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ABSTRACT

The majority of teacher candidates feel unprepared to teach with computers, and few teacher training programs are preparing future educators to effectively use the Internet to enrich their classrooms and contribute to their own personal development. The purpose of this study was to teach the procedural knowledge required to navigate the Internet and thus take students from novice to Internet practitioner status in a minimal amount of time. The study measured the effect of short-term training using the Procedural Knowledge Teaching Model (PKTM). The PKTM was constructed based on research in cognitive science to help students understand how they think, remember, and learn. Forty undergraduate students enrolled in two science education methods courses participated in the study. The design included a pretest-posttest model using intact classes with treatment and comparison groups. The data indicated that short-term training as provided by the Academic Seminar Training Model, a one-session seminar following the three-phase approach outlined in the Procedural Knowledge Teaching Model, was sufficient to change students' behavior and confidence levels regarding the use of the Internet. Contains 28 references. (PVD)

Running head: EFFECTS OF SHORT-TERM INTERNET TRAINING

Procedural Knowledge Teaching Model:
Effects of Short-Term Internet Training on Preservice Teachers

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Paper presented at the World Conference on Educational Multimedia and Hypermedia

of the Association for the Advancement of Computing in Education, Boston, MA.

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Abstract

The purpose of the study was to take students from novices to Internet practitioners in a minimal period of time. The study measured the effect of short-term training using the Teaching of Procedural Knowledge Method. Forty undergraduate students enrolled in two science education methods classes participated in the study. The design included a pretest-posttest model using intact classes with treatment and comparison groups. The data indicated that short-term training as provided by the Academic Seminar Training Model was sufficient to change students' behavior ($p < .02$), familiarity with six of seven Internet terms ($p < .001$), and confidence level ($p < .001$) regarding the use of the Internet.

Procedural Knowledge Teaching Model:

Effects of Short-Term Internet Training on Preservice Teachers

The literature is replete with accounts of research that report on the use of cognitive science methods in instruction (Bereiter & Bird, 1985; Brown, Bransford, Ferrara & Campione, 1983; Brown, Collins & Duguid,1989; Brown, Collins & Holum, 1991; Bruer, 1993; Palincsar & Brown, 1984; Schoenfeld, 1985). Resnick (1987) states research has located a psychological space in which educationally powerful effects seem to occur, but it has not yet adequately explained what happens in space to produce the effects" (p. 27). In this study the research was evaluated to identify cognitive strategies and integrate them into a model for teaching procedural knowledge.

Recent educational and technological developments are challenging educators to redefine traditional approaches to teaching and learning. Accordingly, new partnerships are being formed between school practitioners and college faculty; and distance learning programs are effectively removing miles between classmates. America's local schools are becoming "global classrooms" (Morton & Mojkowski, 1991).

Today, more than 97% of American public schools have classroom computers, and increasing numbers of schools are connecting to the Internet or "information superhighway" (Gallo & Horton, 1994; National Center for Education Statistics [NCES], 1995). As a result, a number of "innovative" educational approaches will become soon commonplace. The success of each global classroom will be determined by the navigating skills of the teacher (Gallo & Horton, 1994), but the majority of teacher candidates feel unprepared to teach with computers (NCES, 1990), and few teacher training programs are preparing future educators to effectively use the Internet to enrich their classrooms and contribute to their own personal development (Honey & Henriquez, 1993).

Research on the impact of computer network training on preservice teacher preparation has focused on the effects of computer access and usage, and students' attitudes (Delcourt & Kinzie, 1993; Farenga & Joyce, 1996c; Hignite & Echternacht, 1992; Hunt & Bohlin, 1993; Sunal & Sunal, 1992). Findings suggest that developing computer network skills increases communication, improves the quality of lesson plans, and contributes to positive perceptions regarding the usefulness of the computer as a teaching tool.

The method of developing computer network skills varies from study to study; however, most programs include multiple training sessions. Factors such as students' prior computer experience and interest, as well as time and resource constraints are all critical when defining the effectiveness of the training model.

