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A Multi-Pronged Approach to Assessing Technical and Non-Technical Workforce Skills in a Two Year College

Dr. Bill D. Bailey, Southern Polytechnic State University

Bill Bailey is currently an assistant professor of industrial engineering technology and quality assurance at Southern Polytechnic State University. He holds a PhD in Technology Management (Quality Systems Specialization) from Indiana State University. He also holds a Master of Science in Industrial Technology degree from North Carolina A&T State University, and a Baccalaureate degree in Psychology and English. Dr. Bailey has extensive manufacturing experience, including lean implementation and training and development. He has developed programs and taught in a community college for several years. He has served as an examiner for several Baldrige based quality award processes, including The Malcolm Baldrige National Quality Award, and state awards in North Carolina and Georgia. His research and consulting interests include the improvement of organizational performance through quality initiatives such as the Malcolm Baldrige National Quality Award Process, Six Sigma, Lean, etc., and the application of these initiatives to education, manufacturing, services and healthcare.

A Multi-Pronged Approach to Assessing Technical and Non-Technical Workforce Skills in a Two year College

Abstract:
This case study will detail the use of rubrics and other assessment tools in a two year Tool, Die and Mold Making program. One outcome of this effort is a comprehensive assessment model that may be adapted and adopted by similar programs. As a result of research and industry feedback, a community college adopted four Workforce Skills to be integrated into all curricula, college wide. Multiple methods of measurement were identified for each workforce skill. The Workforce Skills identified were:

- Communication - Communicate effectively through speaking, listening, and writing.
- Critical Thinking - Use critical thinking to analyze and solve problems.
- Technical Skills - Demonstrate knowledge and competence in academic and technical fields of study.
- Teamwork - Demonstrate positive, effective, and appropriate interpersonal skills.

The integration of these Workforce Skills also resulted in a more comprehensive approach to assessment. This program requires multiple individual and team projects in the laboratory segment, and design projects for the classroom segment of courses within the major. Rubrics were developed for all individual and group projects. As part of the effort to integrate Workforce Skills, written plans, post-project analysis, and presentations were also required. The resulting plans, rubrics, and analysis may be used by students to construct a portfolio over their course of study, which demonstrates all of the Workforce and technical Skills. Student work was evaluated through self-assessment, peer assessment and instructor assessment.

For example: A skill list and corresponding scoring rubric was developed for each lab project. Using these tools, students would assess their own success on a project. The instructor would then perform an assessment. They would discuss the assessments, reach consensus, and agree on a plan moving forward. This approach provides the student with clear expectations, and real time feedback. It also serves to create a culture of continuous improvement. The resulting assessment information can be applied at many levels for continuous improvement. The student can demonstrate skill progression through the portfolio[4]. This information can be aggregated for analysis and improvement at the course and program level. The result is a multi-level model for assessment and improvement.

Background

The focus of this paper is the approach to assessment used in a Tool, Die and Mold Making program at a community college. The community college which is the focus of this study had offered a one year machining diploma for many years. A second year was added to complete an associate degree program in Tool, Die and Mold Making. The second year laboratory was located in a different, much newer facility than the original machining laboratory. The two year associate degree in Tool, Die and Mold Making was important to local industry, and therefore to the college. Even though the need for Tool, Die and Mold Makers was a critical one, the numbers were not large. Shortly after this program was implemented the largest employer of program graduates had significant cutbacks. This did not cause the enrollment numbers to shrink dramatically, but it did suggest that enrollment growth in this program would be limited. In order to best leverage available resources for the program, a complete redesign of the combinations of course offerings, the physical resources, and the human resources was undertaken. At the same time, there was a college wide effort to integrate more general Workforce Skills into technical programs. Together these two efforts, one to integrate Workforce Skills the other to improve efficiency and effectiveness of the program led to changes in the approach to assessment.

Workforce Skills

Accountability of educators and institutions has been a growing issue for several decades. One result has been the SCANS report[1], which defines skills that will be required for employability in the 21st century. This skill list has been modified and adopted by many institutions. The SCANS report of 2000 identified the following essential workforce skill areas; use of resources, acquiring and using information, interpersonal skills, understanding systems, selecting and using technology, basic skills, thinking skills, and personal qualities.

This report was the starting point for the definition of 21st Century Workforce Skills at a community college. A college team was assembled to review this report, assess its applicability to local employers and community college graduates, and advise on implementation. Local employers were interviewed to determine which of these Workforce Skills best fit and best served graduates of a 2 year technical program. The team recommended that four workforce skill categories, which integrate a number of the SCANS categories, be implemented college wide.

The Workforce Skills identified for integration, and acceptable methods of assessment are listed below.

