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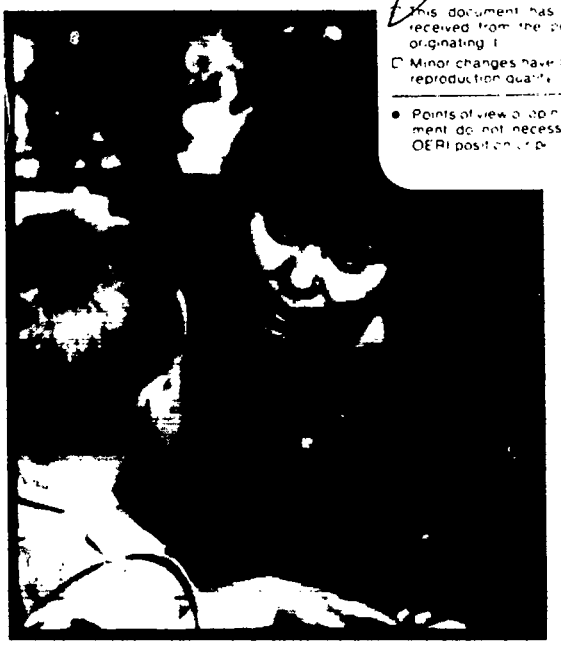
ABSTRACT

This program guide documents a manufacturing job family curriculum that develops competence in generic work force education skills through three courses: Reading Rulers, Charts, and Gauges and Math for Manufacturing Workers I and II. An annotated table of contents lists a brief description of the questions answered in each section. An introduction presents a program abstract and a guide overview. The remainder of the guide is structured according to the four stages in the process of setting up a work force instructional program: partnership building, curriculum development, actual instruction, and evaluation. A detailed table of contents to each section outlines the steps involved in completing each stage. The section on developing partnerships identifies some key partners and structures for achieving their involvement. The section on developing curriculum describes some structures for assessing and organizing input from a variety of sources. The section on teaching the class presents a curricular model with specific examples of daily classroom activities. The section on assessment and evaluation describes a variety of assessment tools and discusses their advantages and disadvantages. The conclusions section offers a preliminary analysis of the program's results and summary of program effectiveness. Appendixes include sample course outlines and lesson plans, registration and evaluation forms, and a selected bibliography divided into work force skills (59 items), background theory (47), and practitioner resources (20). (YLB)

Manufacturing Math Classes:

an Instructional Program Guide for Manufacturing Workers



Workforce Instructional Network

Manufacturing Math Classes:
an Instructional Program Guide for Manufacturing Workers

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Workforce Instructional Network
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Mr. Ashlock conducted interviews and observations with workers, teachers, and employers and collected essential information for the outside evaluator. He also helped obtain inter-rater reliability for the qualitative assessment tools and adapted the Daly and Miller Writing Apprehension Scale to a workplace context.

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Ms. Bagwell provided administrative assistance such as balancing ledgers, handling correspondence, and purchasing supplies.

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Dr. Caverly initiated the premise of delivering workforce literacy to small businesses in a small city, wrote the grant proposal with assistance from Ms. McBride, and created the WIN Instructional Model. He played a role in the development of the Small Business Literacy Task Analysis, assisted in the development of curricula for all four job familes, presented two staff development workshops, assisted in the staff development activities for the Child Care job family. Moreover, he selected some and developed other assessment instruments for all four job families, wrote the "Assessment and Evaluation" section on all four curriculum guides, and served as General Editor for all four instructional program guides.

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Mr. Engel ensured that all grant activities were performed effectively and efficiently. In addition to overall supervision, he formed and chaired the WIN Advisory Council, initiated and developed the multiple partnerships in our instructional network, negotiated consensual approaches to achieve stakeholder buy-in, and led focus groups for the purposes of formative and summative evaluation. Mr. Engel wrote the "Developing Partnerships" section of all the instructional program guides.

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Workforce education, as distinguished from job training, emphasizes instruction in learning how to learn because of the swiftly changing nature of the workplace today. Our focus through a Workforce Instructional Network (WIN) was to work with small businesses in a small town to design instruction aimed at improving the literacy skills of individuals currently in the workforce. We accomplished this by forming a partnership between Southwest Texas State University (SWT), the San Marcos Chamber of Commerce, and the San Marcos Hispanic Chamber of Commerce. The success of our project supports the use of a process-oriented education model which emphasizes transferable skills presented in a series of mini-courses from five to fifteen weeks.

In order to develop our curriculum according to an educational model, we identified those generic workforce education skills underlying job families rather than concentrating solely on the content knowledge needed for a particular job. Through developing competence with these skills, we hope to have equipped these workers for future job changes, many of which cannot even be anticipated in the fast-moving business environment of today. Moreover, these newly developed literacy skills will provide a strong foundation from which these workers can educate themselves given new workforce education demands, resulting in future training savings to the businesses involved. This future efficiency aspect is particularly relevant to small businesses which often rely on on-the-job training by supervisors and co-workers rather than maintaining training staffs.

Four-part instructional model

A process-oriented educational philosophy formed the basis for our four-part instructional model. The first step in this model involved an initiating event which engaged the prior knowledge of the workers, who were considered the content knowledge experts for their jobs. Next, the teacher modeled literacy strategies, using a large-group discussion format, for accomplishing those literacy tasks we were able to identify via a small business needs assessment and through worker participation. Small groups then collaborated on workplace related literacy tasks which required the use of these new strategies. This small group emphasis developed the communication and teamwork skills which are sought by employers, while at the same time developing workers' strategies for accomplishing the workforce education tasks. Finally, learners worked to apply their new understandings during independent practice on workplace and home related literacy tasks.

Workforce Instructional Network
Four-part Instructional Model

In all WIN classes, the basic instructional model contained the following 4 components:

1) an initiating event or focusing activity which emphasized engaging the learners' background knowledge of the topic to be discussed;
2) large-group modeling of a learning strategy;
3) collaborative, small-group practice;
4) independent practice.

Overview of the guide

In keeping with our process-oriented approach to workforce education, this guide was designed to document our Manufacturing Workers Job Family curriculum from the three classes for manufacturing workers. These classes can be a model for many others since the literacy tasks identified are common to many manufacturing environments. For example, workers in our classes were drawn from plants producing heat-conducting wire, oil-field machine parts, and business forms.

We conceptualized the process of setting up a workforce instructional program as having several stages: the stages of partnership building and curriculum development before classes begin, the stage of actual instruction, and feedback and evaluation stages during and after instruction. This guide is structured according to these stages in the life of our grant-funded program.

An annotated table of contents at the beginning of the guide lists a brief description of the questions to be answered in each section. At the beginning of each section, a more detailed table of contents outlines the steps involved in completing each phase of our grant.

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Background and context

The Workforce Instructional Network (WIN) started in May, 1991, at Southwest Texas State University (SWT) through grant (#V198A10219) from the Office of Adult and Vocational Education, United States Department of Education (USDOE) to establish a National Workplace Literacy Demonstration Project for small businesses. This National Workplace Literacy Program arose out of a concern that the U.S. economy was losing its competitive edge in part because the skills of U.S. workers were deficient relative to those of workers in competing nations. In the national discourse about economic competitiveness and the quality of the American workforce, images of workers in huge automobile and steel plants in urban areas predominated. However, 97% of the nations' towns and cities have populations of less than 50,000 people (*Census Tracts*, 1983) . Many of them are like San Marcos, Texas, a community that is characterized by a multitude of small businesses and an educationally disadvantaged workforce. This guide is designed to assist practitioners in designing and implementing workforce education programs for small businesses. Since small businesses rarely budget funds for workforce education activities, the guide will start from the assumption that practitioners will seek grant funds, at least for the start-up phase of their workforce education programs.

Write a grant proposal

We began by approaching the two local Chambers of Commerce (San Marcos Chamber of Commerce and San Marcos Hispanic Chamber of Commerce) for assistance in conducting a general needs assessment of businesses in the community. A preliminary questionnaire regarding business and industry training needs was distributed to the members of the Chambers at one of their monthly meetings. Answers on this questionnaire documented that employers had a general need for increased employee training in a variety of skills. Follow-up discussions with members of the two Chambers at future monthly meetings confirmed the extent of the perceived literacy needs ranging from basic reading, writing, and calculating skills through needs in computer literacy.

To further verify the need for this project, a needs assessment was completed via personal interviews and phone surveys of 20% of the businesses and industries in the San Marcos community. A broad range of the business community including manufacturing, communication, government, education, retail trade, financial, and child care sectors were contacted. Results of this assessment identified over 600 workers in these twenty businesses alone who were in immediate need of basic literacy skills ranging from reading work order forms and filling out quality control sheets accurately to basic mathematical computation skills including fractions, decimals, and percentages, to advanced mathematical computation skills up through algebra, to reading safety memos and warning labels on chemicals, to basic computer literacy, word processing, using disk operating systems, spreadsheets, data bases, and telecommunications. This information demonstrated to us that business owners perceived a need for education for the San Marcos workforce.

Learn about the problems of business

During these discussions with business owners and managers, it was continuously made clear how important it was for us to avoid preconceived notions about their needs and goals. Our early discussions introduced us to different business leaders and provided a forum where we, through active listening, were able to understand some of the challenges each was facing in an increasingly competitive marketplace. We found these businesses were often faced with accelerating rates of change and the need to try new ideas, yet the workforce available to them was poorly equipped to learn new processes and adapt to these changes. Manufacturing workers, in particular, faced a need to learn advanced machinery and to participate in rigorous quality control procedures. Without exception, business owners did not see massive layoffs and rehiring as an acceptable solution to this dilemma since there were few people in the workforce with greater skills. Businesses also valued the loyalty of their current workers and their job knowledge.

This lack of functional literacy skills wastes the potential of the employee frozen at an entry level position and unable to move up into more complex jobs. It also creates a hiring bottleneck at the entry level which harms the employment opportunities of the whole community. Together with the businesses we concluded that in many ways workforce development equals economic development.

Develop a partnership

Based on these discussions and the results of the needs assessment, the proposal development team proposed a partnership between Southwest Texas State University, the San Marcos Chamber of Commerce, and the Hispanic Chamber of Commerce to develop a model for offering effective job related literacy and basic skills programs for the multiple small businesses that are the mainstay of the economy. The guiding concept of the proposed model program was to develop a community-based approach to workforce education. Clearly, it would not be cost effective or logistically feasible to provide instruction to two or three workers at different locations across the community. At the same time, it might be difficult for employers to release workers at the same time to meet at a location in the community.

Our task then was more complicated, or at least different, from *traditional* workforce education programs which are most often partnerships between community colleges and large manufacturers (Chisman, 1992 ; USDOE, 1992). Our strategy was to develop educational programs for job families, rather than specific workplaces. The job families we served were Custodial, Child Care, Manufacturing, and Equipment Operators.

Implement a community-based workforce education model

An initial key WIN objective was to raise community awareness about the need for workplace education. The first step was to establish our position and identity within the community. We had to establish who we were, where we were, and why we were there. This step may appear obvious. Our experience indicated that this was not the case. Although representatives from the business community had been helpful in the proposal development phase, upon funding 12 months later, we had to remind them of who we were and why we were seeking their involvement in the project. This situation was further complicated in the interim because the president of the San Marcos Chamber of Commerce who had signed the original partnership agreement had been replaced, and the San Marcos Hispanic Chamber of Commerce had elected an entirely new Board of Directors. In effect, then, our original project partners did not know who we were, where we were, or why we were interested in workforce education. At a recent meeting of project directors sponsored by USDOE, similar stories were reported from around the country. It was therefore recommended that USDOE streamline its proposal review process. Whether this occurs or not, future projects must consider continually informing partners to anticipate changes in personnel.

Define the mission and connect with partners

Our next step then had to be (re)defining ourselves and our mission to our partners and to convince them to *buy in* to the project. Since our program was of benefit to the Chambers' members, but not directly to the Chambers themselves, their support was nominal. They each agreed to place a member of their Board of Directors on the WIN Advisory Council (see below), but they did not play an active role in recruiting employers or in publicizing our services to local employers. Nonetheless, our formal partnership with the Chambers gave us valuable and needed credibility with area employers and facilitated initial negotiations with employers who became active participants in the network.

Despite the limited role that the San Marcos and Hispanic Chambers of Commerce played in the construction of WIN, we would recommend involving such organizations in the development of multi-stranded workforce education initiatives which target small employers. Specifically, we recommend identifying individuals active in such organizations who have a strong interest in workforce education early on in the planning phase. Meet with them to learn as much as you can about the prevailing perceptions of the preparedness of the local workforce. Among other things, they can help you identify specific employers who are likely to be receptive to your proposed program. Solicit private sector involvement in the development of your workforce education proposal. Such involvement will not only strengthen the proposal, but also facilitate the project implementation process. Working with chambers of commerce and other trade organizations is particularly critical to the success of community-based approaches to literacy development. Such organizations are instrumental in the articulation of the local economic development strategy, and the quality of the local workforce is always a critical component of any such strategy. Let them know you are capable of enhancing the skills of local workers and, with them, determine which sectors of the local workforce are currently considered most critical to the economic vitality and quality of life of your community.

The position which the WIN staff decided to establish was that of a community-based workforce education initiative which would raise awareness of the need for job related literacy instruction across the private and public sectors and concentrate the knowledge and resources of multiple employers, employees, educators, and community representatives on the problem of workforce and community development. From the onset, WIN staff advocated the development of literacy programs that would be flexible enough to meet the needs of multiple workplaces. This was important to establish because it was not cost-effective to customize workplace instruction for a particular small workplace that might only have had two or three workers who would participate. Furthermore, the WIN staff wanted to demonstrate that workplace instruction could be contextualized to a set of proficiencies common to a particular job family rather than a particular workplace. Such an approach was the foundation of our model of workforce education for small businesses and should be of critical interest to other literacy practitioners interested in working with small businesses.

Build on existing resources

A second and equally important reason for choosing a community-based approach to workplace education was the existence of a strong community-based literacy initiative already in San Marcos with which most of the WIN staff had been associated previous to implementation of this project. Building upon existing resources strengthens the community effort and minimizes duplication. San Marcos is a community that has a significant adult literacy problem.

Several organizations were addressing this problem prior to the establishment of the WIN project. The San Marcos Public Library has a very active literacy and General Educational Development (GED) degree preparation program in place. In addition, various community agencies had combined efforts and resources to establish a family literacy program in a public housing complex and to enhance existing programs in order to meet the requirements of the Job Opportunities and Basic Skills (JOBS) program for Aid to Families with Dependent Children (AFDC) recipients authorized by the Family Support Act of 1988. In consultation with the Program Director, the Instructional Coordinator had developed a general workforce education class for custodians working in the physical plant at the university. In addition, the Educational Council of the San Marcos Chamber of Commerce (itself a community-based organization) had asked the Project Director to chair a literacy task force which culminated in the formation of San Marcos Literacy Action (SMLA), a community-based organization dedicated to overcoming functional illiteracy.