Framework for Designing Teacher Training on the Internet

Our goal was to use cognitive strategies to teach procedural knowledge. To accomplish this goal, a framework for designing an effective learning environment was needed. Brown, Collins and Holum (1991) outlined the Principles for Designing Cognitive Environments and the pedagogical strategies to address content, method, sequencing, and social characteristics of the learning environment. Farenga and Joyce (1996b) incorporate some of these cognitive strategies into the Procedural Knowledge Teaching Model (PKTM). PKTM was constructed based on the research in cognitive science to make visible to students how they think, remember and learn (Figure 1). An objective of the model was to use activities to help students realize the similarities between thinking and information processing (Bruer, 1993).

The study's focus was to teach the procedural knowledge required to navigate the Internet. The goal was to take students from non-users to Internet practitioners in a minimal period of time. The learning environment caused us to deal with constraints on time and computer resources, limited computer ability, and high levels of anxiety from some of the participants. It was apparent that many people in the classroom were under the same constraints as business professionals who deliver presentations. In a limited time frame, business professionals need to introduce their product, demonstrate its abilities, and promote its effective use. To accomplish the task in the classroom, we developed the Academic Seminar Training Activity (ASTA) (Farenga & Joyce, 1996a). ASTA has three phases designed to guide learners through a hierarchy of skills ranging from simple activities through complex tasks. To accommodate varying abilities among students, the lessons started at a basic level and moved rapidly to keep interest levels high.

The ASTA phases involve Direct Instruction, Guided Practice, and Open Exploration. These phases parallel the networking pedagogy of Salomon and Perkins (1996, p. 122). The instruction is designed to require students to make limited inferences during the beginning stages of Direct Instruction and broader inferences during Open Exploration. The importance of making inferences to the learning of procedural knowledge should not be overlooked (Black, Carroll, & McGuigan, 1987). The inferences bridge the phases that connect the learner to the steps in the instructional process and to the formation and internalization of procedural knowledge. As the level of inferences is increased at each step, the learner is required to develop broader concepts and greater understanding of the topic. When combined, the concepts should help the learner form a mental model of the system. In the Open Exploration phase, a stronger conceptual basis should allow students to engage in topics more advanced than those pursued in the Direct Instruction phase.

Phase I

Phase I begins with a global overview of the procedures and their relationship to the lesson's objective. A terse overview should provide students with the raw material to begin making inferences about how pieces of the task fit together. The seminar leader's outline creates an anticipatory set to raise the cognitive awareness of the students.

Direct Instruction is delivered by Interpretive Teaching (Farenga & Joyce, 1996a, 1996b). Interpretive Teaching is a form of apprenticeship that is a combination of modeling and coaching. A student is selected to model the process by following the explicit directions of the instructor. At this phase, the instructor coaches the student through the activity. Learning is primarily didactic as students are given the minimal facts to perform the steps needed to complete the activity and foster an understanding of the procedural knowledge. It has been suggested that learning is facilitated when highly contextualized vocabulary and facts are situated in an authentic activity (Brown, Collins & Duguid,1989; Vygotsky, 1962). The purpose of this phase is to convey the tacit knowledge required to start the activity, to control the rate instruction, and to allow the teacher to monitor student activity.

Phase II

The objective of the second phase is to provide the learner with increased support to work independently through Guided Practice (Palincsar & Brown, 1984). Guided Practice that manifests apprenticeship techniques such as scaffolding, articulation, and coaching is used to promote the development of expertise. During this phase, a parallel teaching situation is created whereby the students are replicating the actions from the Interpretive Teaching process. The parallel teaching process enables the student to progress from novice to practitioner. The second phase of PKTM is based on Vygotsky's zone of proximal development (1978), that is, what a student can do with aid of a seminar leader, he can be taught without assistance.

