Foundation and Theoretical Framework for Supplemental Instruction

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Different Approaches to Assisting Students

Traditional Approaches of Assisting Students. Traditional individual tutorial practices may be described as following a medical model: an individual is identified as needing professional assistance on the basis of a) prior history and diagnostic testing, b) self-referral in response to perceived symptoms, or c) referral by another professional in response to observed symptoms. In some institutions, identification of high-risk students is based primarily on prior history of test scores (see "a" above). These tertiary institutions are likely to be somewhat selective, requiring students to submit to extensive pre-matriculation testing and interviews. Professional schools and private, selective colleges are among those fitting this category. Students entering such institutions typically commit for the long term and, at a minimum, can be expected to persist for at least a year. Under these circumstances, academic therapy with students at risk can begin immediately upon matriculation and can continue until students give evidence of being able to function independently in the academic environment.

As noted in "b" above, some students self-refer. Their symptoms in these instances may range from free-floating anxiety in the academic setting to unsatisfactory performance in one or more highly specific settings. The tutor or resource specialist must function first as diagnostician, identifying the basis for the students' self-referral and differentiating between anxiety and a variety of other reasons for unsatisfactory performance. Having established at least a tentative diagnosis, the tutor then becomes the therapist, helping the student to negotiate the academic demands of the institution.

Use of "c" above requires another professional, usually a professor or graduate teaching assistant, to become aware that a student is in academic difficulty. This awareness may come in a variety of ways, most likely in the wake of unsuccessful performance on an academic task. For example, the faculty member may refer the student for tutorial assistance to correct an academic problem that has become apparent because of a low test score. In this instance, the tutor functions, as described in the previous paragraph, first as a diagnostician and then as a therapist.

Rationale for a Non-Traditional Approach. It was in a milieu dominated by tutorial services in the medical model that SI developed. The developers at UMKC found that several assumptions of the medical model either did not apply or were not practiced in their institution. Subsequent adoption of SI on other campuses may suggest that the same assumptions were found wanting on these other campuses as well.

As noted, the traditional model relies on identification of the "high-risk" student, the student who is deemed to be deficient or "at-risk" in some way. In institutions other than those described, (i.e., selective tertiary and professional schools), several factors preclude such pre-matriculation identification.

First, entering students must be known to the faculty and staff in time for key personnel to establish contact with at-risk students. Second, it must be noted in this context that neither prior performance nor standardized testing is sufficiently reliable as a prediction criterion of

who is and is not at risk. As many as 50 percent of those whose prior scores suggest they are at risk prove to be successful without intervention, and many of those who are not identified in this manner prove to be unsuccessful.

Analysis of high school grades and standardized college entrance examinations do not identify all students who will drop out of college for academic reasons (Blanc, et al., 1983; Christie & Dinham, 1991; Martin et al., 1983; Tinto, 1987) and attrition cannot be addressed effectively by providing help only to those students who show either symptoms or predisposing weaknesses. The treatment must be more generalized, and the problem must be addressed at or near its source: the mismatch between the level of instruction and the level of student preparation (Martin, et al., 1977).

Timely identification of students who are at risk is difficult in the traditional model. Faculty who can refer students for corrective instruction are rarely able to make a referral before the scoring of the first course examination. Students who are referred after that time are a considerable disadvantage, trying to catch up with the class after a very poor start. The rate of student attrition across courses is greatest in the first six weeks or after the first exam when students may find their grades disappointing (Blanc, et al., 1983; Noel, et al., 1985).

Students who are at risk are among those least compliant with faculty recommendations for special help, whether for personal counseling or for academic assistance. Such students often perceive that tutorial help, far from relieving them of their academic burden, increases the burden as they must now answer to a tutor in addition to the course professor.

Finally, students who are at risk are notorious for their reluctance to refer themselves for assistance until much too late. Whether through denial, pride, or ignorance, students who need help the most are least likely to request it. So goes the axiom of the learning assistance trade (Somers, 1988).