In short, given WIN's objective of establishing effective literacy programs for multiple small employers and in the context of existing literacy initiatives, it was evident that the WIN staff should extend the pre-existing community-based model to meet the needs of local employers and to establish a public/private sector initiative aimed at overcoming functional illiteracy in the workplace *as well as* in the community. The primary vehicles for accomplishing this community-wide effort toward workforce literacy and economic development were the WIN Advisory Council and San Marcos Literacy Action. These groups had overlapping memberships and complementary missions. Expressed in terms of

raising community awareness, the primary WIN public relations theme was workforce development always equals economic development. In complement, the primary theme of SMLA was an educated workforce (which includes the unemployed and under-employed) enhances the quality of life in the community, and the development of effective and accessible literacy programs is an investment in the future.

Literacy in San Marcos- Preliminary Statistical Summary

City of San Marcos (1990 Census)

Total population	White	Hispanic	Black
28,473	22,527 (79%)	10,571(37%)	1,535(.05%)

Note: Totals do not equal 100% because many residents identified themselves as both white and Hispanic

According to 1980 census and recent SMCISD surveys 46% of the adults over the age of 25 do not have a high school diploma. This represents approximately 11,000 people.

San Marcos Consolidated School District

Total population	Anglo	Hispanic	Black
6,000 +	34%	63%	2.5%

SMCISD statistic: The San Marcos High School class of 1990 entered the ninth grade with 562 students. It entered the twelfth grade with 337: 40 % of the freshmen did not make it to the beginning of their senior year. Of that 40%, 77% were Hispanic. Statistics for how many students dropped out in the twelfth grade are not available at this time. Nor are statistics available on the number of students who did not enter the ninth grade.

Adult and Family Literacy Programs in San Marcos

Total Population		Hispanic	Other
Adult:	1,250	86%	14%
Children:	@120	79 children attended Project PLUS last year	
		30–40 children attend ROOTS program at Jackson Chapel	

Note: These statistics do not include local adults who have attended programs at Gary Job Corps, Rural Capital Area Private Industry Council, the PRIDE Center (@70 students), or the Hays County Law Enforcement Center.

1,250 adults (.5% of the voting age population) put in a minimum of 36,000 hours of participation in area literacy programs.

<u>Conclusion</u>: There are at least 10,000 adults out there without a high school diploma and many more that are functionally illiterate.

Evaluate the context

While WIN believes that it made the right choice in choosing a community-based approach to workforce education in San Marcos, we do not necessarily believe that it is the only approach to workforce education initiatives that target multiple small employers. Rather, we recommend that practitioners carefully analyze the context in which they intend to operate and choose their approach based on that analysis. A significant factor in your analysis should be demographics. For example, you may choose to operate in a community larger than San Marcos that has a large number of small businesses. In such a context, a community-based approach to workforce education may well be too ambitious. You would probably have great difficulty galvanizing the interest of enough key players in the community to make it worth your effort. It is important to be cognizant of the diverse problems, challenges, and opportunities that make up community life. The larger the community, the more diverse, and the more likely that certain sectors of the community will take ownership of certain issues and other sectors do the same with other issues. A promising strategy for developing programs for small employers in a medium-sized or large city might be to target a particular trade or job family and initiate a partnership with the employer trade organization and/or the labor union to which the majority of employees belong.

In economic terms where there is a greater division of labor, a greater division of literacy programs for labor is probably desirable. For example, a large high tech company may want one basic skills program for its chip manufacturing division and another one for its hardware assembly workers. (It is important to note that major components of two such programs could be, and probably should be, the same.) In a small community characterized by small employers like San Marcos, the division of labor occurs at the level of the individual business, each needing labor for one or two product lines of customer services. The division of labor is to some degree community-based and therefore we chose a community-based response.

Reconcile federal priorities with local realities:

Since many workforce education programs for small business are likely to be grant funded, practitioners must reconcile the funding agency's priorities to local realities. In the case of the National Workplace Literacy Demonstration Program (NWLD), USDOE strongly urged practitioners to: 1) obtain at least a 30% in-kind and/or financial contribution from their partners; 2) link instruction to the literacy requirements of actual jobs; and 3) measure the impact of literacy instruction on worker productivity.

While the WIN staff supported all of the above priorities, it had difficulty reconciling each of them with local workplace realities. In its literacy program for child care workers, for example, it was quickly established that most day care centers simply could not afford to contribute to the project. At the same time, both center directors and workers were eager to participate. The WIN staff decided it had an obligation to serve child care providers, despite their inability to pay. (Fortunately, in USDOE terminology, the child care providers are referred to as sites, not partners. Therefore, WIN was not out of compliance with USDOE.) Unfortunately, it is clear that the great majority of day care centers in the

country can not afford to be a partner in NWLD projects. (For more information concerning USDOE definitions, please see the Federal Register, August 18, 1989, page 34419.)

Linking instruction to the literacy requirements of actual jobs can also prove difficult, particularly when those literacy requirements are quite low or when the employer has a different priority concerning the basic skills education of its workers. For example, it was difficult to develop a course of instruction tied to the literacy requirements of custodial work. In our case, this problem was heightened because the primary employer of the custodial workers the WIN staff served wanted a general literacy program as a prerequisite for job-specific training geared toward career advancement.

Measuring the impact of literacy on productivity was the most difficult of all. There are many variables that impact productivity. It is extremely difficult to attribute increased productivity to literacy instruction directly. Therefore, in some job families we used measures that we deemed were correlated to productivity. For example, within the Manufacturing Job Family, workers had little if any literacy requirements on the job. Still, supervisors and management believed their workplace would be enhanced (i.e., more productive) if their staff were to improve their literacy skills. Given improved literacy skills, more workers could work toward and receive their GED, could be promoted, which would in turn open up entry level jobs. Therefore, we argued we had to affect the supervisors' and management's perception of productivity. Within this job family, given increased perceptions of productivity, our project would be deemed successful. Within the Manufacturing Job Family, productivity was measured by the Project Director.

Demonstrate what for whom

Demonstration projects are designed to identify instructional strategies that are replicable in a wide variety of situations and for a wide variety of audiences. In fact, the purpose of this guide is to help you find effective strategies to implement a workforce education program in your company or community. However, we recognize each company and community exists in a unique context, and it is usually necessary to customize your program to that context. In San Marcos, we found it useful to ask the following question: Demonstrate what for whom? After some discussion and an in-service staff workshop, the WIN staff reached the following conclusions for our workplace context. First, we needed to demonstrate to local workers and employers that participation in the WIN project can make a positive difference in the way work is accomplished, however measured. Second, we needed to identify what worked best and recommend it as a promising approach to practitioners who are implementing workforce education projects with these job families.

This was a good first step, but the federal priorities-local realities dilemma was a difficult one, particularly as it relates to program evaluation issues. In our discussions with local businessmen, we sometimes encountered an aversion to government intrusion into their affairs. It is important to account for this possibility when you initiate discussions with employers. The box below describes WIN's encounter with one such employer.

Federal Priorities and Local Realities: You can't get there from here

In the fall of 1991, WIN initiated its first Math for Manufacturing class. The partner company manufactures heat tracing products, usually involving insulated electric wire, for the application of heat to piping, tanks, instrumentation and other types of equipment. Headquartered in San Marcos, the company is competitive on the world market in its niche and has manufacturing and engineering offices in eight countries around the world. The San Marcos plant, the company's largest, employs 220 people, about 50 of whom work in what is called the wire plant. Hearing about the services of the Workforce Instructional Network at a presentation made by the Project Director to the San Marcos Manufacturing Association, the Vice President of Operations called WIN and said he was interested. Negotiations on how the program would be implemented began.

At about the same time, the project's outside evaluator, visited WIN to gather data for his baseline evaluation. He spent a good deal of time talking to project staff about the importance of program evaluation and the need for accountability. He reminded staff that we had proposed to USDOE that we would quantitatively and qualitatively assess learner gain in job related literacy as well as develop productivity measures. Due to the evaluator's comments, federal priorities were in the forefront of our minds during the negotiation phase. The vice-president listened politely as the project director told him the things we would need to do to satisfy our commitment to USDOE. In addition, the Project Director sent a WIN staff member to interview the Vice-President in order to collect some baseline data for the outside evaluator.

The Vice President appeared accepting, and we proceeded to develop an effective and exciting class for 15 of the company's wire plant workers; all but one of whom were women of Mexican and Mexican American origin. In order to gather some data on productivity, the project director met with the Wire Plant Supervisor in order to devise a productivity related supervisor rating scale. In that meeting the project director made some mention of USDOE or the federal government. the Wire Plant Supervisor quickly said: "You better be careful talking about the government with Mr._____ (the vice president). And if you need anything from him, you better ask me to get it for you. He's pretty steamed about the government wanting this and that around here." Well, this was all news to the project director. The supervisor went on to say that the Vice President had said: "You know, if I had known those guys were gonna want so much damn other stuff, I would have just hired a Math teacher from the high school."

The class was a success by every measure, pre- and post- tests, supervisor ratings, and participant observations. After it was over, the Project Director asked if the company would be interested in developing an intermediate Math class. He was told that the company was just about to enter its busiest part of the year and to contact the company in the Spring. The project director did so. He talked to the Plant Supervisor twice and the Vice President once. There was always something that prevented us from getting another class going. The Project Director suspects that the real reason has to do with the problem of reconciling federal priorities with local realities. Yet the class was a success, and the wire plant workers and supervisors still need and want more math instruction. Only time will tell if WIN or some other literacy initiative will be welcome back to the wire plant.

Implement evaluation strategies

Both anecdotal evidence and the literature (cf., Chisman, 1992) indicate that many small businesses do not find formal evaluation as used by educators either useful or cost-effective. Our experience confirmed this and indicated that our small businesses preferred focus groups and other informal methods. On the other hand, USDOE wants and needs hard evidence to demonstrate to Congress and the tax paying public that it is making a positive difference with our tax dollars. Practitioners need to develop creative strategies to meet the somewhat contradictory needs of these two very important "customers."

We chose a strategy that used evaluation methods that were collaborative in nature, such as focus groups with workers, supervisors, and management representatives. If your program is going well, it will be easy for management to note increased employee self-confidence and enhanced job performance. This observation on the part of management may result in the gathering of information you consider valuable for your evaluation. Just be careful how you ask for it. You might try some gentle prompts such as "I wonder if Juan's scrap rate has improved since he began taking classes?" If the company is large enough to have a human resources office, you may be able to work with them on the collection of job related data. Unfortunately, most small businesses do not have such an office, and many do not keep the kind of productivity data that practitioners might find useful.

Utilize the Advisory Council

Another promising strategy is to use the forum of the Advisory Council as the place to discuss workforce education on the global, national and local levels. Begin by informing the Advisory Council about federal priorities. Seek their assessment of local realities in specific relation to those priorities. Share the program evaluation objectives stated in your proposal with the Council and elicit their advice.

USDOE might consider making it a priority that outside evaluators be recruited locally. Such a person could devote his time to building a partnership effort for the *purpose* of program evaluation, thus freeing up the Project Director to concentrate solely on project implementation and program development. The evaluator and the director could then work together to achieve both local and federal objectives. USDOE could hold meetings early in the funding cycle to inform both the local evaluator and project director of its priorities and to provide specific training.

Build the network

The construction of a community-based Workforce Instructional Network involved two distinct processes. One was the creation of a forum which sought community input and

promoted a cross fertilization of ideas and strategies that centered around the educational needs of the local workforce as viewed from diverse perspectives. The other was the creation of a mechanism for implementing actual programs. To initiate the first process, we formed the WIN Advisory Council. The WIN staff invited representatives from across the community who had an interest in the development of an educated and/or skilled workforce to monthly meetings over the lunch hour. In addition to employers who were active WIN partners, we invited literacy professionals, elected officials, representatives from employers not participating in WIN programs, members from boards of community organizations, university professors, workforce education students, students from other literacy programs, floor supervisors, school district representatives, etc. The purpose of this approach was threefold: a) to raise community awareness about the need for workforce education instruction; b) to create a forum where the purposes and methods could be openly discussed; and c) to build community buy-in for WIN objectives.

At the first meetings, the WIN staff introduced the USDOE National Workplace Demonstration Program and attempted to explain it in global, national, and local contexts. Studies and reports such as *America's Choice: High Skills or Low Wages*, (1990)The *Secretary's Commission on Achieving Necessary Skills* (1991), pertinent articles from Business Council for Effective Literacy, *MOSAIC*, and other newsletters were disseminated and referenced so that Council members could view the WIN project as part of a broader context or movement. In addition, the Advisory Council was utilized as a forum to discuss the salient differences between job related functional context education and other more traditional literacy instruction (e.g., library based one-on-one tutoring, English as a Second Language, GED, etc.). This stimulated thought and discussion among employer representatives about what they wanted their employees to learn and why. Did they want to provide GED training for their employees simply because a significant number did not have a GED? Would the academic skills that such training emphasizes have an impact on job performance? Did they want to link the learning to the skill requirements of actual jobs? Did they want workers to learn content or to learn how to learn? Similar questions should be discussed in your advisory council meetings.

We found through these discussions a cross fertilization of ideas began to take place. It turned out that employer representatives from two high tech companies new to San Marcos had extensive experience in basic skills programs in workplace contexts and were doing similar training for their companies. These companies had already committed to their own brand of Total Quality Management. When they moved to our town, they set high minimum skill standards for entry level jobs. Therefore, they did not need WIN services. However, their representatives brought quality experiences and insights to the Advisory Council. In discussions of general literacy versus job related literacy in specific contexts, they were able to make insightful comments based on their experiences. If WIN had limited the Advisory Council to only participant workplaces, this source of expertise would not have been at our disposal.

The second process for developing the Advisory Council evolved after WIN had implemented programs for each of the job families. The Advisory Council began to take a broader view of the issue of workforce development in the community. Toward the end of the grant cycle, the Advisory Council sponsored a workforce development focus group, primarily as a means to assess where to go from here without the support of the USDOE. Employer representatives reported they had difficulty finding qualified applicants, even for low skill jobs. One truly startling revelation that arose out of this discussion was that every employer in the room admitted that most of their skilled employees lived outside the San

Marcos community. If higher paid skilled employees live outside the community, they are likely to spend their paychecks elsewhere. WIN is hopeful that the implications of the above for the local economy will serve as a galvanizing issue for San Marcos Literacy Action to build local support for linking literacy education to actual jobs after the funding period.

The establishment of the WIN Advisory Council was a critical mechanism in the provision of a community base to the Workforce Instructional Network. It created a forum where people could explore the nature of the link between literacy and a good job. It provided a forum for the WIN staff to develop and refine its marketing premise: workforce development equals economic development and enhanced quality of life. Finally, it planted the seed for a private/public sector initiative to develop the local workforce through literacy.