A social learning climate is created by students exchanging ideas, asking questions, and developing and editing concepts that are being formed in the social arena of the classroom. At this juncture, the construction of knowledge and understanding emerges from patterns of social interaction by and among individuals. Salomon and Perkins (1996) describe these phenomena as social interaction and social distribution of knowledge construction. In general, social interaction and social distribution of knowledge are derived from a Vygotskian conception of sociocultural learning and development. Vygotsky outlined both a weak and strong version of learning in social situations. In the weak version, learning is socially facilitated and the learning product becomes the property of the individual. In contrast, the strong version distributes the learning product not only within the individual's mind, but also among group members, thereby creating a social system where achievements become joint property of the individual and the group. It is crucial at this time for the teacher to monitor students' conversations and to ensure proper acquisition of the procedures being taught.

The emphasis is to help students focus their observations as experts would and to gain conscious access of their own problem-solving strategies when making inferences. By the end of the second phase, responsibility for the learning should be shifting from teacher to student.

Phase III

The objective of the third phase is to empower the learner through the use of Open Exploration. The students are encouraged to engage in inquiry-based activities by posing and solving their own problems. Students who are able to complete this stage of the activity are displaying performances of understanding as suggested by Salomon and Perkins (1996). In this phase, the instructor should be engaged in related activities allowing the students to observe and model her behavior while serving as a resource to the class.

Throughout the three phases of the model, making inferences is essential to understanding the task. In the initial phases (I & II), the learner is required to make inferences regarding the organization and function of the concept being taught. In the terminal phase (III), the learner should be able to develop a mental model of the procedural knowledge acquired and inference strategies to complete other relevant activities. At each phase, students are encouraged to reflect on the completed activity--how it can be used, and modified to be a better fit for their needs.

Method

Subjects

The sample of 40 undergraduate preservice teachers was selected from two science education methods classes. Both classes were taught by the same science education professor. All students were preparing to teach at the preschool (7%), lower elementary (68%) or upper elementary (24%) level. Their prior knowledge of the Internet was minimal as indicated by the presurvey data. Ninety-three percent of the students had no previous experience on the Internet.

Instrument

A pre-/post-questionnaire was developed to measure students' levels of interest in educational resources on the Internet, and levels of familiarity with Internet features. Students' ratings of interest and familiarity were based on a five-point Likert-type scale. The questionnaire also measured students' access and usage of the World Wide Web (WWW) and e-mail, and previous Internet training. An open-ended item allowed students to describe how they would use the Internet in their classrooms and lesson plans. In the post-questionnaire, students rated their levels of confidence in using the WWW in lesson planning.

Procedure

The Internet questionnaire was administered to both groups at the beginning of the semester. Upon completion of the questionnaire, all students were given an Internet instructional guide which included a conceptual outline of Internet functions, step-by-step procedures for accessing the WWW and e-mail, and support material (e.g., article reprints, WWW site listings, e-mail "netiquette", etc.).

In addition to receiving the instructional guide, the treatment group participated in a one-session Academic Seminar Training Activity for Internet instruction conducted by two seminar leaders. The structure of the seminar followed the three-phase approach outlined in the Procedural Knowledge Teaching Model.

In Phase I (approximately one hour), the seminar leaders provided an overview of the lesson, introduced Internet vocabulary, and outlined specific steps for operating the computer, sending and receiving e-mail, and accessing the WWW via Netscape.

During this phase of instruction, a student was selected to work at the main computer console. The student, following the explicit directions of the seminar leaders, modeled the activity which was projected on a screen at the front of the classroom. The Interpretive Teaching approach allowed all students to view the activity while paralleling the process at their computer stations.

In Phase II (approximately one hour), the seminar leaders instructed students in accessing three science-related Web sites: (1) The Exploratorium in San Francisco (www.exploratorium.edu), (2) NASA Spacelink (spacelink.msfc.nasa.gov), and (3) The Weather Unit (faldo.atmos.uiuc.edu/WEATHER/weather.html). After exploring the three Web sites and discussing the relationship of these sites to classroom activities, students were directed to the listing of WWW addresses and were encouraged to investigate additional science sites.