SI first developed in an institution that did not fit into the medical model described previously in this chapter. At UMKC, students can register as late as the first day of class, with their prior transcripts and test score data to be submitted sometime before the beginning of the following semester. This large, inner-city, commuter institution, typically turned over 40 percent of its students each semester, most of them due to transfer but some due to the phenomenon now known as "stopping out" as distinguished from "dropping out." "Stopping out" referred to the widespread practice of taking no classes during a semester that would be devoted to other priorities such as working to reestablish a bankroll sufficient to allow subsequent reentry.

Delivery of services from the first day of class changes the support program from a reactive to a proactive mode. One of the non-cognitive variables that differentiates between more capable and less capable students is this: those who are less capable are inclined to do without support services until they need them; those who are more capable will avail themselves of services at the beginning and stop services if they find the services to be neither productive nor essential. The presence of these more capable students in support sessions affirms that the sessions are not remedial. That fact enables less capable students to participate without the fear of stigma.

The integration of skills and content allows the SI leader to meet the perceived content needs of students while delivering essential skills instruction simultaneously. If, as McLuhan argued, "the medium is the message," then the

message of SI is skill instruction, delivered along with the course content material.

Delivering services on an outreach basis, (i.e., in the classroom buildings assigned for regular academic instruction), lends an air of academic credibility to the support service. Similarly, the overt endorsement of the SI program from the participating course professor lends further authority to the claim that SI is valuable.

Of course, the voluntary nature of the SI pact--which is renewable every week (or every day, for that matter)--comforts the wary student who shuns taking on additional responsibility. The combination of voluntary participation, early intervention, and proactive support differentiates the SI model from the traditional medical model that relies on diagnosis of signs and symptoms followed by prescriptive treatment.

Foundation and Theoretical Framework for Supplemental Instruction

Theories Behind the Strategies. The remainder of this chapter briefly describes some theorists and researchers whose work the SI developers found particularly helpful. A conscious decision was made to base the SI model on a developmental perspective because that perspective puts the burden of responsibility on the service providers. Such a theory base assumes that the students will learn if the conditions for learning are in place. The leading researcher in the developmental field at the time the SI model was created was Jean Piaget. Robert Blanc is to be credited with anchoring SI in a developmental framework and designing original research studies (Blanc, et al., 1983; Martin, et al., 1977).

Jean Piaget and Constructivism. Jean Piaget formulated a comprehensive model of cognitive development. Although Piaget studiously avoided prescriptive statements concerning education, preferring to confine his studies to epistemology, several of those with whom he worked have applied his insight to education. The conclusion of this line of research as it applied to SI is this: many students in tertiary educational institutions have not yet developed abstract reasoning that will allow them to learn new ideas simply by listening to lectures and reading text. In recent years, some of Piaget's ideas have been formalized into an educational theory called "constructivism." Proponents of constructivism take their name from Piaget's observation that students must "construct" their own knowledge to be able to understand and use it.

Many constructivists make a clear distinction between information and knowledge. Information is easily transmitted through telling. On the other hand, "gaining knowledge means gaining expertise" (Blais, 1988, p. 3). Learners must be actively involved in constructing the knowledge themselves and understand how to use it. Blais (1988) continues by stating that "telling" students actually perpetuates remedial processing tendencies that many students possess. Good SI sessions model thinking behavior that cause participants to engage the material (i.e., lecture notes, textbook, outside readings) and construct "knowledge" and not just review the "information."

Students typically perceive their need as entirely content-centered. Experience shows, however, that the most common need among marginal students is for the learning and thinking skills that are basic to content mastery. Arons and Karplus (1976) observed that 50 percent of entering college first year students did not have reasoning skills at the "formal," ("abstract") operational level described by

Piaget and Inhelder (1958). The popular and professional literature has not reported improvement since these early studies.