1 Communicate effectively through speaking, listening, and writing.

These competencies will be measured by the ability to: Deliver clear, well-organized verbal presentations that are appropriate for purpose and audience.

a) Use comprehensive listening skills to evaluate messages and respond appropriately.

b) Demonstrate the ability to organize ideas, to write clearly and coherently, and to employ conventional mechanics, usage and grammar.

2 Use critical thinking to analyze and solve problems.

These competencies will be measured by the ability to:

a) Recognize the problem, review information about the problem, develop possible solutions and evaluate the results.
b) Apply mathematical reasoning and problem solving related to the discipline of study.

3 Demonstrate knowledge and competence in academic and technical fields of study.

These competencies will be measured by the ability to:

a) Use computers, printed materials and human resources to access and process information.
b) Read and comprehend materials related to the discipline of study.
c) Possess the necessary academic knowledge and technical skills for entry into employment and/or further study.

#4 Demonstrate positive, effective, and appropriate interpersonal skills.

These competencies will be measured by the ability to:

a) Demonstrate dependable, accountable, flexible behavior.
b) Work effectively and appropriately with others through collaboration and teamwork.
c) Choose ethical courses of action.
d) Demonstrate effective time management skills.

Although these Workforce Skills led to changes throughout the program, this paper will primarily address changes in assessment in the laboratory segment of major courses. Each major course in this program has a significant laboratory segment where students apply, develop and enhance their technical skills. The new assessment model, in addition to integrating Workforce Skills, takes a more deliberate and student centered approach to assessment and encourages self-directed learning[2,3].

The Model

The Assessment Model (figure 1) began with the desired technical skills and Workforce Skills. A complete list of technical skills was developed for the program, for each course, and for each project. Also a list of Workforce Skills demonstrations was developed at program, course and project levels. The model includes a comprehensive self-assessment of both technical and Workforce Skills at the beginning of the program, and again before the last semester. The comprehensive and project self-assessments empower students to manage their own learning with guidance from the instructor.

Laboratory Assessment

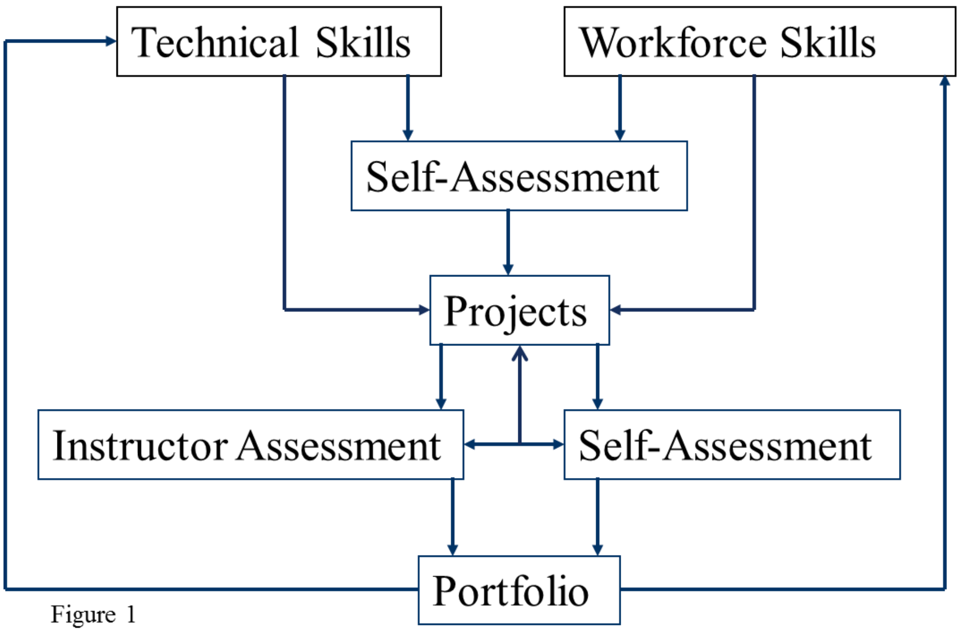

Figure 1

At the end of each individual project, students assessed their performance on both technical and Workforce Skills using inspection sheets, rubrics and other tools. This self-assessment included a reflective paper about the project; what went well, what might be improved, and lessons learned. After the self-assessment, the instructor also assessed student performance. A consensus meeting between the instructor and the student was held to discuss and reconcile any differences, and to plan the next activity. Documentation from this cycle could be accumulated in an optional employment portfolio[4].