During the final phase (approximately 45 minutes), students were allowed to craft their own inquiries and conduct self-directed searches on the WWW. The seminar leaders were involved in their own Internet activities serving as models and resource agents for the students.

Seven weeks after the instructional seminar, the post-questionnaire was administered to the treatment and control groups. The interest, familiarity, and confidence level data were analyzed using t-tests for independent samples. Data regarding frequency of e-mail and WWW usage were analyzed for the treatment and control groups using chi-square. Descriptive statistical profiles were developed based on open-ended response data of how students might use the Internet in their future teaching assignments.

Results

Pre-Treatment

Level of interest. The results of the preliminary questionnaire indicated that there were no significant differences in the interest levels of the treatment and control groups (Table 1). Students expressed strong interest in all of the listed Internet resources. However, the resources in which the students expressed the highest levels of interest were sites which would supply them with specific information, such as lesson plans, data sources, and information searches. Opportunities to communicate with others--connections with other teachers, classrooms and colleges--were rated somewhat lower.

Table 1

Pre-Levels of Interest in Internet Resources by Treatment vs. Control Groups

	Treatment (n = 21)		Control (n = 19)			
Resource	M	SD	M	SD	t-value	p
Lesson Plans	4.81	.51	4.79	.42	.13	.89
Data Sources	4.76	.54	4.58	.61	1.01	.32
Information Searches	4.71	.46	4.79	.42	-.54	.59
Communicate w/ Teachers	4.43	1.08	4.58	.69	-.52	.61
Connect w/ Classrooms	4.43	.98	4.32	1.00	.36	.72
Connect w/ Colleges	4.14	1.15	3.84	1.17	.82	.42

Level of familiarity. Although the students reported high levels of interest in the Internet, levels of familiarity with the Internet were equally low for both the treatment and control groups (Table 2). With the exception of e-mail and World Wide Web, students reported little if any familiarity with Internet features--listserv, http, homepage, search engines and Web sites.

Table 2

Pre-Levels of Familiarity with Internet Features by Treatment vs. Control Groups

	Treatment (n = 21)		Control (n = 19)			
Resource	M	SD	M	SD	t-value	p
E-mail	2.62	1.50	2.58	1.31	.09	.93
Listserv	1.29	.90	1.11	.32	.83	.41
World Wide Web	2.19	1.47	1.95	1.08	.59	.56
http	1.29	.90	1.42	.84	-.49	.63
Homepage	1.29	.64	1.32	.75	-.14	.89
Search Engines	1.05	.22	1.11	.32	-.68	.50
Web Sites	1.86	1.24	1.37	.76	1.49	.15

Use of e-mail and WWW. When asked about using e-mail and WWW, there were no significant differences in usage levels for both groups (Tables 3 & 4). Seventy-one percent of the treatment students and 70% of the control students reported that they never used e-mail ($p = .84$). The majority of students (71% treatment and 80% control) reported that they had never accessed the WWW ($p = .57$).

Table 3

Pre-usage of E-mail by Treatment and Control Groups

	Use of E-mail		
	Never	Weekly	More than Weekly
Treatment Group	15	4	2
	71%	19%	10%
Control Group	14	3	3
	70%	15%	15%

chi-square = .35, df = 2, p = .84

Table 4

Pre-Usage of World Wide Web by Treatment and Control Groups

	Use of WWW		
	Never	Weekly	More than Weekly
Treatment Group	15	5	1
	71%	24%	5%
Control Group	16	4	0
	80%	20%	0%

chi-square = 1.12, df = 2, p = .57

Post-Treatment

Level of interest. A comparison of the post-questionnaire results showed no significant differences in levels of interest in Internet resources for the treatment and control groups (Table 5). Information sources, as opposed to connections with teachers, classrooms or colleges, remained the areas of greatest interest to students.