Students who appear to operate at the concrete (i.e., nonabstract) level consistently have difficulty processing unfamiliar information when it is presented through the abstract mediums of lecture and text. Their questions about material are often detail-oriented and superficial. Rarely do they ask or answer questions that require inference, synthesis, or application. They can operate at more advanced levels once they have mastered a concept; but, to do so, they require regular instruction that either anchors the concept directly in their previous experience or provides a concrete experience with data from which the concept may be inferred (Blanc, et al., 1983; Fuller, 1980; Karplus et al., 1976; Renner et al, 1976).

A variety of tasks can present overwhelming obstacles to individuals who have not attained the advanced stage of intellectual maturity that Piaget and Inhelder (1958) identified as formal or abstract. This problem is complicated in foundation courses where the most common means of assessment is detail-oriented exams, which, by their design, reinforce rote memory. It is, therefore, possible for students both to achieve high marks in courses and to fail to understand the principle concepts that must be assimilated if they are to retain and use the memorized material. The effect of these differences in learning patterns surfaces in more advanced courses that require students to display integration and application of the knowledge they have previously acquired (Chaffee, 1992).

Another leader in the Constructivist movement was Lev S. Vygotsky. He created a concept called The Zone of Proximal Development. This Zone was the gap between where a learner can operate independently and the higher level that the learner could operate at if they were interacting with more capable peers. Through continued practice, the learners increase their capability to think since they are being encouraged by the more capable peers to extend themselves to higher levels of thought (Vygotsky, 1978).

One task of the SI leader is to guide students as they raise their operational levels (Martin, et al., 1983). Specifically, SI leaders focus on intellectual tasks such as the identification and control of variables, a reasoning skill common to both the natural and social sciences as well as mathematics. Similarly, SI leaders focus on helping students to recognize proportional relationships and to use ratio reasoning when it is appropriate to do so. Although students can use hypothetical/deductive reasoning on an informal or intuitive level, they often need help to see the relevance of this kind of thinking in a formal academic discipline. Application of the idea of probability, on the other hand, often escapes students unless direct attention is drawn to it. A task of the SI leader is to make explicit the instances in which the aforementioned reasoning patterns and processes are implicit in either lecture or text.

The SI leader functions in another key role to help students attain academic maturity: the leader helps students to analyze their own learning. This metacognitive approach to learning finds application in its most basic form when the SI leader helps students to figure out what they do and do not understand about a concept and then to frame questions that eventually will lead to their more thorough understanding. Skilled and experienced learners know how to judge their own understanding and to ask such questions. Less successful learners often fail to distinguish between what they do and do not understand. SI leaders, then, must

be sensitive to levels of student development and performance across a wide spectrum.

Some constructivists (Vygotsky, 1962) see collaborative peer group learning activities as preparing learners to become independent in the future. Consistent with this goal, SI encourages similar development since SI sessions, SI leaders, or even other forms of collaborative learning groups may not be available in the future. It is development in this dimension that we believe helps to explain why there are long-term benefits to SI participation (i.e., increased re-enrollment and graduation rates).

Edgar Dale's Cone of Experience. Compatible with Piaget's theory base is Edgar Dale's Cone of Experience (Dale, 1969) which conveys some of Piaget's ideas on learning in a graphic form. Proven useful for working with students in lower grades, this model is also relevant for working with college-aged students. Dale proposes that learning is stimulated progressively from concrete (i.e., hands-on) experiences to abstract (i.e., verbal and visual) symbols. The foundations for instruction reside in direct sensory experiences combined with purposeful interaction with the stimuli sources. Dale's Cone is most useful as a guide for introducing and building concepts. At the most basic and most effective level of instruction, students are introduced to new material through an actual hands-on experience or "doing the real thing." Students see, do, and talk about the concept. Learning is the most complete if these conditions can be met.

At the top of the cone, or triangle, is lecture and text. Dale's model suggests that these passive instructional modes are the least effective ways to introduce new concepts to students. Between the top and the bottom of the cone, Dale has several other levels of instruction including giving a talk, watching a demonstration, seeing a film or picture. For SI leaders, experience with Dale's Cone helps them design the instructional activities to meet student needs.