Create a participatory support structure through focus groups

WIN's partnership with the two San Marcos Chambers of Commerce and the establishment of the Advisory Council were critical steps in the process of establishing a viable workforce instructional network for San Marcos. In business parlance, the Chambers and the Council were the marketing arm of the network. However, another mechanism was needed to produce effective literacy programs for each of the four job families. In order to guarantee that the instruction was job related, the WIN staff believed it was essential to understand the workforce literacy problem from as many perspectives as possible. We felt the best way to accomplish this was to establish planning and evaluation focus groups for each job family toward creating a participatory, collaborative, workforce education effort. This focus group should have at least one management representative, one direct supervisor, one worker, and one educator. Together, the participatory group can work together to understand each other's perspectives and concerns concerning all facets of the planned workforce education program.

The advantages of this participatory approach were numerous. First, it built collaboration from the very start. Management, supervisors, and workers alike were able to see that the WIN staff was interested in addressing the needs, honoring the perceptions, and listening to the ideas of the key stakeholders in the proposed program It created a level playing field, at least for the purpose of education. Workers and employers both knew that they had an active role in the implementation process. Potential problems, such as confidentiality of test scores, relationship of worker participation to job security, nature and extent of employer and employee contribution to the project, and other critical issues were addressed collectively. This participatory approach initiated a process of employer and employee *ownership* from the inception of the program and strengthened the credibility of the WIN staff. Employers and workers alike saw that the WIN staff was being consistent. We did not say one thing to managers and supervisors and another to workers. Also, the openness of the approach afforded the WIN staff high visibility at the various work sites. By the time the literacy task analysis was completed and mini-courses began, workers, supervisors, and management knew who WIN was and why we were there. The potential

for key stakeholders to feel blindsided or left out of the process was minimized. We attempted to develop these focus groups for each job family.

However, as noted above, workforce education programs occur in specific contexts, and literacy providers must have the ability to analyze workplace culture and act quickly on that analysis. We found first impressions were critical. We often were unable to immediately implement a participatory approach for the creation of these focus groups. In some cases, we even encountered resistance. In these situations, we were able to adapt the participatory approach to existing realities without sacrificing fundamental principles such as the WIN staff's commitment to the holistic model of adult literacy development.

WIN was largely successful in implementing the participatory approach to workplace education in the development of three Math for Manufacturers courses. In part, this was true because WIN had learned from its experiences in implementing programs for the other job families. Another factor was the heightened awareness of the importance of having an educated workforce in the manufacturing sector. Virtually all the manufacturers with whom we worked had initiated a quality assurance program and were aware of the importance of enhancing workers' transferable skills to the creation of high performance work organizations.

Our first class for manufacturers was implemented at the company mentioned earlier in the context of federal priorities and local priorities. Despite the aversion that the plant vice-president had for certain aspects of our program evaluation, we were able to get input from all the key stakeholders. The vice-president provided us with valuable information as to why the company was interested in workforce education. As with other manufacturers around the nation, the company was concerned about international competition. In particular, the company wanted to remain competitive in lucrative European markets currently undergoing transition to a huge integrated common market. It was the company's perception that to remain competitive in the new European market, product quality assurance methods would have to be strengthened. This led to a concern for the basic skill levels of their workers.

WIN staff had several meetings with supervisors and workers in the wire plant for purposes of literacy task analysis and program planning. The supervisors met with the project director to devise a supervisor rating scales designed to measure 13 job related behaviors and capabilities and assisted the project by rating workers on the scales before and after instruction. They provided WIN with the results in such a way as to protect worker confidentiality. The results indicated that the supervisors perceived gain in twelve of the thirteen areas. The one area where no gain was observed was a work procedure that management wanted plant employees to be able to do. None of the workers could perform the operation prior to the class. Nor could they after the class. WIN and the company both concluded that the six week class was to short to address the company's desire for workers to perform this specific operation.

Both the Wire Plant supervisor attended Advisory Council meetings during the period that their workers were enrolled in the class, and, despite the difficulties described earlier, the company recently provided release time to about a dozen workers to attend the workplace education classes held at the SWT physical plant.

In addition to the cooperation mentioned above, the company donated its training center to WIN for a two day staff development seminar.

It was at that seminar that the advantages of the participatory approach were discussed in depth. Paul Jurmo and Carol Clymer-Spradling provided WIN staff with an elegant model for structuring participatory approaches that revolved around the simple question of who wants what for what purpose. During the in-service WIN staff were able to ask that question of each other for the first time. A particularly important question that arose at the in-service revolved around how to design curriculum and assessment instruments rigorousness to be educationally valid yet flexible enough to be informed by pertinent stakeholders, in particular workers.

Jurmo introduced the focus group approach mentioned above and Clymer Spradling reminded the staff that we were involved with a demonstration project. She noted that if we had effective curriculum and valid assessment instruments by the end of the project period, we would have accomplished something. Both of these contributions were important, and it was with them in mind that WIN proceeded to implement a new round of Math courses for other companies in the community.

Through a needs assessment process, WIN had determined that there were three companies who wanted to work with us in the development of an instructional program for their workers. Two of these companies were machine shops. One made parts and pumps for the oil industry. The other made clutches and other metal parts for a variety of applications. A third company produced business forms such as invoices and purchase order forms. Based on the participatory model described above, the project director developed a one page proposal for the employers to consider. (see box below.)

Proposal for Implementation
of Mathematics for Manufacturers Class
submitted to Members of the San Marcos Mfg. Assn.
by the Workforce Instructional Network (WIN)
Southwest Texas State University

Based on an analysis of the educational needs of local manufacturers as well as consultation with the WIN Advisory Council and experts in the field of workforce education, WIN requests that manufacturers consider the following format for the planning, implementation, and evaluation of the proposed class(es).

A planning and evaluation team should be formed in order to ensure that representatives of all stakeholders participate in the determination of the objectives and progress of the class. These stakeholders include management, front line supervisors, workers, engineers, and educators. In the case of companies that have already formed a training committee, WIN requests that a worker representative be added to that committee for the purposes of implementing WIN instruction. The rationale for this suggestion is that including the worker perspective may make the class more relevant to the needs of workers. Additionally, if workers are aware that one of them is involved in course development and monitoring , they may be more likely to "buy in" to the course offered.

The rationale for including an engineer on the team is to help WIN and its partners determine the extent to which WIN instruction impacts worker productivity. An engineer from one company has expressed interest in serving as an engineer representative on the team. Any engineers from other companies would be more than welcome.

It is anticipated that the planning and evaluation team would need to meet no more than two or three times. The purpose of the team approach is to ensure that all stakeholders reach a consensus on the purpose and nature of instruction and worker evaluation occurring in the workplace.

An important question is whether WIN will need to set up separate teams for separate workplaces, even if workers are attending the same class. It is the preference of WIN that one planning and evaluation team be instituted for all instructional activities for manufacturers.

WIN is convinced that the teamwork approach to workforce education outlined above is appropriate, particularly when the goal is to enhance the basic skills of workers. We look forward to hearing your response and are more than willing to work with you on any problems or concerns you may have with this proposal.

The employers accepted the proposal as written and the level of cooperation and collaboration between stakeholders was quite high. Two courses were developed utilizing the planning, implementation, and evaluation process discussed above. Management worked with WIN to ensure that all workers in need of the courses would have the opportunity to take them. Supervisors and engineers worked with the instructors in the development of pre- and post-tests, particularly in the area of performance assessment. Rather than rely solely on pen and pencil type questions, WIN was able to assess worker proficiency in their reading of blueprints and the use of micrometers actually used on the job. Manufacturing supervisors checked the questions concerning blueprint reading for accuracy and relevance. They also provided instructors with parts made by the companies which workers were asked to measure with the micrometers and other measurement devices at both the pre- and post- test. Engineers and supervisors assisted the instructor in the proper understanding of blueprints and other aspects of the manufacturing process.

During the planning stage of the intermediate Math class workers from the basic math class who would be advancing to the intermediate class took part in the planning group. They provided WIN staff with information concerning what the workers wanted to learn, as well as feedback concerning the basic math class. The Project Director also met with workers in the math classes for purposes of formative evaluation. He shared the information with the instructors and minor adjustments were made to meet the needs of the workers. worker participation in the formative evaluation focus group and planning groups heightened their buy-in and interest in the course.

These planning and evaluation meetings provided the opportunity for WIN staff to understand what workers, teachers, managers, and supervisors expected from the course. In general, these expectations were quite similar. Nonetheless it was important that all the stakeholders knew that to be so. The participatory process created a spirit that said we were developing the math classes together. True, the teachers and the workers did the bulk of the work, but they supported each other and received support from the other stakeholders on an as needed basis.

WIN believes that the participatory approach strengthened all aspects of the Math for Manufacturers program. Learner gain data and the results of summative evaluation focus groups support that belief. As one plant manager put it. "The classes helped us take a step toward one of our total quality management goals- inspection at the source. They helped us to move inspection from the point of finished goods to the point of manufacturing the goods."

Realities of a Participatory Approach

Based on our experience, WIN recommends the participatory approach to those developing workforce education for small businesses. However, practitioners need to be sensitive to the contexts they are working in and flexible in the development of effective workforce education program.

Early on in our project, WIN staff discovered first hand how a program can be compromised by not informing all stakeholders of your purpose from the outset. An employer approached the WIN staff about the provision of Commercial Drivers License (CDL) instruction to its drivers. In the negotiation phase, the Human Resources Department assured the project director that all arrangements had been made for the classes to begin.

A meeting was scheduled with the plant supervisors, and it was as if they had never heard of WIN. These supervisors had very strong opinions about how the CDL program should be implemented. First, they believed that the employer should provide full release time to workers studying for their CDL test because the new licensing was required by law. The employer had proposed a 50 % time share. Second, the supervisors believed the worker should pay for it because they would have the right to take it with them to a new employer. The employer had proposed that the company pay for the cost of the CDL license. These issues were resolved at a meeting between supervisors, human resources personnel, and the WIN staff, but a negative and combative tone had been established. Other difficult issues quickly arose concerning confidentiality of the needs assessment process: a critical issue due to the large number of Limited English Proficient drivers who needed to prepare for the exam orally in Spanish. Finally, there was a philosophical difference between WIN instructors and the supervisors on how instruction was to take place. Supervisors advocated a quick intensive training approach to achieve the discrete goal of the CDL license. WIN instructors preferred a "learning how to learn" approach with classes to be held four hours a week for five weeks. The WIN objective was for workers to complete the CDL class with the knowledge of how to prepare themselves for any job related certification which required the studying of a manual in order to pass an examination.

All of these problems and differences were worked out, and the classes were taught according to the WIN instructional model. However, there was no mutually agreed upon mechanism for addressing the issues, and unnecessary tension was created. Extensive damage control was required. If the WIN staff had initiated the partnership utilizing the participatory model described above, these issues and differences would likely have surfaced early on and would have been efficiently and effectively addressed in a far more agreeable fashion.

Developing Curriculum

Develop workforce education curriculum around generic literacy strategies

Complete a small business needs assessment

Complete focus group interviews with workers

Gather job-specific material

Observe workers on-the-job

Develop a participatory classroom based upon needs assessment

Establish logistics of the class

Ensure confidential reporting procedures

Negotiate contract with business

Screen with context-relevant task

Re-assess the need and adjust the curriculum

Provide in-service for staff development

Develop workforce education curriculum around generic literacy strategies

We chose to design our curriculum to appropriately meet not only our educational criteria but business needs. Always crucial in workforce education, meeting business needs became more complex when working with several small businesses, each having individual yet common needs. By concentrating on developing curriculum based on educating the workers in generic workforce literacy strategies rather than training for specific job content, the instruction was made flexible enough to meet the needs of workers from several small businesses. For example, workers in our classes were drawn from plants producing heat-conducting wire, oil-field machine parts, and business forms. Instruction centered around exploring math strategies associated with specific tasks or machines on the shop floor. Participants were also encouraged to develop independent questioning and learning strategies to be able to solve problems not discussed in class.

> *I began to balance my checkbook, figure my taxes, and most of all, I feel more confident in dealing with math in my daily life*
>
> *--Student, Math for Manufacturers I*

The focus on educating for generic, workforce education strategies rather than training for individual job skills also enhanced the transferability of the learning in several ways. We expect the generic, workforce education strategies to be helpful in a variety of flexible job options, such as accurate centering of bolt holes or paper perforations. In addition, the generic task focus also enabled some participants to develop applications of these skills in their personal lives. For example, some stated that they intended to show their children better ways of studying school subjects. In addition to the usefulness of the actual techniques, this last personal goal can be considered evidence of an increased academic self-confidence, especially since the participants who mentioned it had themselves neither completed high school nor gotten their GED's.

Complete a small business needs assessment

An effective means for determining the educational needs of the businesses you hope to serve is a Literacy Task Analysis. Descriptions of the formal process can be found elsewhere (Drew & Mikulecky, 1988). We found we needed to modify this process to work with small businesses while retaining the three main points of triangulation: interviews, materials inspection, and job observation. Therefore, we created a needs assessment to look at each worker's job from several viewpoints in order to get a clear picture of the literacy tasks or demands involved in its completion.

Complete focus group interviews with workers

We formed focus groups rather than conduct only individual interviews within each organization in order to interview the various workers involved in a job (see above). Often in small businesses, several workers performed several jobs. Moreover, we found it important to get input from each level of the business organization. Management gave us a *big picture* of how each job fit into overall business needs, such as in terms of quality goals; the first-line supervisors contributed information about the problems with actually completing the goals; and the front-line employees were the *job experts.* Usually these focus groups were composed of people at all levels discussing concerns together. However, an uncomfortable management climate in some small businesses mitigated against focus groups. In these climates we interviewed the same players separately.

In addition to the information-gathering function of the interviews, direct contact with each set of concerned workers early in the development cycle increased the commitment of the organization. This buy-in was crucial to our success. The lack of commitment almost torpedoed our work with one organization for another job family. We neglected to work directly with the first-line supervisors of people who needed to pass a Commercial Drivers License exam because, as a new state law, the need seemed evident. This was a mistake, and it took a lot of energy to mitigate the damage done by this oversight. By contrast, our close relationship with supervisors at two manufacturing plants proved invaluable in designing relevant, learner-appropriate curricula. First-line supervisors were found to determine whether a program, and the workers who participate in it, will be viewed positively or negatively by other workers.

Gather job-specific material

The next step in our needs assessment was to gather all the materials which potential workers were expected to use when completing a particular job, as well as those general materials such as safety warnings, newsletters, and policy manuals which are part of their work environment. These materials were used to provide a functional context for instruction. All our math classes, for example, used charts, tools, prints, and work orders directly available on the shop floor. However, materials themselves should be carefully evaluated in the curriculum development process. Occasionally, what looks like a lack of necessary skills in the workforce can actually be traced to poorly designed materials. In that case, new materials rather than classes can be suggested to more appropriately meet the business' needs.

