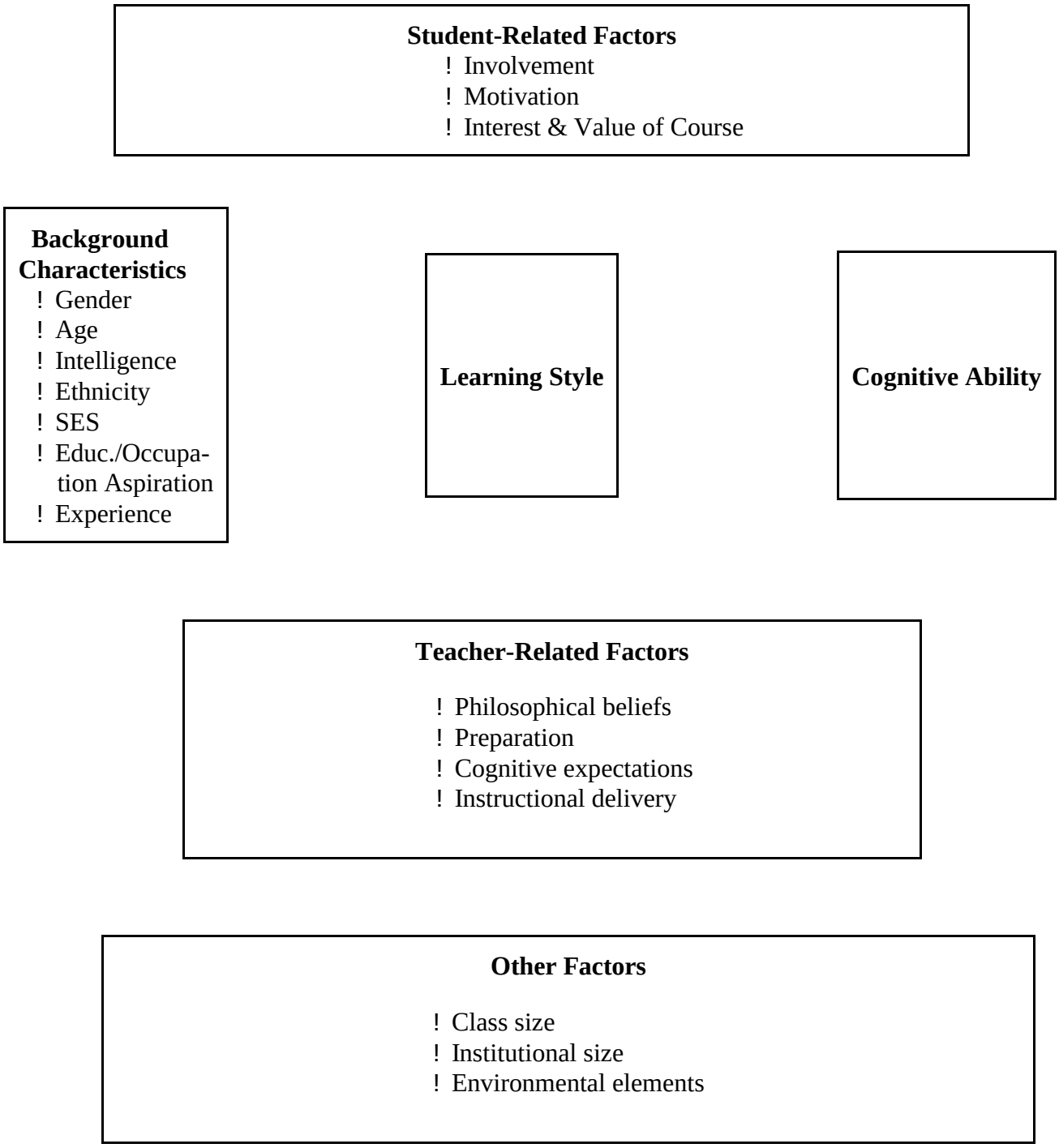


Figure 1. Conceptual Framework

also played an important role in cognitive development. Pascarella (1985) suggested that student attributes such as gender, age, ethnicity, social economic status, intelligence, and educational/occupational aspiration were worth considering in terms of influence in cognitive development. Other factors have also been identified through the literature. Among them were

class size, institutional size, and environmental elements such as mental activities in class and while studying for courses, reasons for studying, work patterns, and the role of the teacher (Fisher & Grant, 1983; Chickering, 1972).