Table 5

Post-Levels of Interest in Internet Resources by Treatment vs. Control Groups

	Treatment (n = 21)		Control (n = 19)			
Resource	M	SD	M	SD	t-value	p
Lesson Plans	4.80	.52	4.61	.70	.95	.35
Data Sources	4.70	.47	4.61	.50	.56	.58
Information Searches	4.60	.60	4.39	.85	.89	.38
Communicate w/ Teachers	4.15	1.04	4.50	.62	-1.24	.22
Connect w/ Classrooms	4.15	1.09	4.56	.86	-1.27	.21
Connect w/ Colleges	3.85	1.18	4.17	1.04	-.87	.39

Level of familiarity. When levels of familiarity with Internet features were evaluated for both groups, treatment subjects' ratings documented significantly higher levels of awareness regarding nearly all of the Internet features ($p \leq .001$) with the exception of search engines (Table 6). Since students were introduced to a single search engine (Yahoo) during the instructional seminar, it appears that they had insufficient information and experience to generalize regarding other search engines.

Table 6

Post-Levels of Familiarity with Internet Features by Treatment vs. Control Groups

	Treatment (n = 21)		Control (n = 19)			
Resource	M	SD	M	SD	t-value	p
E-mail	4.05	1.10	2.63	1.38	3.56	.001
Listserv	2.10	1.12	1.05	.23	4.00	.000
World Wide Web	4.00	1.03	2.06	1.21	5.36	.000
http	4.00	1.17	1.33	.59	8.71	.000
Homepage	3.15	1.66	1.22	.55	4.69	.000
Search Engines	2.15	1.31	1.67	2.35	.79	.433
Web Sites	3.75	1.16	1.56	.98	6.24	.000

Use of e-mail and WWW. As seen in Table 7, following the treatment, the pattern of e-mail use was significantly different for the two groups ($p = .01$). Approximately, 60% of the treatment group used e-mail on a weekly or more frequent basis as compared to 21% of the control group.

The findings displayed in Table 8 document that post-treatment WWW activity differed significantly by group ($p = .02$). Sixty-five percent of the treatment students accessed the WWW at least weekly as compared to only 21% of the control group.

Table 7

Post-usage of E-mail by Treatment and Control Groups

	Use of E-mail		
	Never	Weekly	More than Weekly
Treatment Group	8	9	3
	40%	45%	15%
Control Group	14	3	3
	79%	5%	16%

chi-square = 8.51, df = 2, p = .01

Table 8

Post-Usage of World Wide Web by Treatment and Control Groups

	Use of WWW		
	Never	Weekly	More than Weekly
Treatment Group	7	9	4
	35%	45%	20%
Control Group	15	3	1
	79%	16%	5%

chi-square = 7.69, df = 2, p = .02

Confidence levels. When asked to rate their ability to use the WWW in lesson planning, treatment students were significantly more confident than control students (p =

.000). These findings suggest that the short-term treatment actually translates knowledge into the action of incorporating the WWW into classroom practice.

Table 9

Level of Confidence Using the WWW in Lesson Planning by Treatment vs. Control Groups

	Treatment (n = 20)		Control (n = 19)			
Resource	M	SD	M	SD	t-value	p
Confidence Level	3.40	1.23	1.42	.61	6.31	.000

Future use. The open-ended items elicited multiple responses regarding how students might use the Internet. The activities were broadly categorized as accessing information to enhance teaching effectiveness and communication with others. The responses paralleled pre-treatment interest expressed in Table 1. That is, the majority of treatment students would use the Internet to access lesson plans (62%) and research on teaching (38%). In contrast, only 16% of the control group plan to access lessons or research. Communication with others was of secondary interest to both groups (Table 10). Many more control group students felt unsure (21%) or unable to respond (32%) regarding how they might use the Internet as compared to the treatment group (10%).

Table 10

Future Use of the Internet by Treatment vs. Control Groups

Use	Treatment ($\underline{n}$ = 21) Percentage	Control ($\underline{n}$ = 19) Percentage
Access Information		
Lessons Plans	62%	16%
Research on Teaching	38%	16%
Communication		
Teacher to Teacher	33%	21%
Student to Student	19%	11%
Students to Field Professional	19%	11%
Teacher to Field Professional	0%	5%
Other		
Unsure/Not Enough Information	0%	21%
No Response	10%	32%

Note. Totals do not equal 100% due to multiple responses.