Observe the workers on-the-job

The third point of the triangulation was actual job observation. This gave us a context for the information gained in the interviews and provoked further clarifying questions about the literacy strategies of the workers. In addition, observation helped avoid misunderstandings of the nature of the job which would not be uncovered in an interview-only approach.

Employees often did not realize the extent of the various literacy tasks required by their jobs nor did they identify them as such. For example, since the *reading-to-do* found on a job is different from the *reading-to-learn* remembered from school days (Mikulecky & Diehl, 1980) workers may say they don't read on the job, whereas observation gathers more accurate data on the frequency of their actual job-related interactions with print.

Job observation in the Manufacturing Job Family revealed a significant number of literacy and numeracy strategies tied both to current job performance and to opportunities for job advancement. Proficient workers analyzed blueprints to check specifications and calculate materials measurements and cutting and boreing tolerances. Reference materials were accessed to solve problems, and a variety of calculations were used daily. A more complete listing of literacy and numeracy strategies taught for this job family are available in the syllabi and sample lesson plans in Appendix A.

Develop a participatory classroom based upon needs assessment

The curriculum was considered the road to our instructional goal. Therefore, based upon the needs assessment, we identified suggested basic topics, a sequence for the topics, some materials and handouts to be used, and pre-tests and post-tests before beginning the class. Still, the curriculum was considered tentative until actual class members were involved in the development. There are three important reasons for running workforce education classes in this participatory manner. First, the workers are the *job experts* and their continuing input is essential to determining the validity of instruction. There is little time to waste in unnecessary instruction, and they are prime experts in what instruction is relevant to their needs.

Second, sharing the power of the class tended to increase the commitment of class members. This commitment was crucial to success and can be easily lost if the classes come to be viewed as just something "done to" the workers by management or by educators unconcerned with them. This commitment is also enhanced because a participatory approach demonstrates respect for the learners as successful adults who bring many skills with them to class.

> *The most helpful thing in this class is that we all work as a group helping each other out on our mistakes.*
>
> *--Student, Math for Manufacturers I*

Third, several of the underlying skills considered important by businesses today, such as those associated with problem-solving and teamwork, are developed best in the atmosphere of mutual respect fostered by participatory education.

Characteristics of an Effective Participatory Instructor:

Flexible

- willing to adapt new teaching strategies
- able to take and give constructive criticism
- able to approach problems and explain ideas from many angles, not just "This is my way, the right way."
- employs a team-player approach
- facilitates group interactions

Experienced in the Real World Application of the Content Area

- knows subject thoroughly to allow teaching from numerous perspectives and validating/building from learner's prior knowledge
- quickly builds bridges from academic jargon to real world contexts

Student-Centered

- sensitive to workers' perspectives
- able to listen, as well as lecture
- patient with disparate background knowledge and rate of progress of varied adult learners
- acknowledges learner gains in as many areas as possible, not just pre/post-test numbers
- shows workers s/he cares
- sensitive to multicultural issues

Establish the logistics of the class

Educators who are used to working in an established educational institution often do not have to think of some of the logistics associated with developing a class. However, we found workforce education requires a more entrepreneurial approach. Such things as finding a place to teach, discovering a source for overhead projectors and blackboards, and arranging for copying services must be done. One important item to consider was the confidentiality of a classroom site. One of our classes moved to the community room of the local public library rather than use a training room in one of the involved organizations. Since the supervisors' offices were off of the training room, employees sometimes felt that management could "look over their shoulders." The library room was better able to meet the workers' needs for confidentiality during class.

Ensure confidential reporting procedures

Confidentiality was also an issue for reporting student progress. We found it very important that the workers feel comfortable during the learning process. This was especially true of our workers whose past educational experiences had been negative. They needed to know that the inevitable mistakes they make while learning would not have a negative effect on their job ratings. To ensure this confidentiality as learners, we negotiated agreements with all employers to provide learner gain reports either in the aggregate or individually with randomly-assigned numbers, rather than names of workers.

Negotiate contract with business

The program director needed to negotiate an informal agreement with the businesses for both programmatic and individual learner concerns. One aspect of this agreement was the incentives which were used to encourage workers to attend and the various ways workers were going to demonstrate their commitment. In the case of the manufacturing classes, employers paid half release time, and employees donated the other half of class time. Since the employees came to class during the regular working day there was no need for additional support structures such as child care or transportation.

Screen with context-relevant task

We chose to screen workers to answer two questions: 1) What are the interests and needs of workers; and 2) Which workers are not at appropriate functional levels for the class as designed and can be referred to a more appropriate support structure? The screening process included several perspectives in order to get the most complete information to answer these questions. Perspectives included information from the needs assessment, the worker's self-perception of need, the perceptions of management and supervisors, an interview with an educator during the first class to prepare the Individual Educational Plan to assess possible English as a Second Language (ESL) needs and student goals, and pre-tests to determine general and job-specific literacy levels and functional math levels. These several perspectives provided both qualitative and quantitative information for the educator to determine what was best for each student.

sample page from pre-test

Math for Manufacturers II

Reading and Calculating with Blueprints

Name _____

Date _____

Employer _____

Measuring Tools

Measure the labeled parts with the tools on the table. Write your measurements on the lines below.

Bore gauge	A1	_____	A2	_____
Vernier caliper	B1	_____	B2	_____
ID Micrometer	C1	_____	C2	_____
OD Micrometer	D1	_____	D2	_____
Protractor	E1	_____	E2	_____

Using Reference Materials

On what page in the Machinist's Ready Reference book would you find information on converting fractions to decimals?

On what page in the Machinist's Ready Reference book would you find information on drilling speeds for high speed drills?

Blueprint Reading and Calculating

Use the attached blueprints to answer the following questions.

PRINT 1

What is the wall thickness of the 51/8" diameter?

What is the difference between the larger bore and the largest outside diameter?

Re-assess the need and adjust the curriculum

The results of the pre-testing and interviews were then evaluated. At this point, some workers were referred to alternative educational providers for help with ESL or beginning literacy instruction. The goals and interests of the workers remaining in the class were mined for commonalities and progression of ideas. Workers and instructor together prioritized interests and ideas to come up with a progression of class themes. This progression was then matched to our curriculum developed prior to class and compromises were made. The flexibility of this approach created a need for on-going instructor support staff provided by the Instructional Coordinators.

Provide in-service for staff development

A particular addition to our course development was the provision of staff development workshops. Most of our staff had not worked in workforce literacy environments, had little experience with qualitative and quantitative assessment, and had virtually no experience with the WIN instructional model. We solicited consultants from the field at large as well as from SWT to deliver three workshops. Outside consultants were hired to provide a two-day workshop to help us corroborate our priorities to demonstrate "what" for "whom". This workshop was extremely fruitful to evaluate these priorities and document what information needed to go to whom. Two half-day workshops were given by the Program Director on the WIN instructional model as well as administration and scoring of the cloze instrument. For the novice instructors, these proved useful. In addition, the Instructional Coordinators held weekly staff meetings where instructional issues were discussed, pedagogical strategies confirmed, and problems resolved. To foster transfer for instructors, several of the instructors sat in the class for an entire mini-course to observe and act as teacher's aide. For the next iteration of the mini-course, the instructor taught the course with the Instructional Coordinator observing and acting as a teacher's aide. This transfer of responsibility for instruction proved successful as performance varied little from those mini-courses taught by the Instructional Coordinator and those taught by novice instructors. We would, therefore, recommend you solicit consultants for staff development in curriculum development, the WIN instructional model, and qualitative and quantitative assessment.

Teaching the Class

Teach process not content

Use WIN four-part instructional model

Initiating event

Modeling and large group discussion

Guided practice

Independent practice

Graduation ceremony

Teach process not content

Based on the needs assessment procedures identified in part II, three separate courses were developed for manufacturing workers. The first was "Reading Rulers, Charts, and Gauges," a 6-week course specifically for wire-production employees. Two other 10-week courses were based on observations at several job sites. Math for Manufacturing Workers I covered whole number and decimal operations, as well as reading rulers, gauges and other measuring tools, and a brief introduction to mechanical blueprint reading. Math for Manufacturing Workers II concentrated on reading blueprints, accessing the Machinist's Ready Reference Manual, and learning to perform a variety of calculations necessary for manufacturing.

Although the content of the courses was based on specific job needs, one of the main topics addressed in each course was the instructional *process* of teaching the participants how to learn independently. Workers were expected and guided to contribute greatly to the pacing and presentation of ideas (see WIN Instructional Model below). This method of teaching surprised many of the workers who, following the traditional model, initially expected the class to consist largely of lectures on specific literacy areas. Workers were surprised to be forming, then answering, their own questions about subjects. Other aspects of the instructional model, detailed below, contributed to a consistent effort to model and practice the *process* of independent, holistic learning by using the *content* derived from job tasks.

Specific literacy tasks covered in the courses included reading rulers, micrometers, and blueprints. Calculations included extrapolating values from charts, figuring payroll deductions, and calculating angles of bevels or other unknown dimensions. More detailed information about the literacy tasks can be found in the lesson plans in Appendix A of this guide.

Classes were held twice weekly for 2 hours each session. The class length was based largely on business constraints and educational concerns. We felt that a twice-a-week class spread out over several weeks gave the workers the time needed to practice and refine their use of the techniques from class in practice attempts at home and on the job. The usual two-day seminar of traditional training would not have permitted this guided growth process.

Reading Charts, Rulers, and Gauges
Course Outline

Week One

Monday, 9/23 Reading Charts
Wednesday, 9/25 Reading Rulers

Week Two

Monday, 9/30 Reading Gauges
Wednesday, 10/2 Reading Micrometers

Week Three

Monday, 10/7 Understanding Decimal Place Values
Wednesday, 10/9 More Pesky Place Values

Week Four

Monday, 10/14 Rounding and Comparing Decimals
Wednesday, 10/16 Using Proportions

Week Five

Monday, 10/21 More Proportions
Wednesday, 10/23 Even More Proportions!

Week Six

Monday, 10/28 Review
Wednesday, 10/30 Post-Test and Party!

Use WIN four-part instructional model

A process-oriented educational philosophy formed the basis for our four-part instructional model. The first step in this model involved an initiating event which engaged the prior knowledge of the workers, who were considered the content knowledge experts for their jobs. Next, the teacher modeled literacy and numeracy strategies, using a large-group discussion format, for accomplishing those literacy tasks we were able to identify via the needs assessment and through participatory learning with the workers (see above). Small groups then collaborated on workplace related literacy and numeracy tasks which required the use of these new strategies. This small group emphasis developed the communication and teamwork skills which are sought by employers, while at the same time developing workers' strategies for accomplishing the workforce education tasks. Finally, learners worked to apply their new understandings during independent practice on workplace and home related literacy tasks.

WIN Instructional Model

Initiating event/focusing activity

- engages prior knowledge
- builds on learner strengths
- demonstrates relevance/connection of new knowledge to old knowledge

Teacher modeling/large group discussion

- uses master/apprentice conception of literacy
- demonstrates metacognitive strategies
- validates a variety of strategies from students

Small group collaborative practice/application

- encourages a community of teachers/learners
- gives learners opportunity to develop teamwork skills being emphasized by business
- safe risk-taking environment, especially for LEP students

Individual practice/application at home and work

- transfers strategies to variety of contexts
- encourages metacognition
- incorporates writing across content areas

Initiating event

At the beginning of the class, activities were oriented toward engaging the background knowledge of the workers. Starting with information the learners already knew reinforced their self-confidence about the importance of their prior knowledge and lessened the feeling of the class as remediation. Starting instruction by building on strengths already held also decreased the alienation and helplessness many students felt toward learning. The participatory nature of the class was enhanced by acknowledging the co-learner status of instructor and student, with students as experts in job content and instructors as experts in applying learning strategies. The brief "survey" of background knowledge also served as a mini-diagnosis for the teacher. She could have a rough idea of the level of expertise of each of her workers and so know at what level to begin instruction, what analogies would be relevant in teaching, and who could be called upon early as an "expert" to help model concepts. Initiating events included asking when students had used adding and subtracting decimals at home and work in the past month, and what students could already decipher from a blueprint. Other examples of initiating activities can be found in the Lesson Plans in Appendix A.

Modeling and large group discussion

The next step in the class was the instructor modeling a technique for solving a math problem, such as how to subtract decimals to calculate net pay. The instructor would talk about her process for solving the problem while encouraging class members to contribute their ideas, also. This combination of teacher modeling and large group discussion was very flexible and could be altered as needed according to the progress of the participants. Some methods were modeled almost exclusively by the instructor the first time. Other methods were presented mostly by the students, with the instructor facilitating a summary, if necessary.

Modeling included both demonstrating the straight mathematical operations (working problems out on the board) and arriving at a class consensus as to the steps involved in solving the problem. Steps were written out in words on the board. Verbalizing the problem-solving process was initially difficult for most students and required a lot of teacher modeling and facilitation. However, when the process became more familiar, it provided the students with a systematic framework from which to approach new problems. It also demonstrated the transferability of mathematical procedures and helped students move away from their previous model of math as a grab-bag of magical numerical answers derived more by luck than method.

Guided practice

The next step added a guided practice of the techniques from the modeling. Math operations were practiced with different problems, or a different blueprint was analyzed. Students formed their own groups of 2-5 members. They were encouraged to talk aloud about their problem-solving process in order to arrive at a consensus on both the numerical answer and the steps of the mathematical procedure.

This small group practice was intended to mirror and evaluate the strategies learned during the large group modeling, but with much less direction from the instructor. The instructor's role in this step changed from director to facilitator. Workers were encouraged to actively involve all group members in a discussion of each worker's understanding of how to use the strategy. If questions arose as to what math method to use, for example, the instructor's first response was usually, "What does your group suggest? Who have you asked within your group?" This collaborative small group activity validated workers' roles as co-teachers and encouraged workers to think of knowledge as being actively constructed, not passively received. Problem-solving was guided toward being an on-going collaborative effort, not a random guess for the right answers to complete the worksheet.

Independent practice

The fourth step provided the workers with a chance to independently practice the new techniques. Individuals wrote their own examples of problems from home and work, then detailed the steps they used to solve them. Students could access whatever resources they deemed appropriate for the task, such as reference materials, class notes, co-workers, or the instructor. The social, collaborative approach to problem-solving was designed to mimic actual job conditions of problem-solving. However, each example had to be original. Creating original examples helped each student come to an understanding of the relevance of the mathematical procedure discussed in class to his or her own life.

Graduation ceremony

A final component of each class was recognition for the workers who participated. A brunch was given in honor of those attending each class at which Certificates of Attendance were presented (see Appendix B for an example). This brunch was attended by program staff and workers' managers and supervisors, and pictures were taken for the local newspaper and company newsletters. This recognition provided feedback to the workers on the importance we place on the literacy improvement. For adults who have had little if any academic success in their lives, this recognition was well- received.