While a number of factors have emerged from the literature on student cognitive development, an additional factor identified was student learning style. Learning style is one factor researchers claim influenced student educational performance (Dunn & Dunn, 1979; Claxton & Murrell, 1987). Gregorc (1979) described learning style as "consisting of distinctive behaviors which serve as indicators of how a person learns from and adapts to his/her environment. It also give clues as to how a person's mind operates" (p. 234). Learning style research has been applied at an ever-increasing rate to the problems of education (Doebler & Eicke, 1979). Claxton and Murrell (1987) suggested that learning style could be an extremely important element in the move to improve curricula and the teaching process in higher education.

Field-dependent and field-independent learning styles have been widely and extensively studied and have the broadest application to educational concerns (Witkin, Dyk, Faterson, Goodenough, & Karp, 1962). Witkin, Moore, Goodenough, and Cox (1977) suggested that students who preferred a field-dependent learning style tended to perceive the world globally, found it more difficult to solve problems, were highly sensitive and attuned to the social environment, tended to favor the "spectator approach" to learning, and would adopt the organization of information to be learned. Additionally, students who preferred a field-dependent learning style were more extrinsically motivated and responsive to social reinforcement.

Conversely, students who preferred a field-independent learning style tended to view the world more analytically, found it easier to solve problems, and were more likely to favor "inquiry" and independent study. In addition, field-independent students tended to provide their own structure to facilitate learning, were more intrinsically motivated, and were generally unresponsive to social reinforcement (Witkin et al., 1977).

The conceptual framework (Figure 1) serves as a benchmark for beginning to address the developmental cognitive abilities of students enrolled in colleges of agriculture. This study sought to investigate the influence learning style had on the cognitive development of students enrolled in a college of agriculture. Additionally, the study sought to control statistically for variance accounted for by personal characteristics.

## Purpose and Objectives

The purpose of the study was to examine and explain the variance in the critical thinking abilities of students enrolled in the College of Agriculture at a land-grant university. The study was guided by the following research objectives and hypothesis:

1 Describe selected personal characteristics (age, gender, GPA, ethnicity) of students.

2. Describe the performance measure on critical thinking abilities of students.

3. Explain the variance in critical thinking abilities accounted for by learning style beyond that contributed by gender, age, and GPA.

$H_1$: Learning style will be positively related to critical thinking ability.

## Methods/Procedures

### Population and Sample

The accessible population for the descriptive-correlational study was senior students enrolled in the College of Agriculture at The Ohio State University during the Autumn Quarter, 1992 (N=388). An up-to-date list of seniors was obtained from the College Office and served as the

frame for the study. A sample of 196 students was drawn randomly from the population of senior students. The sample size (n=196) was determined using Krejcie and Morgan's (1970) table of sample sizes, specifying a five (5) percent margin of error.

Instrumentation

Two instruments were used to gather the data: the Group Embedded Figures Test (GEFT) (Witkin, Oltman, Raskin, & Karp, 1971) and the Developing Cognitive Abilities Test (DCAT) (Beggs & Mouw, 1989). The GEFT was used to assess the learning style of students as either field-dependent or field-independent. Individuals scoring greater than the national mean (11.4) were considered to be leaning toward the field-independent learning style, while subjects scoring less than the national mean were considered to be leaning toward the field-dependent learning style (Witkin et al., 1971). The maximum possible raw score on the GEFT was 18.

The validity of the GEFT has been established by determining its relationship with its "parent" test, Embedded Figures Test (Witkin et al., 1971). Because the GEFT was a speed test, internal consistency was measured by treating each scored section (sections two and three) as split-halves. Witkin et al. (1971) reported a corrected Spearman-Brown reliability coefficient of .82 on the GEFT.

The DCAT was used to assess critical thinking abilities of the students using items on three content areas (verbal, quantitative, spatial). The critical thinking abilities are consistent with the Analysis and Synthesis levels of Bloom's taxonomy (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956). The evaluation level of Bloom's taxonomy was deleted from the general intent of the DCAT.