Discussion

The data indicate that short-term training as provided by the Academic Seminar Training Model was sufficient to change students' behavior and confidence levels regarding the use of the Internet. These findings question our previous study of multi-session Internet training (Farenga & Joyce, 1996c). However, the results mirror the outcomes reported by Black et al. (1987) on determining effective minimal instruction. Black et al. found that the use of inferences and edited procedures increased the acquisition of procedural knowledge.

At the heart of the issue is the independent variable of amount of time necessary to train students to use the Internet as a productive tool. In general, the more speed and accuracy with which the skill or procedure can be performed, the freer students are to devote the limited capacity of their short-term memory to deal with other issues (Gagne, 1985; Miller, 1956). In reexamining our task, it appears that it is not only a matter of time, but also the structure of realistic tasks within the time frame. For us, this meant that the task needed to be situated in an authentic learning activity in which the students anticipated learning a skill which would enhance their teaching performance.

An interpretation of the findings indicates that interest does not automatically provide sufficient motivation to be translated into action. A broader implication of these findings suggests that methods of instruction which are not structured or embedded in authentic learning situations may be inadequate to empower students to convert their interests--no matter how strong--into knowledge. In this study, ASTA was demonstrated to be an effective means of activating and converting interests into performances of understanding (Salomon & Perkins, 1996).

The findings in Phase I suggest that knowledge which is connected and specialized to its context of action is more likely to be acquired. This occurred in our model for the treatment group which displayed higher levels of familiarity with the features of the Internet. The study's findings parallel the work of Brown et al. (1989) and Vygotsky (1962) which documents that learning is facilitated when highly contextualized vocabulary and facts are situated in an authentic activity. Further, Brown et al. assert "learning and acting are interestingly indistinct being a continuous life-long process resulting from acting in situations" (p. 33).

A secondary outcome of parallel teaching was a mitigation of students' anxiety levels toward the computer. This permits the student to concentrate on the strategies being taught. Present research has not identified the manner in which cognitive strategies affect instruction as suggested by Resnick (1987).

In Phase II, the realistic task involved navigating the WWW to visit science-related Web sites. At this stage, the students began to assume additional responsibility for learning while making inferences regarding Web site information and its practicality to teaching. Students were also determining the protocol to retrieve data as evidenced by down-loading lesson plans. During the latter part of Phase II and into Phase III, they cooperatively exchanged WWW-based lesson plans and discussed their possible implementation and integration into a science teaching unit. At this point, the dynamic exchange of ideas among students created a synergistic atmosphere suggested by Vygotskian theory of "activity" and as identified by the Activity-Oriented Model of instruction of Rubtsov and Margolis (1996).

In Phase III, treatment students reported significantly higher levels of e-mail and WWW usage. These findings concur with those of heightened confidence levels regarding the integration of the WWW into classroom instruction. At this stage, students were gradually assuming primary responsibility for learning and showing greater understanding of the Internet schema.

Post-treatment perceptions of Internet use clustered around obtaining lesson plans and gathering information regarding effective teaching methods. To a lesser extent, students predicted that they would use the Internet as a specific learning medium for communication. This approach to the Internet may reflect an extrinsic motivation on the part of the student--"what's in it for me".