Assessment and Evaluation

Worker's perspective

Instructor's perspective

Evaluator's perspective

Supervisor's perspective

Management's perspective

Conclusions

Summary

With our participatory approach, the responsibility for each class's success was shared by workers, teacher, and evaluators. Workers were constantly encouraged to provide feedback to the instructor and to monitor their satisfaction with class progress. Instructors were encouraged to assess and adapt their instruction to the workers' needs. Evaluators were encouraged to assess the workers' progress with tools that informed both the student and the instructor. This triangulation led us to select some specific assessment tools while we developed others in a formative effort to identify the most valid instruments and procedures for evaluating worker progress.

Worker's perspective

Develop an Individual Education Plan

At the outset of each class, instructors completed an interview with each worker to design an Individual Education Plan. Using the *WIN IEP Interview Form* (see appendix B), instructors orally interviewed each worker. This information helped the instructor screen for workers who were in need of ESL instruction and identified the worker's goals and aspirations for the class. This information was then used to adjust the curricular goals for the class (see above)

Collect on-going feedback from workers

A second, effective procedure was to request from workers their perceptions on the success of a given class as it was in progress. To gather this information, we constructed a *WIN Formative Evaluation Form* (see appendix B) and administered it following selected mini-courses. This form provided the instructor of the mini-course instant feedback from the workers about the most and least useful parts of a given lesson. It further gave instructors information about problems early enough during instruction so that immediate corrections could be made. The anonymous, written format not only helped some workers express themselves more freely than a oral format, but it provided a forum to practice writing strategies.

Collect transfer feedback from workers at the end of class

A third procedure for gathering evaluation information which we found useful was to have workers complete a *WIN Participant Evaluation Form* (see appendix B) on the final day of class. This information helped confirm the extent of transfer that workers were making from the class to the literacy requirements of the their job and their personal lives. It also uncovered any global dissatisfactions, such as too little time to prepare homework between classes.

Collect exit interview feedback

A fourth procedure was an exit interview conducted with each participant. During this conversation, oral feedback was gathered f om workers to confirm the transfer of the class information to work or to home (e.g., sample information received, "I can check my work more easily," or "I can balance my checkbook now."). Information from these exit interviews was then compared with the student's Individual Educational Plan (IEP) designed at the outset of the course and examined for goals achieved and new goals set. These new goals helped program staff determine new mini-courses that needed to be offered or referrals to other community service or educational programs for additional support.

Conduct formative evaluation focus groups

In addition to the above feedback, the project director conducted focus groups with workers enrolled in the math courses midway through each iteration. The purpose of these meetings was to gather worker input regarding the instructional content of the class. WIN staff believe that adult learners, in general, know what they want to learn. The focus groups provided the workers with the opportunity to present their views of the class to the project director and the instructor. The director began each focus group by asking the workers who they were and what kind of work they did . He then asked why they were in the class. Workers in the Math 1 class stated that they were in the class in order to prepare for more advanced Math, Algebra, and Trigonometry courses. They also stated that they wanted a second chance for an education, and several expressed resentment concerning their experience in the school system. Workers in the Math 2 class noted that they enrolled in the class for reasons of personal and career advancement. They all tended to agree with the statement made by one worker that "these days companies are unstable-- and the more you know-- the better chance for another job-- or to keep the one you've got." The formative evaluation focus groups continued to discuss what the workers wanted to learn, what they expected to gain through participation in the class. Workers were also encouraged to make suggestions for improving the class. The information garnered in these focus groups was useful for purposes of comparison with the resu ts of summative evaluation focus groups at the end of the Math for Manufacturers project component. In general, the match between worker responses in the formative and summative evaluation focus groups was very close, indicating to us that the math classes were worker centered.

The primary work-related benefit of participation in WIN math mini-courses reported by workers was increased confidence and ability to inspect their own work at the point of production. Workers said that before taking the mini-courses they only looked at the section of a parts blueprint that detailed the machining operation they were to perform. Now, they know how to read the entire blueprint and can check to see if the part matches the print when it arrives at their machine and check it again when they have finished their particular machining operation. They also reported being able to catch discrepancies between the part routing sheet and the part blue print. For example, the routing sheet might say to machine the part with mill grade steel while the blueprint indicates stainless steel of titanium. Other benefits mentioned by workers included increased competence with various measurement tools such as protractors and drill bore gauges.

Some of the workers in the mini-courses performed work other than machining. Assembly and shipping workers reported that the class "...made it easier to work with other people" and that the instruction in blueprint reading helped them to ensure that all the parts necessary for proper assembling or shipping were where they should be. One worker

labored in the front office. She was responsible for taking customer orders over the phone. She said that now that she has learned to read blueprints she can correctly determine how much material to order to fill a given order. She also said that she is more confident speaking with customers in the areas of requesting clarification and specific information. She said this was particularly important because the specifications she puts on the order sheets are not checked again until the products are ready to be shipped.

Other benefits the workers mentioned were increased confidence and familiarity in using the *Machinist Ready Reference Manual.* This allowed them to access resources to get information instead of interrupting supervisors or quality control personnel.

Workers had few complaints. Some thought that the mini-courses were too short. Others felt too much time was spent on the four basic mathematical operations. Workers expressed a desire for more time to work on decimal to fraction conversions. There were minor complaints about class scheduling. At one plant, it was difficult to attend the mini-courses at the end of the month due to increased workloads. Workers in one focus group said they would like the opportunity to take a course in the basics of business management. They wanted answers to the following questions. How does a business run? What makes it go? What makes businesses succeed or fail?

Instructor's perspective

These same four tools used for the worker's perspective helped inform the instructor's perspective for each course. These tools gave the instructor information about the workers' progress in learning the strategies, their concerns about strategy usage, and any transfer of strategies to work and home literacy task demands.

A focus group approach was also utilized for the development of the Math 2 class. Upon completion of the first iteration of the Math 1 course, a focus group consisting of a worker who had completed the Math 1 course and who was to take the Math 2 course, a floor supervisor, a management representative, the project director, the instructional director, and the instructor met to plan the second course. The goals of the focus group were to build ownership for the course on the part of all stakeholders, to actively develop the partnership between all stakeholders, to ensure instructional relevance to both management and worker concerns, and to develop an evaluation plan for the course.

This focus group was quite valuable to the instructor because it established a precedent for the collaborative development of the course. When the instructor needed access to a particular blueprint to demonstrate a concept, plant supervisors would provide it and make certain that the instructor understood both the print and the manufacturing process to which it was related. Furthermore, when WIN staff decided to incorporate performance assessment into the pre- and post- test, the supervisors assisted in developing the problem to be actually solved. For example, as a means of student assessment, workers were asked to look at a blueprint, and then make the proper measurement with gauges and micrometers from the workplace. Supervisor participation in the design of these problems and, most importantly, in checking worker response for accuracy was critical. Supervisor

participation made the course more job related because they knew what the workers needed to know and apply on the job In addition, supervisor support and participation made the instructor a more workplace knowledgeable teacher. We would recommend similar instructional planning groups, whenever possible, as an effective means of implementing workplace related instruction.

A final observation on the instructor's perspective concerns the small group practice component of the WIN instructional model. The primary instructor for the manufacturing job family had no prior experience with the WIN instructional model. He, therefore, experimented with the make-up of the small groups in terms of the math proficiency levels of the workers. In some iterations, the small groups were made up of workers of more or less homogeneous skill levels. In others, the small groups were made up of people with widely heterogeneous proficiencies. From the instructor's perspective, the classes functioned much better with the heterogeneous groupings. Heterogeneous groups fostered quality interactions among workers and between workers and the instructor. When the heterogeneous small group model was employed, a healthier atmosphere of mutual respect developed in the classroom . WIN would recommend such groupings to literacy practitioners who adopt or adapt the WIN instructional model to their specific contexts.

Evaluator's perspective

A variety of instruments were also used to document worker gain from the evaluator's perspective. We were attempting to document gain in both workplace literacy and general literacy from both quantitative and qualitative viewpoints as well as to document improved productivity. Several instruments were piloted to find the best mix which would be both informative and non-intrusive to formatively evaluate the curriculum. This also would provide a triangulation on the worker's perceptions and the instructors perceptions as measured by the informal procedures discussed above.

In order to screen workers who had identified themselves as being interested in the Math 1 and 2 courses, WIN utilized a generic Math Check from the Hadley Press. It was more or less arbitrarily decided that workers who scored at 80% or above would not be in need of the Math 1 course. After the screening process was complete, the list of students to be recruited for the Math 1 course was sent to three manufacturers. One of the manufacturers requested that the actual test results be sent to them. WIN refused for reasons of confidentiality. It turned out that the reason the company wanted to see the tests is that they did not believe that some of their workers were in need of the Math 1 class, as the screening instrument indicated. Rather than turning over the test scores for those individuals which we saw as potentially damaging to WIN's credibility with the workers, the Instructional Coordinator suggested that the company knew more about the capabilities of its workers better than a non-work-related screening instrument could tell us. Due to some rather quick thinking on her part, a potential problem was averted and the company recommended to the workers in question that they wait and enroll in the Math 2 class.

Although instruction for the manufacturing job family was almost wholly math related, WIN also used a standardized literacy test, the Hadley Adult Placement indicator, as a

quantitative indicator of general literacy performance level. The *Adult Placement Indicator* satisfied our non-intrusive criterion, since it was typical of most traditional general literacy measures and our workers reported being more comfortable with its format. Performance on this instrument suggested the workers were between sixth and eight grade level in reading ability informing the instructors that most of the workers had a basic competency level. It also served us as a screening instrument finding workers who had Limited English proficiency and were taught individually by an ESL instructor. Also, this instrument proved to be a useful measure of general literacy. Nevertheless, from the evaluator's perspective, this instrument left much to be desired in terms of aiding us in assessing workplace literacy.

Next, two workplace math tests were constructed as quantitative workplace literacy measures, one for each mini-course, to be used as a pretest and posttest. These tests reflected many of the math literacy skills needed for performing in a manufacturing workplace: for example, computing deductions on a payroll stub; performing basic operations with fractions, decimals, and percentages on workplace related items; reading charts, blueprints, and tables; and using measuring tools from the manufacturing workplace such as rulers and micrometers (see Appendix A for a copy of these tests). The difference in the tests was the level of complexity. Each test was administered near the beginning of the class and again near the end. It proved to be very informative for the worker, the instructor, and the evaluator in terms of workers' math literacy skills and the gain in those skills.

To satisfy our concerns with attrition rates in traditional adult education programs, we measured attendance rates for our two mini-courses. For the Math I mini-course the attendance rate averaged 88.5%. For the Math II mini-course the attendance rate averaged 89.2%. This attendance rate was significantly above the national average of 50-75% (Chisman, 1990). We argue our participatory, collaborative approach to workforce literacy has much to do with this reduced attrition.

Finally, we wanted a measure of productivity. Since production rates were difficult to gather on these workers, we chose to use focus groups to gather productivity data. The purpose of these focus groups was to assess or gauge the impact of worker participation on worker productivity. Management at two of the manufacturing plants had tried to assess this impact by analyzing the worker efficiency data they routinely keep. In both cases, they were unable to tie the efficiency data to the literacy instruction, and both concluded that there were too many variables involved. One plant manager cited a slow-down in orders during the instructional period. This caused a dip in the efficiency data because workers tended to slow down in order to have something to do all shift. This phenomenon he attributed to human nature. At the other plant, they had changed the way they measured worker efficiency midway though the instructional period. It was therefore decided to attempt to tie changes in worker defect or scrap rate to performance in class. The plants track defect rate to keep costs down. Fifty mistakes with bar stock might not cost as much as one mistake with an exotic metal. For this reason the defect rate data was hard to analyze. Company management simply told us that the analysis of the defect rate data would not make sense to the "lay person".

Lacking any hard data, we therefore decided to hold focus groups to assess the impact of worker participation in our class to worker performance on the job. Separate focus groups

were held. One with workers. One with supervisors and management. Summaries of the three perspectives follow.

Supervisor's perspective

Supervisors interviewed after the mini-courses ended reported similar information. One supervisor who was very active in the planning, implementation, and evaluation of the course reported that the biggest gain was the increased ability of workers to correctly match blueprints to parts even when the print involves work done by other workers. He said workers were better able to check their own work. He noted that workers now checked with quality control people and supervisors in order to validate their own conclusions whereas prior to instruction workers left all inspection related duties to quality control and floor supervisors. He also noted increased self-esteem among the workers. This was demonstrated in their increased contribution to the plant's quality improvement teams. After participating in WIN mini-courses, workers were more vocal about questioning management decisions concerning the manufacturing process. Specifically, workers now made suggestions on how to streamline the company's manufacturing plan in order to reduce cost.

A supervisor from another plant offered the following when asked about the impact of the WIN mini-courses: "I don't have to hold their hand anymore. The workers are more confident with bore gauges, other measurement tools, blueprints, and the fraction/decimal conversion chart. They don't ask me to double-check their work all the time and the scrap rate hasn't gone up so they must be doing it right." This supervisor also provides some interesting anecdotal evidence about the spin-off effect of our workplace education program. He has received post-secondary training in both engineering and ergonomics. At the same time, he has always experienced great difficulty with the reading process. On his own initiative, he went to the adult education project at the public library and requested a tutor to help him with his reading. He now regularly meets with his tutor in the evenings.

Management's perspective

In the development of the two Math for Manufacturers mini-courses, WIN enjoyed significant input from management. Management representatives were instrumental in recruiting workers, coordinating class schedules, and informing us as to the content of each mini-course. Due to the small size of the manufacturing plants, management was fully aware of class activities and were in a position to make observations about the results of the mini-courses. In general, the management view collaborates the perspectives outlined above. Specifically, the Personnel Director at one plant felt that the workers were excited by the class. She noted that there had been what she termed a "GED spin-off." Apparently, participation in the class had stimulated four or five workers to enroll in GED classes on their own time. Finally, she noted that the data in all the production and assembly line efficiency reports which workers must fill out daily had far fewer mathematical errors than prior to WIN instruction.

Management representatives at another very small plant said that they noticed very specific changes in the performance of individual employees. A typical comment was as follows. "I noticed that David is more confident with the measurement tools. First, it was the bore gauge and now I see it with all of them." The plant manager noted that the class freed up the time of the manufacturing supervisor to "...do more important things like fixing machines." This same manger also made the clearest, most concise, statement concerning the relationship between WIN mini-courses and increased productivity. He said, "The classes helped us take a step toward one of our total quality management goals- inspection at the source. It helps us to move inspection from the point of finished goods to the point of manufacturing."

In the end, this focus group approach proved extremely useful for gathering productivity data from the perspective of the workers, the supervisors, and the management of those manufacturers involved. While it does not provide hard data, it was informative from the evaluator's perspective to see that all who were involved were satisfied.