Vincent Tinto's Model of Student Retention. Tinto's model of student retention is one of the most frequently cited in professional literature. Tinto's research suggests that students who are integrated into both the academic and social dimensions of the institution are more likely to persist (Tinto, 1987; Tinto in Spann, 1990). Institutions bear part of the responsibility for student success since the decision to leave an institution is more a function of what occurs during the college experience rather than with what preceded it. (Tinto, 1987).

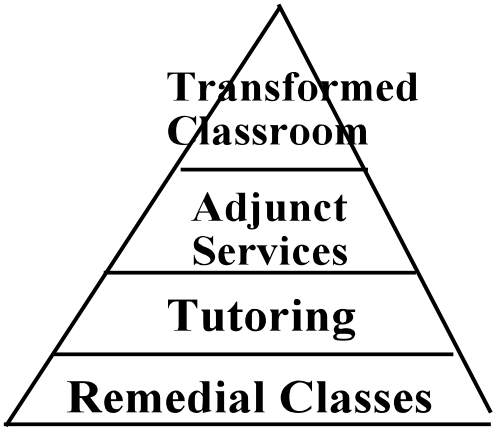
"Drawn from the work of Durkheim and Van Gennep, this theory will argue that colleges and universities are like other human communities; that student departure...necessarily reflects both the attributes and actions of the individual and those of the other members of the community in which that person resides. Decisions to withdraw are more a function of what occurs after entry than of what precedes it. They are reflections of the dynamic nature of the social and intellectual life of the communities housed in the institution, in particular of the daily interaction occurring among its members. Student departure may serve as a barometer of the social and intellectual health of institutional life as much as of students' experiences in the institution" (Tinto, 1987, p. 6).

Nationally, high rates of student attrition among first-year college students continue to be a trend (American College Testing Program, 1993). Tinto identified four significant factors in student attrition (Tinto, 1987; Tinto in Spann, 1990): many students feel socially isolated on campus; students have difficulty in

adjusting to the new environment; students suffered from incongruence (i.e. they are not able to link the knowledge received from class lectures to what they already understand); and students have trouble in the college environment.

The SI Program can be part of a broad institutional response to help address these four factors. The SI review sessions provide a safe environment within which students can discuss and process the course material with others. SI students become acquainted with one another as they interact. The SI leader facilitates the discussion so that students can adjust, discuss what they do not understand, and discover strategies that unlock the mystery of learning at college. SI participants experience more academic success in target courses than their non-participating peers (Martin, et al., 1977, 1983, 1990).

A key concept in Tinto's model is that the departure decision for a student is more heavily influenced by experiences with the college environment than by the previous academic and social experiences that occurred before college attendance. The institution has an opportunity to manipulate its environment to provide, through informal and formal contacts, an opportunity for the student to be integrated into the social and academic dimensions of the institution.



Rather than remain powerless in the face of high attrition, the institution can decide to make available resources and to change its campus environment. SI is a viable and effective option for changing the campus environment. Through SI, students become less isolated and are helped in assimilating into the culture of the institution, both academically and socially.

Keimig's Hierarchy of Learning Improvement Programs. Keimig (1983) developed a "Hierarchy of Learning Improvement Programs" by which programs were differentiated on the basis of two criteria: the comprehensiveness of the program and the degree to which the program was institutionalized into the overall academic delivery system.

Highly ranked programs were not isolated, but were integrated into the heart of the institution. From lowest to highest, the four levels of programs in Keimig's hierarchy were: isolated courses in remedial skills, tutorial assistance to individual students, course-related supplementary learning activities, and college courses that have been significantly changed and have comprehensive learning systems built into them.