This study raises some critical issues for future research:

1. Examining the use of the Procedural Knowledge Teaching Model (PKTM) in other areas of instruction;

2. Questioning the effectiveness of long-term, non-integrated Internet instruction;

3. Evaluating the importance of situated cognition and inferential progression at specific stages of instruction; and

4. Using the Academic Seminar Training Activity (ASTA) in other academic and non-academic environments.

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Procedural Knowledge Teaching Model

Farenga & Joyce (1996)

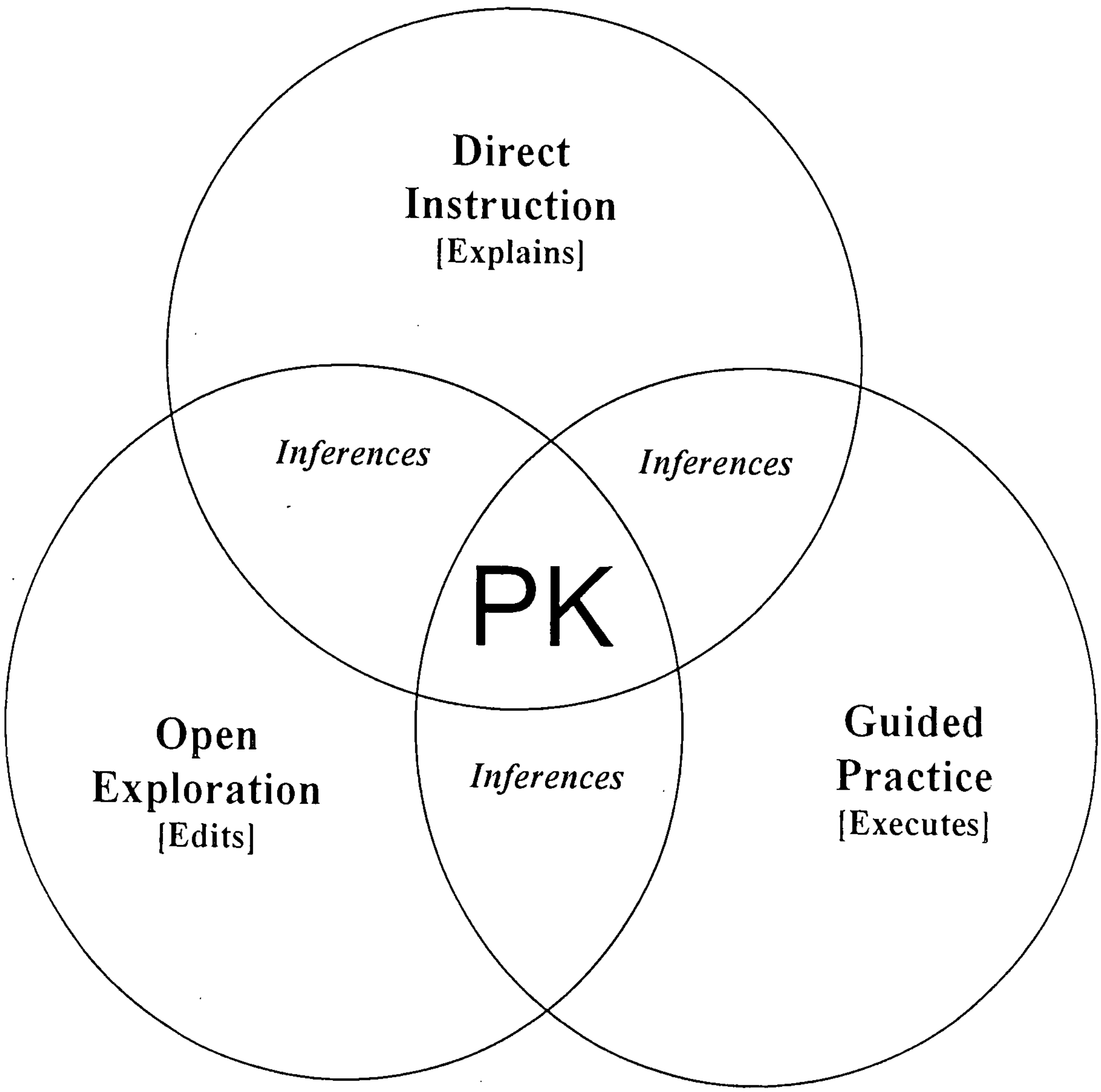

Figure Caption

Figure 1. Procedural Knowledge Teaching Model.

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