We would, therefore, recommend a careful screening procedure and a variety of job-specific literacy measures. Specifically, if a measure of general literacy is desired, we would recommend using the *Adult Placement Indicator* to screen students into the most appropriate level of instruction, to inform both workers and instructors about general literacy performance, and to document transfer of workplace literacy performance to general literacy performance for the evaluator. We would recommend using our math tests or similar ones for measuring workplace related math literacy skills. We would recommend using focus groups to gather informed opinions about the quality of instruction and its impact on productivity. Finally, we would recommend monitoring attendance to confirm whether the WIN Instructional Model will reduce attrition in other job settings.

Conclusions

The final responsibility of any workforce literacy effort is determining whether the needs of all concerned parties have been met and then communicating this to each stakeholder. As you may know, one of the complicated aspects of workforce education is the number of stakeholders who may be involved. In our case, we had eight separate stakeholders for each mini-course: SWT, the WIN program staff, the USDOE, an outside evaluator, each of the workers, each of the manufacturing businesses, the two Chambers of Commerce, and the workforce literacy field at large. In order to clarify these priorities, we solicited an outside consultant. This proved to be extremely fruitful as we discovered that a grid showing "WHO wants WHAT MEASURE for WHAT PURPOSE" was not only simple, but useful for our formative evaluation and our summative evaluation.

Following this suggestion, we chose to satisfy these stakeholders on two levels. On a long-term level, SWT, the USDOE, an outside evaluator, the two Chambers of Commerce, and the workforce literacy field at large will receive this document to inform them in future decisions about workforce literacy implementation for small businesses. On a more immediate level, the WIN staff and the workers received the information to meet their needs for refining the curriculum and the instruction. Moreover, on an immediate basis, the manufacturing businesses received attendance data to maintain their payroll records. Learner gain data was also reported on an immediate basis to the manufacturing businesses. However, we reported it anonymously or in the aggregate. We found it vital to make sure that needed feedback was given to and received from each stakeholder at this immediate level and that this communication was fostered so that future mini-courses can be developed.

In the end, we determined five questions should be answered by this WIN demonstration project. These questions and the answers also document the success of this project.

Did we reach our service goals?

Our project as a whole served 232 workers in four job families from 33 separate small businesses. In this Manufacturing Job Family y specifically, we offered six iterations of two mini-course to 77 workers. Of those 77 workers, 68 successfully completed the mini-course for an average retention rate of 88.3%, significantly above traditional adult literacy retention rates of 50-75% (Chisman, 1990). Our attendance in this mini-course was an equivalent of 89%.

Was instruction successful?

The holistic, participatory nature of our instruction proved successful from both qualitative and quantitative perspectives. We were able to pilot quantitative and qualitative general and workplace specific literacy measures and assess the effectiveness of each. We were able to develop informal measures of workplace literacy from the workers', the instructor's, and the evaluator's perspectives. We were able to develop a consensus about the relationship between WIN instruction and plant productivity.

We piloted the use of two WIN developed measures of workplace literacy math skills. Performance for the Math I mini-course averaged 41.2% for the pretest and averaged 60.5% for the posttest marking an 19.3% gain. Performance for the Math II mini-course averaged 57.4% for the pretest and 84.4% for the posttest marking a 27.0% gain. These data suggested that the instruction was successful for the workers in both mini-courses.

Perhaps more importantly, performance reports from the focus groups indicated that workers found greater self-confidence in workplace skills and increased literacy skills by participating in the mini-course. Supervisors confirmed workers' ability to participate in workplace tasks with greater independence. Workers, supervisors, and management connected this independence with improved productivity.

Did the mini-courses continue beyond the granting period?

The 18-month life of this grant was not long enough to deal with the whole of the community need for workforce education. WIN Advisory Council meetings and discussions with former and current workers indicate a continuing need for the types of literacy instruction covered in the mini-courses offered for this Manufacturing Job Family.

Under what conditions is this project replicable?

WIN's Instructional Model has demonstrated its flexibility and replicability by being used in eight different mini-courses across four job families: Custodial, Child Care, Manufacturing, and Equipment Operators. Within the Manufacturing Job Family, the model was used for two mini-courses. These mini-courses were taught by three different instructors to test out the transferability to instructors and to workers from a number of workplaces. The holistic, participatory nature of our instructional model should be replicable to a number of sites outside the San Marcos area. The applicability of our specific lesson plans (see Appendix A), however, will depend to what degree your workers, business climate, and other resources match our programs.

How was the project disseminated ?

The WIN demonstration project has produced several tangible end products. This guide contains a narrative of our process for developing mini-courses for Manufacturing Job Family workers, course outlines and lesson plans, sample administrative forms, original qualitative and quantitative assessment instruments and accompanying user's information, student publications, and a selected bibliography. Similar guides exist for mini-courses for the Equipment Operators, Child Care, and Custodial Job Families. The mini-courses for the Equipment Operators Job Family focus on passing job-related certification examinations. The mini-courses for Child Care Job Family teach strategies for accessing print resources to solve job-related problems as well as writing to apply for certification. The mini-courses for the Custodial Job Family teach strategies for accessing print resources to solve job-related problems as well as writing for clerical job tasks. Within each guide, program implementation strategies from both an administrative and an instructional viewpoint are also provided.

There are several important reasons for a thorough dissemination of this project's results, and several different strategies are required to accomplish such a dissemination. One need

was to create good public relations for the project and its partners. To do this we have been in contact with various state and local news agencies. This is a successful literacy program that needs to be part of the community consciousness. We would recommend you promote your workforce literacy program to solicit future endeavors.

Next, we wished to benefit and strengthen the newly emerging field of workforce education. For this, we needed to produce publications for a professional audience and make presentations at relevant conferences. This audience of experts helped us through peer review to refine our own program. The qualitative assessment instruments were introduced at a workforce literacy conference in Dallas, and the WIN Instructional Model was presented at the national COABE conference in Bismarck, ND, at the annual national meeting of the National Association of Developmental Education in San Antonio, TX, and at the annual meeting of the College Reading and Learning Association in San Francisco.

Next, and perhaps most importantly, this material should be used in a continuing effort to educate the business community about the need for workforce education and the resources which are available to meet that need. In order to do this, we have disseminated this curriculum guide to the business trade journals and national workforce literacy organizations. We must cultivate an understanding of business needs and develop a presence within business-oriented organizations. This will help us create the true business-education partnership needed to guarantee this country's economic future.

Summary

Our project demonstrates that a holistic, participatory, process-oriented workforce education program created in partnership with a small-business community within a small city can meet the needs of both employees and employers in overcoming the *skills gap* currently existing in business and industry in this country. Furthermore, we assert that the participatory approach is essential in developing those Information Age skills like problem-solving, teamwork ability, and communication skills. In addition, the process-oriented rather than content-oriented nature of our instructional approach will support the growth of workers who must be flexible enough to cope with a constantly changing work environment by transferring their learning skills to each new situation which calls on them to master a new machine, work comfortably with a new process, or make a positive contribution as part of a restructured organization.

Appendices

Appendix A: Sample Course Outlines and Lesson Plans

Apendix B: Registrtion and Evaluation Forms

Selected Bibliography

Workforce Skills

Background Theory

Practitioner Resources

APPENDIX A

SAMPLE COURSE OUTLINES AND LESSON PLANS

Reading Charts, Rulers, and Gauges
Course Outline

Week One

Monday, 9/23	Reading Charts
Wednesday, 9/25	Reading Rulers

Week Two

Monday, 9/30	Reading Gauges
Wednesday, 10/2	Reading Micrometers

Week Three

Monday, 10/7	Understanding Decimal Place Values
Wednesday, 10/9	More Pesky Place Values

Week Four

Monday, 10/14	Rounding and Comparing Decimals
Wednesday, 10/16	Using Proportions

Week Five

Monday, 10/21	More Proportions
Wednesday, 10/23	Even More Proportions!

Week Six

Monday, 10/28	Review
Wednesday, 10/30	Post-Test and Party!

Reading Gauges

Initiating Event

Review past homework

Discussion: What do you already know about reading gauges?

- Examples
- Uses
- Procedures
- Problems

Large Group Discussion and Modelling

Reading Gauges is like reading ruler

- Special division of whole into parts
- Different way of showing measurement
- Circle vs. line

Clock is common kind of gauge

- overhead of various clock times -- make sure all can read clock
- Elicit how much time between numbers; link to divisions in ruler and other gauges
- Come up w/steps for reading clock
  - Estimate range of final outcome -- approximate hour
  - Read hour (whole number) and record
  - How many divisions between numbers? Each number worth 5 minutes.
  - Count number of parts used in that division and record. (Multiply small division by 5 to get minutes.)

Small group Practice

Apply same steps to reading gauges

- Review group roles and assign
- Solve group handout
- Report any confusions back to large group

Large group

Review and clarify areas of confusion. Detail process used to resolve/clarify problems. (In other words, think out loud.)

What do you know now about reading gauges?

Independent Practice

Worksheet with transfer questions (attached)

INDEPENDENT PRACTICE #3

Try to find an example of using a gauge at home and at work. Write down what you were trying to find out when you used the gauge at each place.

Write down the steps you used to figure out what you want to know.

Write another real-life question that someone else could answer using a gauge.

Reading Micrometers

Initiating Event

Review past homework

What do you already know about reading micrometers?

- Examples
- Uses
- Procedures
- Problems

Large Group Discussion and Modelling

Micrometer is special kind of measuring tool, like ruler and gauge

- Special division of whole into parts
- Different way of showing measurement
- Circle and line

Elicit steps of reading measuring tools

- Estimate range of final outcome -- whole numbers, halves, thousandths
- Read whole number and record
- How many divisions between numbers? Ten, tenths, etc.
- Count number of parts used in that division and record
- Repeat for each smaller division

+ Explore physical micrometer

- Have you seen it before? Where? What's it used for?
- What is largest number? Is there whole number reading? Why?
- How many divisions between large numbers? What is that called? Practice setting different numbers?
- Repeat for each smaller division. Point out where marker is to determine reading.

Small group Practice

Apply same steps to reading micrometers

- Review group roles and assign
- Solve group handout
- Report any confusions back to large group

Large group discussion

Review and clarify areas of confusion. Detail process used to resolve/clarify problems. (In other words, think out loud.)

What do you know now about reading micrometers?

Independent Practice

Worksheet with transfer questions

Manufacturing Math 1
Course Outline

Week 1
- registration and introduction
- pretests
- writing sample and Individual Education Plan
- expectations and concerns

Week 2
- adding whole numbers and decimals
- subtracting whole numbers and decmals

Week 3
- multiplying whole numbers
- multiplying decimals
- long division, whole numbers

Week 4
- dividing by decimals
- review four basic operations
- review/practice independent practice questions
- goal review

Week 5
- place value
- naming decimals
- ordering decimals, smallest-largest
- concept of fractions
- decimal-fraction conversion
- fraction-decimal conversion
- reading fraction-decimal conversion chart
- mixed numbers- improper fractions conversions
- equivalent fractions
- ordering fractions

Week 6
- reading rulers
- reading gauges
- reading dial calipers

Week 7
- reading micrometers
- reading vernier calipers
- reading bar micrometers
- reading depth micrometers
- reading telescope micrometers

Week 8
- reading blueprints part 1
    - types of drawings
    - parts of a blueprint
    - alphabet of lines
    - symbols of materials

Week 9
- reading blueprints part 2
- dimensioning
- tolerancing
- geometric characteristics - brief intro.
- datum reference - brief intro
- surface texture scale - brief intro

Week 10

- post tests
- review portfolio
- fill out participant observation forms
- discuss future plans for GED practice tests
- graduation celebration

Lesson 16--The Blue Print System

Focus (15 minutes)

Briefly review last class topic
Any questions or problems about last class?
Any comments--Whaaaaatt...I don't hear anything?

Engage Prior Knowledge (10 minutes)

What kind of examples can you think of when you have come across different types of drawings--drawing used for different functions? Name some. If no one responds----

Use a few examples like production drawings, detail drawings, and assemble drawings (remember spending most of Christmas Eve night putting together toys for the kids!)

Write down responses as they occur. Map if possible, showing organization. Use these examples when modeling

Large Group Discussion--Types of Blue Prints (20 minutes)

Production prints
Tool prints
Detail prints
Assembly prints
Installation prints

Engage Prior Knowledge--Parts of a Blue Print (10 minutes)

Think about the kinds of information you find on a drawing
Write responses on board as they occur
Map to show typical location and organization of drawing

Large Group Discussion (30 minutes)

Pass out hand-out #12 showing parts of blueprint
Explain each of the following parts, drawing on worker responses on board

- title block--what types of information are included here?
- list of material
- note area
- revision block
- picture (drawing) area

Pass out drawing for students to use for the next few classes

Small Group Practice (15 minutes)

Ask students to locate and label the following parts of their drawings

- title block
- note area
- revision block
- picture area
- scale date of drawing
- who checked drawing
- drawing number
- manufacturer
- tolerance

Swap prints and check each other's papers
Discuss differences of opinion, confusions, other problems
Report back to whole class-reach consensus

Independent Practice (20 minutes)
Independent practice sheet #12
Pass out study guide on lines
discuss if time allows
look study guide over for next class

Lesson 17--Alphabet of Lines

Focus (5 Minutes)
Briefly review last class's topic
Ask for feedback--question, problems, comments?--cool!

Engage Prior Knowledge--Standard Line Forms (10 minutes)
What examples of different kinds of lines can you think of when you read a blueprint.
The names are as not important as discussing what information they tell us (function)
Write responses on the board as they occur

Model/Large Group Discussion--Alphabet of Lines and Section Symbols (20 minutes)
Explain and discuss each line symbol on study guides
Discuss each metal section symbol on study guide

Small Group Practice (10 minutes)
Pass out new drawing showing line types and section symbols
Ask learners to label as many lines and sectional symbols as they individually can
Work with other members of group to label lines and symbols they are not sure of
Now compare answers and discuss differences of opinion, confusion problems
Report back to large group--reach consensus

Individual Practice (20 minutes)
Ask learners to find and label the following lines on their large drawings from last class

- center line
- object line
- border line
- leader line
- extension line
- dimension line
- ID dimension
- OD dimension
- O.S. radius
- section detail (steel)

Engage Prior Knowledge on Dimensioning and Tolerancing (10 minutes)
What kind of dimension and tolerance examples can you think of when you read plans?
Write responses on board as they occur.