Remedial courses were rated lowest by Keimig since they often taught academic skills in isolation from actual course content. It was very difficult for students to transfer successfully the skills necessary to succeed from the remedial course to other college-level courses. Students soon reverted back to their old habits. In some cases, the exit competencies required in the remedial courses were not as high as the entry level prerequisites for the introductory level college courses.

In terms of long-term effectiveness, tutoring was also rated near the bottom of the academic

support hierarchy. Keimig found four major disadvantages with individual tutoring:
1. Because of its "drop-in" nature, it lacked systematic activity;
2. Tutoring failed to provided enough assistance soon enough to make a difference;
3. The assistance was too late since it generally came after academic difficulty or failure has been experienced; and
4. The students who needed tutoring the most generally used it the least.

In a review of the professional literature concerning tutoring, Maxwell (1990) observed the following: some students find that high-ability or more experienced students benefit most from tutoring; it is rare for studies to show that tutored students improved their grades; thee is no evidence that tutoring helps the weakest students.

Using Keimig's model, programs similar to SI were ranked near the top of the effectiveness scale since, "...students' learning needs are presented as being necessary because of the nature of the objectives and content of the course rather than because of students' deficiencies. Therefore, all students have access to supplementary...instructional experiences which benefit nonremedial students as well" (Keimig, 1983, p. 23). The key to program success is the link between academic services and specific courses.

Keimig's description of the highest level of program in her hierarchy, the comprehensive learning system, was reserved for classes where the professor has make significant changes in his/her instructional delivery. "The student's overall developmental needs are provided for, including interpersonal and affective needs and cognitive and requisite skills. The instructor monitors students' responses (including learning) and adjusts teaching strategies and learning experiences individually" (Keimig, 1983, p. 24).

It should be noted, however, that some institutions (e.g., Salem State University) have introduced SI through faculty development grants. Because the SI leaders and the course professors worked closely together as a team to meet student needs, the SI program at Salem State would meet Keimig's "highest" level. The SI program, as it is usually implemented, complements the professor's instructional style and requires no change by the professor in the way the instructional material is initially delivered. Most professors would not choose to modify their courses to fit the criteria for Keimig's Level Four designation. Therefore, SI is able to fit the criteria for the highest rated type program that does not require professors to change their instructional style. Using SI to facilitate faculty development, however, appears to be a growing trend within institutions not only here in the United States, but in other countries also.

Metacognition. An emerging area of research is the field of metacognition. This field is concerned about the awareness of learners as they participate in the act of learning. A leading researcher in this area is Dr. Claire Weinstein. In her research, Weinstein and some of her colleagues have identified variables that separate expert and novice learners: experts know more; knowledge held by experts is better organized and more integrated; experts have more effective and more efficient strategies for accessing and using their knowledge; experts seem to have different motivations for acquiring and using their knowledge; and experts evidence more self-regulation in both the acquisition and application of their expertise (Weinstein and Stone, In press).

Weinstein has identified four kinds of knowledge that expert learners need: knowledge about themselves as learners (e.g., their cognitive characteristics); knowledge about the cognitive demands of the academic tasks; knowledge of a wide variety of strategies, tactics, and study skills; and prior knowledge of the content material (Weinstein and Stone, In press).

SI leaders can play a valuable role in helping students move from the "novice" stage to the "expert" stage. Through a variety of activities, SI sessions provide constant feedback so that SI participants are aware of their comprehension level of the course material before major examinations. This gives them opportunities to correct and change study behaviors before the penalty of a low examination score. SI leaders can model and use a variety of learning strategies during the SI sessions. SI participants have the opportunity to practice these activities during the sessions before leaving the group to go back and use the strategies by themselves when they study alone. Since the SI leader has already taken the same class as the SI participants, the SI leader can share what kinds of cognitive demands will be required for the particular class that they are enrolled in. SI leaders can help students discover the links between prior content material, current material, and preview future course content.

Weinstein states, "An expert learner is a self-regulated learner. Self-regulated learning requires skill, it requires will, and it requires executive control" (Weinstein and Stone, In press, pp. 9-10). SI sessions are designed to lead students to become independent learners.