Project planning and assessment documents

Each individual project and each team project required a detailed written plan. Highly skilled practitioners often create mental plans rather than written ones. For these courses written plans became required to reinforce both the planning and writing processes, and to facilitate problem solving early in the process. This process also reinforces several of the Workforce Skills. A generic planning form (Table 1) was used for all individual projects. Table 1 only shows four rows, but the form was expanded as needed. A typical individual project may have 15 - 25 steps identified. Team project planning was done at a slightly higher level of detail. The team project planning sheet is similar to the individual one, but instead of listing tools, materials, etc., and measurement, it has columns reflecting team assignments, interim due dates and completion dates.

Project Planning Sheet

Project Page of

#	Operation	Tools, Material, etc.	Measurement	Est. Hrs	Act Hrs

Table 1. Project Planning Sheet

When projects were complete students measured their own work, subject to random audits, using the inspection sheet (Table 2). As with the planning sheet, the form is expanded to meet the needs of the project. Every dimension on the product drawing was numbered, and a corresponding number was entered in the first column. The next four columns were filled out during the planning process. Results and accept / reject columns were filled out as they were inspected. Most inspection was completed as the project was made. Points were assigned to each dimension varying with the number of features in the project, with other points assigned for overall appearance. In order for a student to get full points on a feature, it must be within the middle 50% of the tolerance. Features that are in tolerance, but outside the middle 50% receive 90% of the possible points for that feature. Features that are out of tolerance by less than 100% of tolerance receive 80% of the points for that feature. Scoring progressively declines the farther out of tolerance the feature is. Using this system, students could generally calculate their own grade on a project.

Inspection Sheet **Page of**

Project Made by: Date

#	Feature Description	Dimension	Tolerance	Method of Measurement	Result	Accept/ Reject

Table 2. Inspection Sheet

Team projects were major projects that take the entire semester to plan and execute. These projects made up half of each student's final grade. Scoring was based on four factors.

Planning	10 possible points
Execution	30 possible points
Paper	5 possible points
Presentation	5 possible points
Total	50 possible points

In order to ensure fairness, and to reinforce and grade teamwork skills, students also completed a peer evaluation (Table 3). Individual grades may be adjusted upwards or downwards from the team grade based on the peer evaluation and the instructor's evaluation. The peer evaluation used a five point scale, and students rated themselves and their peers on the quality and quantity of their contributions using the rubric that follows the peer evaluation form.

Team Member	Quality	Quantity

Table 3. Peer Evaluation Form

1. Overall, how much did this person contribute to the QUALITY of your Group Project?
   - 5 – Outstanding, superlative, tremendous contributions that made the project truly outstanding
   - 4 - Above average, contributed truly outstanding work on a consistent basis
   - 3 – Average, contributed consistently on a regular basis and substantively furthered the project
   - 2 – Below average, contributed some to the project, but lacked consistency.
   - 1 – Ineffective, with only a minor impact on the project

2. Overall, how much did this person contribute in terms of QUANTITY of work for your Group Project?
   - 5 – Far above average, assumed much greater work load and responsibility than was typical in this group
   - 4 – Above average, contributed more work and assumed more responsibility than was typical in this group
   - 3 – Average, assumed fair share of workload, consistently met obligations and deadlines, helped others as needed, and took on some extra tasks
   - 2 – Below average, partially but not completely met obligations and deadlines, rarely took on extra tasks
   - 1 – Far below average, rarely fulfilled obligations, met few deadlines

Project Assessment, Consensus and Planning

Projects were both individual and team based. As noted, individual projects were self-assessed, and team projects included a peer evaluation. Skills lists and scoring rubrics were developed for each project in the major courses. Using the project scoring rubrics (inspection sheets), students were able to assess their own work on a given project. The student self-assessment was followed by an instructor assessment. The student and the instructor would then meet, discuss the assessments, and arrive at consensus. The culmination of the consensus meeting was a plan for the next project. If a student struggled with some of the technical skills in a project, they were assigned a different project that demanded similar skills. If a student performed well on a project, they would be assigned a project with a more demanding level of skills. Since many, but not all, students entered the program with some level of technical skills, this approach allowed for customization of the content, to ensure that each student made progress in their technical skills, regardless of their starting point. This approach provides the student with clear expectations, and real time feedback. It also serves to create a culture of continuous improvement. Although the purpose the model was to institute structured assessment, it also serves to reinforce the Workforce Skills, since all of the workforce skills are utilized in self-assessment.

Portfolio, course and program assessment

Although not required, students could collect documentation of both technical skills and Workforce Skills across courses, and throughout the program. This portfolio[4] can be used to demonstrate both the level and the progression of the student's skills. Content of the portfolio would include planning sheets, product drawings, inspection sheets, reflective papers, pictures and any other relevant documentation for both individual and team projects.

The information collected from the individual and instructor assessments can be aggregated. This aggregated information can then be compared to course and program objectives for assessment. Course assessment can be accomplished by reviewing the technical and Workforce Skills identified for a particular course and assessing how well students demonstrated these skills though the various assignments, projects and student portfolio[4] development. Assessment of the portfolios of graduating students against the program goals could be used to evaluate the effectiveness of the program.