Modeling/Large Group Discussion (20 minutes)
Nature of dimensioning

- rules
- types

Nature of tolerancing

- definition
- rules
- types

Small Group Practice (10 minutes)
Pass out hub drawing
Have workers locate and label dimensions and tolerance of each division indicated on drawing
Work with other group members on difficult or confusing items

Compare answers and discuss differences of opinions and areas of confusion on problems
Report back to large groups--reach consensus
Have learners locate and label the following dimensions and tolerances on their large drawings from last class

- OD Diameter
- ID Diameter
- max OD
- width of groove
- distance between top of seat and top of groove
- height of beveled area above groove
- depth of notch
- thickness of seat

Individual Practice (15 min)
Independent Practice #13

Lesson 18--Geometric Characters and Datums

Focus (10 minutes)
Briefly review dimensioning and tolerancing
Ask for feedback--any questions? problems? comments?
Make sure class members understand the basic principles of dimensioning and tolerancing

Engage Prior Knowledge--Geometric Characters and Datum (5 minutes)
What kinds of examples of geometric characteristics and datum can you think of when reading blueprints
The symbols are important--in order to interpret and understand the blueprint
Write responses on the board as they occur

Model/Large Group Discussion--Geometric Characteristics & Datum (20 minutes)
Geometric Characteristics
- distribute study guide

Explain and discuss definitions of geometric characteristics and associated symbols
- location
- orientation
- run out

Datum
- distribute study guides
- definition
+ parts of datum
  - geometric characteristi , symbols
  - tolerance values
  - datum ID

Small Group Practice (10 minutes)
Locate and integrate datum
- on "seat" drawing

Discuss meaning in groups and reach consensus
Report back to large group

Individual Practice (20 minutes)
Distribute "Hub drawings"
Locate and interpret 8 datums shown
Work with other group members if help is needed

Model/Large Group Discussion--Surface Texture and Symbols (10 minutes)
Distribute study guide
Explain and discuss meanings of symbols
- micro-finish
- natural removal

Small Group Practice (10 minutes)
Locate and explain surface texture symbols on "Seat" drawing
Report back to large group--reach consensus

Model/Large Group Discussion--Time required to machine parts (10 minutes)
Determining factors

- size of surface to be machined
- machines cutting surface size
- depth of cut
+ smoothness (finish) of surface required
    - cut 80% with rough blade
    - then cut 20% with fine blade
- number of parts to be machined
- minutes per part. (Remember to divide by 60 to convert from minutes to hours.)

Small Group Practice (10 minutes)
Distribute handouts
Model 1st example of run quantity
Assign workers to individually figure 3 additional runs
Get help fro group members if needed--reach consensus
Report back to whole class

Individual Practice (15 min)
Independent Practice #14

COURSE OUTLINE
MANUFACTURERS' MATH 2

Week One

Introductions
Registration
Pre-testing

Weeks Two and Six
BLUEPRINT READING

A. Large Group - Blueprint #1
   1. Ask learners what they see on the blueprint.
   2. Classify responses into three groups:
      a. most know it;
      b. some know it, or know something about it (need to review);
      c. most don't know it.
   3. Make list and map student responses on flip-chart; groupesponses according to:
      a. geometric symbols,
      b. dimensions,
      c. line types,
      d. part features eg. radius & chamfer,
      e. parts of the blueprint,
      f. drawing types.

B. Small Group - Blueprint #2
   1. Make a list of items and symbols that the group members see on their blueprint.
   2. Organize the list into groups based on learner familiarity:
      a. items that are known;
      b. items that are a little fuzzy - need to be reviewed;
      c. items that are unknown.

C. Independent Practice - Blueprint #3
   1. Make a list of items and symbols that the worker sees on his/her blueprint.
   2. Organize the list into groups based on learner familiarity:
      a. items that are known;
      b. items that are a little fuzzy - need to be reviewed;
      c. items that are unknown.

Weeks Two and Six
LEARNING STRATEGIES

A. Large Group
   1. Generate list of learning strategies:
      a. Ask people;
      b. Use references;
      c. Use your own skills.
   2. Engage prior knowledge - Ask learners to share strategies that have worker for them in the past.
   3. Demonstrate use of reference materials:
      a. do a think aloud;
      b. model how to use the table of contents and index;
      c. model using a glossary and reading a chart;
      d. explain and model skim & scanning reading to find specific informatiom.

4. Find the meaning of a specific symbol on blueprint #1 by myself using the think aloud procedure.
    a. Look up two more symbols using progressively more learner input.
    b. Ask a learner to find the meaning of a symbol by himself.

B. Small Group
1. Find information on blueprint #2 using learning strategies generated in the large group.
2. Ask the group members to share (discuss metacognative procedures) how they found the answers.

C. Independent Preactice
1. Individually find answers to questions on blueprint #3 using learning strategies developed in large group.

Weeks Three-Four and Seven-Eight
MATHEMATICAL CALCULATIONS

A. Large Group
1. Ask learners to list the types of math calculations that can be made based on this blueprint.
2. Classify responses into three groups:
    a. most know,
    b. some know,
    c. most don't know.
3. Make list and map learner responses on flip-chart grouped according to:
    a. find dimensions not given,
    b. math operations using decimals,
    c. math operations using fractions,
    d. converting decimals to fractions,
    e. converting fractions to decimals,
    f. solve calculations involving tapors, circles and tolerancing.
4. Model math operations:
    a. Use think aloud to work through an example taken from blueprint #1;
    b. List the steps used to work through the operation;
    c. Work through other examples using progressively more class input;
    d. Ask a learner to work through a problem independently;
    e. Use a functional book as reference for various operations and as a source for further independent practice.

B. Small Group Practice
1. Use the possible operations on blueprint #2.
    a. facilitate group interaction,
    b. encourage talk aloud about metacognative procedures;
    c. write down procedural steps to solve calculations.

C. Independent Practice
1. Use the operations discussed in the large group to solve calculations on blueprint #3.
2. Write down math work and steps used to solve calculations.

Weeks Five and Nine
MEASURING TOOLS

A. Large group
1. Ask students to list the measuring tools necessary to check the dimensions of this part.
2. List and map student responses on the flip-chart according to:
3. Classify the responses into three groups:
    a. tools they know how to use;

b. tools they need to review;
c. tools they don't know how to use.

4. Teacher models the use of each tool:
   a. OD micrometer,
   b. Fowler micrometer,
   c. Dail gauge,
   d. Protractor,
   e. Feed and speed calculator.
5. Write the steps to use each tool after it is modeled.
6. Check workers' ability on tools:
   a. Ask for the procedural steps;
   b. Have learners demonstrate tool using skills.

B. Small Group Practice

1. Each group member measurs different parts using the proper tool as folows:
   a. the first worker uses the tool;
   b. the second member verbalizes the steps;
   c. the third writes the steps down;
   d. the fourth raises questions and comments for group discussion
2. The group members rotate places so that each gets a chance to play a different role.
3. Measurements and procedures are compared and discussed.

C. Independent Practice

1. Individually practice measuring parts with each type of tool.
2. Write down the steps to measure part with each tool.
3. Have co-worker measure the same part.
4. Compare measurements and discuss differences if any.

Week Ten

Post-Test
Participant Observation Forms
Graduation Party

MANUFACTURING MATH 2
COURSE CONTENT

A. Brainstorming Rules - Expectations & Concerns
B. Blue Print Reading
    1. Introduction
    2. Visualizing Drawings - Types of Views
    3. Parts of a Drawing
    4. The Alphabet of Lines
    5. Section Lining Symbols
    6. Rules of dimensioning & Tolerancing
    7. Geometric Characteristic Symbols
    8. Datums
    9. Surface Texture Symbols
C. Learning Strategies - Machinists' Ready Reference Book Organization
D. Geometric Features (in second set of prints, weeks 5-9)
    1. Radius (arc)
    2. Chamfer (bevel)
    3. Bore & Tap
    4. Flange
    5. Taper
    6. Diameter
    7. Threads
    8. Angle (degrees)
    9. Bolt Circle (circumference)
E. Mathematics
    1. Decimals
    2. Fractions
    3. Formulas
        a. Geometric
        b. Trigonometric
        c. Cutting Time
F. Measuring Tools
    1. O.D. Micrometer
    2. Fowler Micrometer
    3. Dial Caliper
    4. Protractor
    5. Feed & Speed Calculator
    6. Gauge Blocks
    7. Bore Gauge & Super Micrometer
    8. Telescope Gauge & depth micrometer
    9. Vernier Caliper

WEEK 2 - INTRODUCTION TO LEARNING STATEGIES

FOCUS - ENGAGE PRIOR LEARNING (10 MINUTES)

A. Review print #1 study topics on flip chart.

MODELING AND LARGE GROUP DISCUSSION (50 MINUTES)

A. Generate list of learning strategies (draw on workers prior knowledge):
   1. Ask People:
      a) ask supervisor,
      b) ask co-worker,
      c) ask engineer/draftsman,
      d) ask teacher,
      e) ask inspector.
   2. Use References:
      a) use charts and tables:
         1) abbreviations,
         2) fraction/decimal conversions,
      b) use Machinist Ready Reference Manual,
      c) use feed and speed calculator,
      d) use dictionary / glossary,
      e) use operator's manual,
      f) use tolerance and dimension book.
   3. Use Your Own Skills:
      a) observe co-workers,
      b) experiment cautiously (30 minutes - maximum),
      c) double check data using alternate methods,
      d) use math skills with or without calculator,
      e) use logical (common sense) problem-solving/trouble-shooting method of finding information (4 steps):
         1) What is the problem?
            State the problem as clearly as possible.
         2) What different ways can I think of to handle it?
            Create several solutions and think about the advantages and disadvantages of each.
         3) Which one should I try first?
            Choose one solution and try it.
         4) Did it work?
            Figure out what worked and what did not work about the solution - if there is still a problem, go back to step one.
      f) take notes to aid memory,
      g) improvise - modify stategy to use in new situation.eg. Clint Eastwood in Heart Break Hill; protractor to measure angle of taper.
      h) combinations of the above strategies.

B. Teacher models strategy for using references in front of class.
   1. Do a think aloud using Machinist Ready Reference Manual:
      a) use index,
      b) use table of contents,
      c) scanning,
      d) reading charts.
   2. Look up more items using progressively more student input;
   3. Ask student to look up term independently;

C. Ask a student who knows item to teach it to the class.
1. pretend he/she is a supervisor;
2. plan how to approach and ask question;
3. keep asking questions until you get a clear answer;
4. practice roll-playing.

SMALL GROUP PRACTICE (30 MINUTES)

A. Find and share answers to list of items that need to be learned from print #2.

INDEPENDENT PRACTICE (30 MINUTES)

A. Work on independent practice sheet #2 - blueprint #3.

WEEK 3 - LIST MATH CALCULATIONS

LARGE GROUP DISCUSSION/BRAINSTORMING (60 MINUTES)

A. List all of the kinds of mathematical calculations you can make based on blueprint #1 or the tools & machines you would use to manufacture this part. For example:

1. Convert tolerance from Limit Dimensioning to + Toleranceing & vice versa (also find the total allowable amount of tolerance):
   a) depth of flange,
   b) i.d. diameter,
   c) o.d. diameter,
   d) o.d. diameter at taper.
2. Find dimensions of features not given on print:
   a) depth of shaft,
   b) shaft wall thickness,
   c) width of flange (offset),
   d) distance of bolt holes from edge of flange.
3. Operations with decimals:
   a) addition - overall size of part,
   b) subtraction - find a dimension not given,
   c) multiplication - find proportion of small OD at chamfer,
   d) division - find proportion of small OD at chamfer
4. Calculate the degree of angle at chamfer.
5. How to locate tap holes mathematically.
6. Figure the scale of this drawing.
7. How to figure .01 radius.
8. Tap size equivalency in decimal figure.

B. Make a list / map organization of learners responces on flip chart.

C. Ask workers to respond to how well they know the calculations listed.

D. Color code the list of various calculations as follows:

1. almost all know it;
2. Some know it & some don't, or it's sorta fuzzy need to review it;
3. Almost all don't know it.

E. Ask workers to plan where they want to begin.

SMALL GROUP PRACTICE (30 MINUTES)

A. Brainstorm/list all of the math calculations you can make based on blueprint #2.

B. Move chairs to facilitate group discussion if necessary.

INDEPENDENT PRACTICE (30 MINUTES)

A. List all of the kinds of math calculations you can make based on blueprint #3. Fill out Independent Practice Sheet#3A.

NAME_____

MANUFACTURING MATH 2
INDEPENDENT PRACTICE #1

Make a list of terms and symbols that you are learning about from your own blueprint #3. Place each item in one of the three columns below depending on how familiar you are with it.

ITEMS I KNOW & CAN TEACH OTHERS	ITEMS I NEED TO REVIEW	ITEMS I DON'T KNOW

NAME_____

MANUFACTURING MATH 2
INDEPENDENT PRACTICE #2

Make a list of symbols and terms that you are learning about from your own blueprint #3. Beside each symbol or term briefly explain it and write the learning strategy that you are using to find out what these things mean. If the item requires several steps to learn it, list those steps also. (For example, if you use your Machinists' Ready Reference Manual to look up a term or symbol, note that you first looked up the word in the index, which refered you to page---, then you scanned that page until you found the definition of the word which gave you a general understanding, finally you asked Juan, a co-worker, who used an example here in the shop which made the meaning real clear to you.) If you have to read a chart or table to find the information you are searching for, note which chart it is and where you found it. Use the back of this sheet if you run out of space. If you have any questions, please ask me. Goooooood Luck!

NAME_____

MANUFACTURING MATH 2
INDEPENDENT PRACTICE #5

Try to find an example of each of the 2 math operations (addition & subtraction) using decimal numbers from print #3. Write down what you are trying to find out when you list the math calculations. (For example, "I want to know the overall size of the part; I will find this by adding each dimension of the sections of the part together.")

Write down the steps for both operations that you use to figure out what you want to know. Show your math work, pretend you are teaching these steps to a new worker. Be as specific as possible.

Write down another real life question involving decimal numbers and one of the math operations that someone else could answer using blueprint #3.

APPENDIX B

REGISTRATION AND EVALUATION FORMS

WORKFORCE INSTRUCTIONAL NETWORK

STUDENT REGISTRATION FORM

1. Name: _____ Date: _____

2. Place of employment:_____ Class name: _____

3. Job Title:_____ Supervisor: _____

4. Equipment Operated:_____

5. Number of years/months employed at current workplace:_____

****

6. Highest level of schooling: grade____ High school diploma_____

GED diploma____ Years of college _____ College degree_____

Other education or training: _____

****

7. Number of children: _____ 8. Are you a single parent? yes no

9. Did you grow up in a Spanish speaking or bilingual household?_____

10. Do you speak Spanish in your home today? (circle one)

always sometimes almost never never

11. Do you speak Spanish in the workplace? (circle one)

everyday at least once or twice a week almost never never

****

(WIN staff use only)

Pre-Test:_____ Post-Test_____ Hadley_____

Referral: Where_____ Why _____

Concurrent Enrollment (WIN & Place of Referral) yes no

Other Indicators:_____

_____

_____

County/District No. _____ Site _____

Ten County ACE Co-op
Adult Education Record

Registration Date _____ Instructor _____

PERSONAL DATA

Last Name | First Name | M.I. | Social Security No.