Collaborative Learning. The effectiveness of peer collaborative learning has been well researched and documented. Early theorists--Dewey, Piaget, and Bruner–provided clear direction that leads to the value of peer collaborative learning. Developmental psychologists carried on the early research, and recent research in college student development and retention lends further empirical support.

Since its inception in 1973, the SI model relied on peer group learning, now described as collaborative learning (Tomlinson, 1989; Whitman, 1988). A recently completed comprehensive annotated bibliography on collaborative learning (Tumey, 1993) includes reference to the SI model in over fifty collaborative learning citations, giving SI a significant representation.

As Maxwell (1979) has noted, however, most of the research and work on collaborative learning had previously been conducted at the elementary and secondary school level; its systematic introduction to postsecondary education and research on its effects in higher education settings only date from the 1970s. However, several researchers have documented it increasing influence in higher education in recent years (Cooper, et al., 1990; Goodsell, et al., 1992). The success of Treisman (1990) in improving academic performance of non-Caucasian mathematics majors has generated widespread interest in his academic program that includes, as an important component, collaborative learning.

When comparing students studying alone to those studying in groups, educators have found that group study results in higher levels of thought and increased retention of information (Johnson et al., 1991; Light 1990, 1992). Research conducted by Light (1992) at Harvard University found group work particularly important for persistence in science courses. Shlipak (1988) also found that group work was very important for the persistence of women in the physical sciences.

In addition to improved academic performance, it is generally believed that students enhance their self-esteem through collaborative learning. "Considerable evidence shows a collaborative environment will elevate students' feelings of self-worth more than a competitive one" (Sandberg, 1990, p.2). Students will not have an opportunity to increase their self-confidence if they do not have an opportunity to practice their skills. Traditional classrooms with a lecture-based format typically fail to provide an opportunity for peer-group interactions. SI sessions provide a safe and non-threatening environment for students to clarify their understanding and practice newly learned skills. Mastery of content material leads toward increased self-confidence.

Some researchers have suggested that collaborative groups provide a better learning environment for returning women students than traditional lecture-based classes (Belenky et al., 1986). Other researchers cite the cognitive and affective domain increases with the support of peers for high-risk students (Brookfield, 1987; Johnson et al., 1984, 1986, 1991; Resnick, 1987; Slavin, 1983, 1988, 1989/90). A program of Supplemental Instruction can be one component in a comprehensive plan to help change the campus climate for today's diverse student body.

Conclusion

It has been nearly two decades since Supplemental Instruction first appeared in higher education. After starting at the University of Missouri-Kansas City in 1973, it has been implemented at a variety of institutions across the U.S. and around the world. Borrowing ideas from developmental psychology, SI has attempted to encourage students to become actively involved in their own learning. By integrating appropriate study skill with the review of the course content, students begin to understand how to use the learning strategies they have heard about from teachers and advisors. As new educational theories and practices have surfaced, the SI model has been adapted to incorporate the best in educational research.

With the increasing diversity of today's college students and the advent of alternative admission programs, the student body is continuing its evolution into a heterogenous group reflective of American society. The popular and professional literature often carries articles decrying the poor academic preparation level of students and/or poor quality of teaching by classroom professors. Few solutions have been offered that work. From our point of view, the matter is moot. Many professors have tenure and colleges need all the students that they can recruit. Rather than blaming either of the two parties, strategies must be developed that allow for students to succeed while ensuring that academic standards are maintained, if not strengthened. SI, as one component, can help contribute to an overall institutional plan for student success.

In addition to the primary benefit of helping students perform better academically, collaborative learning groups provide an environment for students to work together. It is interesting to note that most jobs in the "real world" require teamwork and camaraderie to maximize both individual and group rewards. While education purports to prepare students for this world, traditional modes of instruction still encourage individualism and often discourage cooperation.