The DCAT was considered a standardized instrument and has been assessed for content validity and reliability (Wick, 1990). The reliability estimate, expressed as Kuder-Richardson-20 as a measure of internal consistency, were established by the developers of the instrument. A reliability estimate of .75 was reported for Critical Thinking Abilities (Wick, 1990). Personological data was gathered from College records.

Data Collection

Data collection began by mailing students a letter of invitation strongly encouraging participation in the study. The letter was structured according to Dillman (1978) and specified four dates and times with two data collection sessions on each date. Students were invited to attend one of the eight sessions offered. Students were able to indicate their willingness to participate on a self-addressed, stamped postcard. Ten days after the initial mailing, follow-up efforts were conducted via telephone to determine students' willingness to participate in the study. A make-up data collection session was offered to students unable to attend their scheduled session. All data collection sessions were located in the same room.

A total of 47 percent (n=92) of the students in the sample participated in one of the eight scheduled or one make-up data collection session. Students who did not participate in the study were treated as non-respondents and considered to be non-response error.

Non-response error was controlled by sampling the non-respondents and comparing them with the respondents. A sample of 10 percent of the non-respondents (n=11) was randomly drawn and statistically compared to the sample of respondents (n=92) on variables of interest as suggested by Miller and Smith (1983). No significant differences ($p>.05$) were found between the sample of non-respondents and respondents. Thus, the non-response data were pooled with the respondent data, yielding a sample size of 103 (53.0%) and allowing generalization to the sample/population (Miller & Smith, 1983).

Data Analysis

The data were analyzed using SPSS/PC+.

Descriptive statistics such as frequencies, central tendencies, variance, and ranges were used to simplify and characterize the data. Hierarchical multiple linear regression was used to explain the variance in students' critical thinking abilities. An alpha level of .05 was set a priori.

## Results and Conclusions

Table 1 presents the summarized data on students' background characteristics (age, gender, learning style, and cumulative GPA). Ethnicity was dropped from consideration as a variable due to the lack of variance (94.2% white; 4.8% African-American; 1.0% Hispanic).

According to the data, the mean age ($X_1$) of senior students was 23.65. The mean of gender ($X_2$) indicates 43 percent were female and 57 percent were male. Learning style - GEFT ($X_3$) mean score was 12.42 out of a total possible score of 18. Using the national norm as the midpoint (Witkin, Otlman, Raskin, & Karp, 1971), senior student can be dichotomized as either field dependent or field independent. As such, further data analysis reveals that 38.8 percent of the students tended to lean toward a field-dependent learning style. While 61.2 percent of the students tended to lean toward a field-independent learning style. Academically, the data records a cumulative Grade Point Average ($X_4$) mean score of 2.54 for students. As the dependent variable of the study, the Critical Thinking Abilities mean score for senior students was 17.04 out of a possible score of 27.

A correlation matrix was generated containing the dependent variable, the variable of interest, and the control variables (Table 1). Variables used as control variables in examining the relationship between learning style and critical thinking were age (r=-.08), gender ($r_{pb}$-.02), and GPA (r=.33). The variable of interest, learning style, was correlated with critical thinking (r=.36).

The correlation matrix also served to reveal the presence of multicollinearity -- a potential violation of the assumptions in using multiple linear regression. Using the rules of thumb offered by Lewis-Beck (1980), none of the bivariate correlations exceeded the stated .80 coefficient, nor did the range of $R^2$ (.04 - .13) reveal a potential threat to the assumptions after each independent variable was regressed on all other independent variables.

Using hierarchical multiple linear regression analysis (Table 2), 22 percent ($R^2$=.216) of the variance in senior students critical thinking abilities was accounted for by the optimal linear combination of GPA, age, gender, and GEFT score (F=6.76, p<.05). The control variables were entered into the equation first. The three control variables (GPA, age, and gender) contributed 13 percent of the variance in senior students' critical thinking abilities. Isolating the variance contributed by the control variables, the variable of interest--learning style (GEFT), uniquely accounted for an additional 9.1 percent of the variance in senior students' critical thinking ability (t=3.38, p<.05).