Address | City | State | Zip Code

Home Phone | Work Phone | Sex | Age | Date of Birth

Ethnicity ( ) American Indian ( ) Asian ( ) Black ( ) Hispanic ( ) White

PROFILE (codes on reverse side)

Employment Status ( ) Residence ( ) Special ( )

PROGRAM PLACEMENT (definitions on reverse side)

ESL - Placement Test

1. ( ) 5. ( ) 9. ( ) 13. ( )
2. ( ) 6. ( ) 10. ( ) 14. ( )
3. ( ) 7. ( ) 11. ( ) 15. ( )
4. ( ) 8. ( ) 12. ( ) Total ( )

( ) I. Beginning
( ) II. Intermediate
( ) III. Advanced

ABE - Pre-Test

SCORE	LOCATION	DATE

( ) Beginning ( ) Intermediate

ADULT SECONDARY ED. (GED)

Subject Area	Score
Writing	
Social Studies	
Science	
Literature	
Math	

( ) GED

ACHIEVEMENTS

( ) Improved basic skills

Improved or obtained competencies in
( ) Government and Law
( ) Community Service
( ) Parenting
( ) Occupational Knowledge
( ) Health Care
( ) Consumer Economics

( ) Completed Level 1 or its equivalent
( ) Moved to a higher level
( ) Obtained high school diploma
( ) Passed all GED tests
( ) Entered another education or training program
( ) Received U.S. citizenship preparation instruction

( ) Improved English language skills
( ) Voted for the first time
( ) Got a job
( ) Got a better job or salary increase
( ) Removed from public assistance

REASON FOR SEPARATION

( ) Completed objectives
( ) Class ended
( ) Health problems
( ) Day care problems
( ) Transportation
( ) Family problems
( ) Location of class
( ) Lack of interest
( ) Conflict with schedule
( ) Took a job
( ) Changed address or left area
( ) Other known reasons
( ) Unknown reason

POST-TEST RESULTS

TEST _____

SUBJECT AREA	SCORE	LOCATION	DATE

GED

SUBJECT AREA	SCORE	LOCATION	DATE
Writing			
Social Studies			
Science			
Literature			
Math			

AT HOURS COMPLETED ( ) COMPLETION DATE ( )

Let's Get Started!

What is today's date?

_____

What is your name?

_____

What is your job title?

_____

Where do you work?

_____

Please take your time to answer the following questions. Be as honest and complete as you can. Use the back of this sheet or another piece of paper if you need more room. Your answers will help me know what and how to teach to meet your needs. Let's create a class together!

Why are you in this class?

_____

_____

_____

What are the two most important things you want to learn from this class?

_____

_____

_____

Do you think it is easy or hard to learn new things? What makes you think that?

_____

_____

_____

What are your plans when you finish this class? Do you think you'll do your job any differently? Will you take other classes? Do you hope to get a promotion or different job?

_____

_____

_____

Workforce Instructional Network

Individualized Education Plan

for

_____

Date_____

Education/Learning Goals (both at work and home--now and in the future)

_____ _____

_____

Pre-test Results

Areas I can teach others_____

Areas I can review_____

Areas I can study_____

Student Comments

Additional areas I'd like to teach others

_____

Additional areas I'd like to review or study (for home or work)

_____ _____

Instructor Comments

Additional areas you could teach

_____

Additional areas you might like to review

_____

Student Placement (Present and Projected)

Enrolled in WIN course (titles and dates)

_____

Referred to other programs (specify)

_____

WIN Formative Evaluation Form

1) The best thing about class this week was

2) Pick one sentence to complete:
This week, I learned

That was important because

This week, I didn't really learn anything important. Next week, what needs to happen so I can learn something useful is

3) The one thing I would like to change about class this week is

4) Other comments, gripes, suggestions, questions, etc.?

PRACTICE TIME OUT OF CLASS

Name _____ Date _____

Thank you for participating in WIN classes. We hope you're finding this class both enjoyable and useful.

As you know, we at WIN are very interested in how useful this class is to you right now. We'd like to know how often you can use the material and strategies we've discussed here *outside* of class. We'd appreciate it if you could use the form below to jot down any instances outside of class where you've used what we've discussed together.

Some examples might be time you've spent reading your textbook or doing individual practice assignments. Other examples are using new math or reading skills to solve a problem at work, or using new strategies to help your kids with their homework. Maybe something we talked about in class encouraged you to go to the library or drag open a book you hadn't read before. For however you've used ideas from this class at home or work, please jot down the **amount** of time you spent and a **short description** of what you did. One entry might look like this:

Monday 30 minutes doing practice sheet
15 minutes reading library book

Day	Amount of Time	Description
Monday		
Tuesday		
Wednesday		
Thursday		
Friday		
Saturday		
Sunday		

WORKFORCE INSTRUCTIONAL NETWORK (WIN)

PARTICIPANT OBSERVATIONS

WIN is in the process of developing instruction for workers in various workplaces in San Marcos. Your comments about the class you have just completed will help us to better meet the educational goals of other workers and their employers. **Please be specific and honest in your answers. Thank you.**

1. When you enrolled in this class, what did you expect to learn?

2. What did you like best about the class?

3. What did you like least about the class?

4. What did you find most helpful?

5. What did you find least helpful?

6. Do you think that taking the class will help you in your job? How?

7. Do you think that taking the class will help you in your life outside of work? How?

8. How did you feel about the length of the course: too long, too short, about right? Why?

9. Do you have any suggestions on how to improve the class?

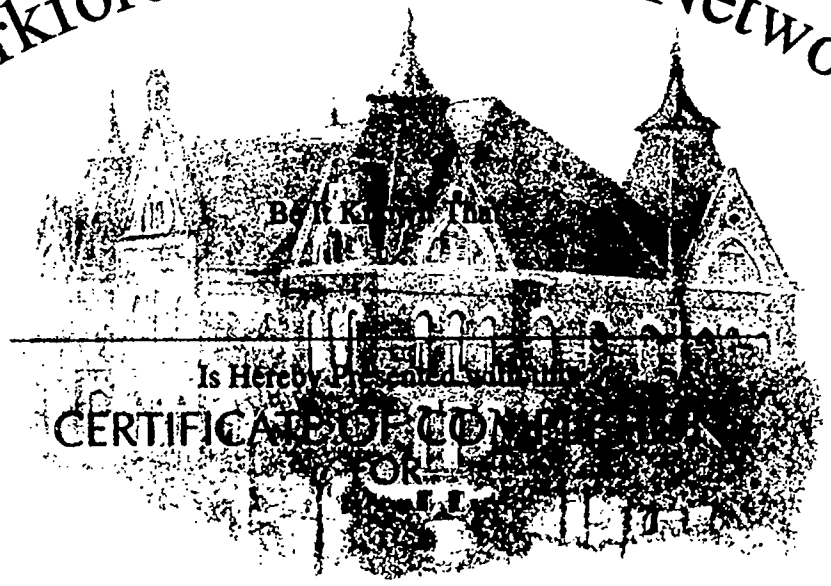
10. Are there other courses that you would like to see offered ?

11. Have you enrolled in another Adult Education program such as a GED class? Where?

12. What did you learn?

Thank you for your help! **See you in the Spring!**

Workforce Instructional Network



Dated this day _____

SOUTHWEST TEXAS STATE UNIVERSITY 1899

School of Education

Center for Initiatives in Education

90

_____

Project Director

91

_____

Instructor

Mathemetics for Manufacturers I Test

Test B **name:**

_____

date:

_____

Directions:

You can write your answers on the test or use the additional space or the back for computing your answer. If you have any questions, ask your instructor.

PART I:

1.) Circle the larger number.

a) .6678 or .67

b) 22.304 or 17.306

c) .26 or .167

2.) List the letters of these cans from heaviest to lightest.

Can A; .9462 kg Can D; 4.124 kg

Can B; .672 kg Can E; .6 kg

Can C; 2.35 kg

CANS _____ _____ _____ _____ _____

heaviest lightest

3.) Circle the larger fraction.

a.) $\frac{3}{8}$ or $\frac{1}{4}$

b) $\frac{3}{4}$ or $\frac{5}{8}$

c) $\frac{1}{8}$ or $\frac{1}{2}$

4.) Arrange the following pieces of cable from shortest to longest.

Cable A; 15 inches

Cable B; 3 feet

Cable C; 1 yard 7 inches

Cable D; 48 inches

Cable E; 1 yard 2 inches

CABLE _____ _____ _____ _____ _____
shortest longest

5.) Round 72.8361 to the nearest tenth of an inch. _____

6.) Round 3.34567 to the nearest thousandth of a meter. _____

7.) Juan inspects resistors at an electronics firm. He measures the resistance of each resistor and reports their resistance to the nearest tenth of an ohm. For each of the following numbers, what resistance should he report?

RESISTANCE	NEAREST TENTH
a.) 0.8372	_____
b.) 0.307	_____
c.) 0.2930	_____
d.) 0.3873	_____

PART II:

Use the mileage chart on the last page to answer questions 8 - 12.

8.) What is the mileage from Boston to Miami? _____
miles

9.) What is the mileage from Detroit to New York? _____
miles

10.) Find the mileage for a round trip between Seattle and Chicago. _____
miles

11.) How much farther is it from Houston to Detroit than from Houston to Chicago?

_____ miles

12.) What is the distance of a trip from Miami to Chicago to Detroit? _____
miles

The table on the last page gives output in amps for given lengths of cable and voltages. Use this table to answer questions 13, 14, and 15.

13.) At 224 volts what would be the amperage output for 30 feet of cable?

_____

14.) At 226 volts what would be the amperage output for 16 feet of cable?

_____

15.) At 222 volts what would be the amperage output for 12 feet of cable?

_____

PART IV:

16.) Solve this proportion $\frac{3}{24} = \frac{?}{8}$? = _____

17.) Company XYZ manufactures plastic molded boxes. To make 20 boxes, 25 pounds of carbon black is mixed with 5 ounces of petroleum distillate. An order is received for 185 boxes. How much carbon black and how much petroleum distillate must be used to fill this order?

carbon black _____ petroleum distillate _____

18.) An employee at Statana Inc. makes 366 parts in 3 hours. At the same rate how many parts will this person make in one 8 hour shifts?

_____

19.) Emilo puts 8% of his salary into a retirement plan. His company adds another 4% to his retirement. If his salary is $1500 per month, how much monthly contribution would be added into his retirement plan?

_____

20.) Until July of this year, Anna made $16,000 per year. Her raise in July was 5%. Her employer was also going to award her an additional 10% bonus in December for her good safety record. How much was Anna's bonus?

Math for Manufacturers II
Reading and Calculating with Blueprints

Name _____

Date _____

Employer _____

Measuring Tools

Measure the labeled parts with the tools at the table. Write your measurements on the lines below.

Dial caliper A1 (OD) _____ A2 (ID) _____

ID Micrometer B1 _____ B2 _____

OD Micrometer C1 _____ C2 _____

Protractor D1 _____ D2 _____

Using Reference Materials

1. On what page in the Machinist's Ready Reference book would you find information on converting fractions to decimals?

2. On what page in the Machinist's Ready Reference book would you find information on drilling speeds for high speed drills?

3. Use the Feed and Speed Calculator to find the removal rate when the surface speed is set at 320 feet per minute, the depth of cut is set at .120 inches, and the feed rate is set at .024 inches per revolution.

4. Use the Feed and Speed Calculator to find the cutting time for a part when the feed rate is set at .024 inches per revolution, the RPM is set at 90, and the length of cut is set at 60 inches.

Blueprint Reading and Calculating

Use the attached blueprints to answer the following questions.

PRINT 1

5. What is the wall thickness of the 5 1/8" diameter?

6. What is the difference between the larger bore and the largest outside diameter?

7. What is the difference between the smaller bolt circle diameter and the given outside diameter in the frontal drawing?

8. What is the difference between the two outside diameters on the smaller end of the drawing?

PRINT 2

9. What is the angle of the bevel in detail A?

10. What is the distance from the bottom of the groove to the bottom of the part?

11. What is the total amount of tolerance allowed for the vertical dimension of the groove?

12. What is the difference between the inside diameter and the maximum outside diameter, excluding the tolerance?

13. What inside radius is shown in detail A?

14. Put a G by the notes section, an H by the drawing number, and a K by the revision table.

15. Put a 1 and a 2 next to two different datums on the print. On the lines below, describe what 3 bits of information each datum provides.

1. _____

2. _____

Calculating Positive and Negative Numbers Along an Axis

The line below represents one axis on a machine. Use it to calculate the following problems.

-5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5

16. If the machine offset is already set at +1 and you need to bore to +5, how many units will you have to bore?

17. if the machine offset is already set at +1 and you need to bore to -2, how many units will you have to bore?

18. If the machine offset is already set at -2 and you need to bore to -5, how many units will you have to bore?

19. If the machine offset is already set at -2 and you need to bore to +5, how many units will you have to bore?

20. If the machine offset is already set at 0 and you need to bore to +5, how many units will you have to bore?

21. If the machine offset is already set at 0 and you need to bore to -3, how many units will you have to bore?

rev. 5/11/92

Behavioral Observation Scale

4 = every class session
3= once every 2-4 sessions
2= less than once every 2-4 sessions
1= never

_____ 1. Asks for clarification when prompted

_____ 2. Asks for clarification without prompting

_____ 3. Suggests solutions to own problems

_____ 4. Suggests solutions to group problems

_____ 5. Encourages other group members

WORKFORCE INSTRUCTIONAL NETWORK (WIN)

Supervisor Evaluation of Wire Plant employees enrolled in WIN classes

Employee Name _____ Date_____

Please rate each employee on a scale of 1- 10 for each category. An average worker would be rated 5. A top employee would be rated 8 or above. A bottom employee would be rated at 2 or below.

1. The employee is confident in his or her ability to perform his or her job.

1 2 3 4 5 6 7 8 9 10

2. The employee's supervisor is confident in the ability of the employee to do his or her job.

1 2 3 4 5 6 7 8 9 10

3. The employee is knowledgeable about and familiar with the operation procedures of the wire plant.

1 2 3 4 5 6 7 8 9 10

4. The employee can perform amperage testing competently and independently.

1 2 3 4 5 6 7 8 9 10

5. The employee is able to identify the different types of cable used in the wire plant.

1 2 3 4 5 6 7 8 9 10

6. The employee is familiar with the various cable options present in the wire plant.

1 2 3 4 5 6 7 8 9 10

7. The employee is able to respool wire and correctly adjust amperage readings.

1 2 3 4 5 6 7 8 9 10

8. The employee is able to measure circuits on different types of cable.

1 2 3 4 5 6 7 8 9 10

9. The employee is able to trace untagged or incorrectly tagged cable from sequence number to test sheet.

1 2 3 4 5 6 7 8 9 10

10. The supervisors have to go back and redo the employee's work.

very often **often** **seldom** **almost never** **never**

11. The employee is able to perform the High Voltage Potential (Hipot) operation.

yes **no**

12. The employee is able to check the resistance on TEK cable.

yes **no**

13. How many machines can the employee currently operate adequately?

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