While there must be a balance between individual and group work, students may be ill-prepared to fit into a multicultural work world if they have not learned the skills of collaboration

and cooperation. Vincent Tinto said this most succinctly.

"One way of integrating all students is to make sure our learning communities are open communities. We must make sure that classrooms do not disenfranchise or isolate students by their structure or by their content. We have to be concerned about the classroom experience as a liberating, integrative experience for all, not just some, students. We also have to think about the ways in which the classroom experience can lead students to develop supportive, rather than competitive, peer relationships; that is, we must seek ways to integrate, not isolate, the academic and social experiences of students. To have one with the other is a mistake." (Tinto in Spann, 1990, p. 22).

References

American College Testing Program. ACT institutional data file, 1992. Iowa City, IA: American College Testing Program, Inc., 1992.

Arons, A.B., & Karplus, R. "Implications of accumulating data on levels of intellectual development", American Journal of Physics, 1976, 44, 386.

Belenky, M.F., Clinchy, B.M., Goldberger, N.R., & Tarule, J.M. Women's ways of knowing: The development of self, voice, and mind. New York: Basic Books, 1986.

Blais, D.M. "Constructivism: A theoretical revolution in teaching", Journal of Developmental Education, January 1988, 11(3), 2-7.

Blanc, R.A., DeBuhr, L., & Martin, D.C. "Breaking the attrition cycle: The effects of Supplemental Instruction on undergraduate performance and attrition", Journal of Higher Education, 1983, 54(1), 80-89.

Brookfield, S.D. Developing critical thinkers: Challenging adults to explore alternative ways of thinking and acting. San Francisco: Jossey-Bass, 1987.

Chaffee, J. "Critical thinking skills: The cornerstone of developmental education", Journal of Developmental Education, Spring 1992, 15(3), 2-4, 6, 8, 39.

Christie, N.G., & Dinham, S.M. "Institutional and external influences on social integration in the freshman year", Journal of Higher Education, 1991, 62, 412-436.

Cooper, J., Prescott, S., Cook, L., Smith, L., Mueck, R., Cuseo, J. Cooperative learning and college instruction: Effective use of student learning teams. Long Beach, CA: The California State University Foundation, 1990.

Dale, E. Audiovisual methods in teaching. New York: Holt. Rinehard and Winston, Inc, 1969.

Fuller, R.G. (ed.). Piagetian programs in higher education. Lincoln, NE: ADAPT, 1980.

Goodsell, A., Maher, M., & Tinto, V. Collaborative learning: A sourcebook for higher education. University Park, PA: National Center on Postsecondary Teaching, Learning, and Assessment, 1992.

Johnson, D.W., Johnson, R.T., & Smith, K.A. Cooperative learning: Increasing college faculty instructional productivity. ASHE-ERIC Higher Education Report No. 4. Washington, D.C.: The George Washington University, School of Education and Human Development, 1991.

Johnson, R.T., & Johnson, D.W. "Action research: Cooperative learning in the science classroom", Science and Children, 1986, 24, 31-32.

Johnson, D.W., Johnson, R.T., Holubec, E.J., & Roy, P. Circles of learning: Cooperation in the classroom. Washington, D.C.: Association for Supervision and Curriculum Development, 1984.

Karplus, R., Lawson, A.E., Wollman, W., Appel, M., Bernoff, R., Howe, A., Rusch, J.J., & Sullivan, F. Science teaching and the development of reasoning: A workshop. Berkeley, CA: Regents of the University of California, 1976.

Keimig, R.T. Raising academic standards: A guide to learning improvement. ASHE-ERIC Higher Education Report No. 4. Washington, D.C.: Association for the Study of Higher Education. ED 233 669, 1983.

Light, R.J. The Harvard assessment seminars, Second Report: Explorations with students and faculty about teaching, learning, and student life. Cambridge, MA: Harvard University, 1992.

Light, R.J. The Harvard assessment seminars: Explorations with students and faculty about teaching, learning, and student life. Cambridge, MA: Harvard University, 1992.