Implementation and outcomes (phase 1)

The assessment model was implemented first in the second year of the Tool, Die and Mold Making curriculum. This was chosen as the starting point because it was the origin of the model, and much additional development was needed for first year courses. In year one of implementation, the model was used on all of the second year core courses for this curriculum. This pilot included most but not all of the elements in the model. Because the model calls for a comprehensive self-assessment on both technical and workforce skills at the beginning of the program, the comprehensive assessment for second year students was not yet in place. At the beginning of the semester, informal assessment of technical skills, done jointly by the student and the instructor was used to determine which individual projects to select.

At the end of each individual project, students performed a self assessment on both technical and workplace skills. This self assessment was performed using two methods. The first was the inspections sheet shown in Table 2. Using this document, students are able to evaluate their performance and estimate their grade. This also reinforces technical skills through the inspection process, and workplace skills two, three and four. Mathematical skills from workforce skill number two, technical skills from workforce skill number three, and choosing ethical courses of action from workforce skill number four are all required to complete this part of the assessment. The second method is a brief reflective paper focused on the just completed project. This paper requires the student to practice workforce skill number one, effective writing, and workforce skill number two, recognizing problems, analyzing problems and developing possible solutions.

The next step in the model is the instructor assessment, which includes a review of the self-assessment and discussion with the student to jointly determine the next project. This step also include checks such as an audit of the inspection sheet to ensure that the technical skills required for inspection are properly used, and to verify the students ethical choices.

These steps from the middle of the model were used for one year within the core courses for the second year of the curriculum. They were well received by students who responded informally that they appreciated the autonomy and self-directed nature of the process, while enjoying the security of having someone with more expertise verify that they were not going off track. It is this author's conclusion that this pilot was a success, and that it supports the model for use in laboratory situations of this type.

Implementation and outcomes (phase 2)

The second phase of implementation required the extension of these methods to the first year of the curriculum. This was complicated by other significant changes in the program. As a result of a separate instructor initiated improvement initiative, the laboratory facilities for the first and second year were combined, and scheduling of the laboratory sections was reconfigured for mixed groups and to give students more flexibility. This was viewed positively in terms of creating or enhancing the culture of self-directed learning[2,3]. However, it also required significant resources to move and reconfigure the laboratory space, and to reconfigure laboratory scheduling. The other major challenge in the second phase was the amount of work required to create all of the necessary documentation for the projects, including grading rubrics for each one. As a result of these challenges, phase 2 implementation did not include the whole model. As in phase 1, the emphasis was on the middle of the model. The broad initial self assessment was not yet developed or implemented, and the portfolio was still optional. However, feedback from students was positive. They cited many of the same advantages as the previous second year students, and also enjoyed more flexibility and a fresh laboratory space thanks to the other improvement initiative.

Implementation and outcomes (phase 3)

The third phase of implementation was to include initial self-assessment by students, and increased emphasis on the portfolio. As sometimes happens, external events got in the way. This project was begun during a time of significant change for the college. After 20 years under one president, a new president began the year before implementation began. At the end of phase one implementation the second year instructor, who was the catalyst for much of this work left the college to move to another state. The following year, after the phase two implementation, the first year instructor was lured back to private industry and left the college as well. Amidst these changes, phase three of the implementation stalled out and was not completed.

Conclusions

In an ideal world, there would be full implementation and great success to report. Unfortunately, this project did not reach that point. However, this author decided to share this model in the hopes that it will inform other improvement efforts. All of the elements in this model, self-directed learning[2,3], project based learning[3], self-assessment and portfolio[4], have been studied and are supported in the literature. This model is an effort to integrate them in to a coherent system. Ideally there would be more complete results to report. But the feedback and results that were achieved in our limited implementation were very positive and encouraging. Perhaps a new application of these ideas will be attempted, and further insights gained in the future.

Future Research

Although the model was not fully implemented, the development work that was done need not go to waste. The basic model that is presented here offers an opportunity for organizations with similar needs to adapt and adopt this approach. Additional development of the comprehensive self assessment is needed. This is likely to be in two parts. An instrument for assessment of workforce skills may be available in standardized tests already in use. An instrument for the assessment of technical skills would need to fit the particular discipline. However, this does not necessarily mean that it would have to be developed anew. There are skill standards for different industries and job positions that could be adopted, although some modification or customization might be desirable. There has been ample research on the use of portfolio[4] for this element to be adopted with very little development time. Additional research might include a more formal and structured assessment of student feedback, as well as the use of aggregated data for assessment and improvement of program.

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