## Educational, Scientific, and Practical Importance

A moderately positive bivariate relationship (r=.36) existed between learning style and critical thinking of students. However, this relationship does not control the multicollinearity of extraneous variables. In his address to the agricultural education profession, McCracken (1991) argued a

Table 1. Summary Data: Regression of Critical Thinking Abilities on Selected Variables (n=103)

| | Intercorrelations | | | | | | |
|---|---|---|---|---|---|---|---|
| Variable | $X_1$ | $X_2$ | $X_3$ | $X_4$ | Y | Mean | SD |
| Age ($X_1$) | 1.00 | -.19 | -.05 | .07 | -.08 | 23.65 | 4.13 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Gender* ($X_2$) | 1.00 | .26 | .09 | -.02 | .57 | .50 |
| GEFT ($X_3$) | | 1.00 | .27 | .36 | 12.42 | 4.27 |
| GPA ($X_4$) | | | 1.00 | .33 | 2.74 | .57 |
| Critical Thinking Abilities (Y) | | | | 1.00 | 17.04 | 3.78 |

*0=female; 1=male

Table 2. Hierarchical Regression of Critical Thinking Abilities on Control Variables and Variables of Interest (n=103)

| Variable | $R^2$ | $R^2$ Change | *b* | *t* | *p* |
|---|---|---|---|---|---|
| Control Variables | .130 | .130 | | | |
| GPA | | | 1.81 | 2.81 | .005* |
| Age | | | -.10 | -1.16 | .248 |
| Gender[a] | | | -1.15 | -1.54 | .128 |
| Variable of Interest | | | | | |
| GEFT | .216 | .091 | .30 | 3.38 | .001* |
| (Constant) | | | 11.17 | | |

*p<.05 for individual variables; Standard Error=3.58; Adjusted $R^2$=.18; For Model: F=6.76, p<.05

[a]: 0=female; 1=male.

need to control for variance in a dependent variable that is presumably "caused" by one or more independent variables extraneous to relation under investigation. Hence, by nullifying variance of the control variables (age, gender, and GPA), the current study indicates approximately 9 percent of the variance in critical thinking abilities in students enrolled in the College of Agriculture is uniquely accounted for by learning style. The study also suggested a substantial proportion (91%) of the variance in student critical thinking abilities remains unaccounted.

Yet, by most standards, the ability of one variable to contribute uniquely 9 percent of the variance in a dependent variable suggests learning style is indeed a significant variable that educators need to be familiar with to use in promoting and developing critical thinking abilities in students. So, what can be recommended about an attribute variable that is said to remain static across one's life? One must first keep cognizant that learning style should be conceived as referring to *actions*, rather than *abilities* of students. As such, instructors should construct an educational environment conducive to promoting actions that contribute to critical thinking. This is not to say that instructors change students' preference for learning (learning style); rather, instructors need to use the students' learning style in the planning and delivering instruction. In the delivery, instructors should use a variety of teaching methods, curriculum materials, and evaluation techniques into classroom discourse to reach students with differing learning style.

Instructors need in-service training on learning styles. With leadership from a college teaching committee, learning style workshops should be designed and implemented by teacher educators in agricultural education with expertise in learning theories. At the styles workshops, faculty can gain knowledge about learning styles by having their own learning style assessed. Guild indicated it is

important for instructors, when working with students, to understand both their own and the students' learning perspectives (Brandt, 1990), because as Dunn and Dunn (1979) suggested, instructors teach the way they learn.

Furthermore, research needs to continue along this line of inquiry. Identifying factors that contribute to the development of critical thinking in students of all ages persists as a pressing issue for educators and researchers. As a cognitive process function, critical thinking has continued to elude the development of any "recipe" formula in developing these essential skills. Nonetheless, effort should be exerted to forage factors that make unique contributions to the development of critical thinking abilities. With 91 percent of the variance unaccounted for by this study, teacher-related and student-related factors identified in the conceptual framework, as well as others, might be worth investigating.

## References


Bane, R. K. (1969). Relationship between measures of experiental, cognitive, and affective teaching behaviors and selected teacher characteristics. Unpublished doctorial dissertation, University of Florida, Gainesville.

Beggs, D. L., & Mouw, J. T. (1989). Assessing dimesions of ability. In American Testronics, Developing Cognitive Abilities Test: Comprehensive assessment program. Chicago: American Testronics.

Bloom, B. S., Englehart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (1956). Taxonomy of educational objectives-handbook 1: Cognitive domain. New York: David McKay.