Martin, D.C., & Arendale, D. "Supplemental Instruction: Improving student performance, increasing student persistence," ERIC Document Reproduction Service. ED 327 103, 1990.

Martin, D.C., Blanc, R.A., DeBuhr, L., Alderman, H., Garland, M., & Lewis, C. Supplemental Instruction: A model for student academic support. Kansas City, MO: The University of Missouri and ACT National Center for the Advancement of Educational Practices, 1983.

Martin, D.C., and others. The learning center: A comprehensive model for college and universities. Kansas City, MO: University of Missouri, 1977. (ERIC ED 162 294).

Maxwell, M. "Does tutoring help? A look at the literature", Review of Research in Developmental Education, 1990, 7(4), 1-5.

Maxwell, M. Improving student learning skills: A comprehensive guide to successful practices and programs for increasing the performance of underprepared students. San Francisco: Jossey-Bass, 1979.

Noel, L., Levitz, R., Saluri, D., & Associates. Increasing student retention: Effective programs and practices for reducing the dropout rate. San Francisco: Jossey-Bass, Inc., 1985.

Piaget, J., & Inhelder, B. Growth of logical thinking. New York: Basic Books, 1958.

Renner, J.W., Stafford, D.G., Lawson, A.W., McKinnon, J.W., Friot, F.E., & Kellogg, D.H. Research, teaching and learning with the Piaget model. Norman, OK: The University of Oklahoma Press, 1976.

Resnick, L.B. Education and learning to think. Washington, D.C.: National Academy Press, 1987.

Sandberg, K.E. "Affective and cognitive features of collaborative learning", Review of Research in Developmental Education, 1990, 6(4), 1-4.

Shlipak, A.M. Engineering and physics as cultural systems: Impressions of science students at Harvard/Radcliffe. Thesis submitted to the Harvard University Department of Anthropology for the degree of Bachelor of Arts with Honors, 1988.

Slavin, R.E., Maden, N.A., & Stevens, R.J. "Cooperative learning models for the 3 r's", Educational Leadership, December 1989/January 1990, 47, 22-28.

Slavin, R.E. "Cooperative learning and student achievement", Educational Leadership, 1988, 46(2), 31-33.

Slavin, R.E. Cooperative learning. New York: Longman, 1983.

Somers, R.L. Causes of marginal performance by developmental students. Boone, NC: Natioanl Center for Developmental Education, Appalachian State Univ., 1988.

Spann, N.G. "Student retention: An interview with Vincent Tinto", Journal of Developmental Education, September 1990, 14(1), 18-20, 22, 24.

Tinto, V. Leaving college: Rethinking the causes and cures of student attrition.

Chicago: The University of Chicago Press, 1987.

Tomlinson, L.M. Postsecondary developmental programs: A traditional agenda with new imperatives. ASHE-ERIC Higher Education Report No. 3. Washington, D.C.: Association for Study of Higher Education, 1989.

Treisman, U., & Fullilove, R.E. (1990). "Mathematics achievement among African-American undergraduates at the University of California, Berkeley: An evaluation of the mathematics workshop program", Journal of Negro Education, 1990, 59(3), 463-478.

Tumey, S. (ed.). Annotated bibliography of student peer collaborative learning. Kansas City, MO: Center for Academic Development, University of Missouri-Kansas City 1993.

Vygotsky, L.S. Mind in society. Cambridge, MA: Harvard University Press, 1978.

Vygotsky, L.S. Thought and language. Cambridge, MA: Harvard University Press, 1962.

Weinstein, C.E., & Stone, G.V.M. "Broadening our conception of general education: The self-regulated learner." In N. Raisman (Ed.). Directing general education outcomes. San Francisco: Jossey, Bass, Inc., In press.

Whitman, N.A. Peer teaching: To teach is to learn twice. ASHE-ERIC Higher Education Report No. 4. Washington, D.C.: Association for the Study of Higher Education, 1988.