Brandt, R. (1990). On learning styles: A converstion with Pat Guild. Educational Leadership, 48(2).

Chickering, A. W. (1972). Understanding academic experience. Journal of Educational Psychology, 63(2), 134 - 143.

Claxton, C. S., & Murrell, P. H. (1987). Learning styles: Implications for improving education practices. ASHE-ERIC Higher Education Report No. 4. Washington, D.C.: Association for the Study of Higher Education.

Dillman, D. A. (1978). Mail and telephone surveys: The total design method. New York: John Wiley & Son.

Doebler, L. K., & Eicke, F. J. (1979). Effects of teacher awareness of the educational implication of field-dependent/field-independent cognitive styles on selected classroom variables. Journal of Educational Psychology, 71(2), 226-232.

Dunn, R. S., & Dunn, K. J. (1979). Learning styles/teaching styles: Should they... Can they...Be matched? Educational Leadership, 36, 234-244.

Flander, N. A. (1970). Analyzing teacher behavior. Reading, MA: Addison-Wesley.

Fisher, C. G., & Grant, G. E. (1983). Intellectual levels in college classrooms. In C.L. Ellner & C.P. Barnes (Eds), Studies in college teaching, (47-60). Lexington, MA: D.C. Heath and Co.

Gall, M. D. (1970). The use of questions in teaching. Review of Educational Research, 40(5), 707-721.

Gregorc, A. F. (1979). Learning/teaching styles: Potent forces behind them. Educational Leadership, 36, 234-236.

Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. Educational and Psychological Measurement, 30, 607-610.

Lewis-Beck, M. S. (1980). Applied regression: An introduction. Series: Quantitative Applications

in the Social Sciences. A Sage University Paper, No. 22.

McCraken, J. D. (1991). The use and misuse of correlational and regression analysis in agricultural education research. Proceedings of the Eighteeth Annual National Agricultural Education Research Meeting, Los Angeles, CA.

McKeachie, W. J. (1980). Implications of cognitive psychology for college teaching. New directions for teaching and learning: Learning, cognition and college teaching, No. 2. San Fancisco: Jossey-Bass.

McMillan, J. H. (1987). Enhancing colleg students' critical thinking: A review of studies. Research in Higher Education, 29, 3-29.

Miller, C. (1989). Cognitive levels of instruction and student performance in college of agriculture courses. Unpublished doctorial dissertation, The Ohio State University, Columbus.

Miller, L. E., & Smith, K. (1983). Handling nonresponse issues. Journal of Extension, 10, 45-50.

Pascarella, E. T. (1975). College environment influences on learning and cognitive development. In J.C. Smart (Ed), Higher education: Handbook of theory and research, Vol. 1. New York: Agathon Press.

Pickford, J. C. (1988). Selected student and professor variables related to cognitive achievement in College of Agriculture courses. Unpublished master's thesis, The Ohio State University, Columbus.

Thomas, R. G. (1992). Cogntive theory-based teaching and learning in vocational education. (ERIC Document Reproduction Service No. ED 345 109)

Torres. R. M. (1993). The cognitive ability and learning style of students enrolled in the College of Agriculture at The Ohio State University. Unpublished doctorial dissertation, The Ohio State University, Columbus.

Weiss, C. A. (1993). But how do we get them to think? In M.Svinicki (Ed), Teaching excellence: Toward the best in the academy. Ames, IA: POD Network.

Wick, J. W. (1990). Developing cognitive abilities test. Technical Manual (Reproducation edition). Chicago: American Testronics.

Witkin, H. A., Dyk, R. B., Faterson, H. F., Goodenough, D. R., & Karp, S. A. (1962). Psychological Differentiation. New York: John Wiley & Sons.

Witkin, H. A., Moore, C. A., Goodenough, D. R., & Cox, P. W. (1977). Field-dependent and field-independent cognitive styles and their educational implications. Review of Educational Research, 47(1), 1-64.

Witkin, H. A., Oltman, P. K., Raskin, E., & Karp, S. A. (1971). Group Embedded Figures Test Manual. Palo Alto, CA: Consulting Psychologist Press.

Young, R. E. (1982). Instructional development ways and means. (ERIC Document Reproduction Service No. ED 224 426)