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# COMPARING THE EFFECTIVENESS OF ERROR AVOIDANCE, ERROR MANAGEMENT AND TEAM-BASED LEARNING PROGRAMS FOR SAP SOFTWARE TRAINING

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COMPARING THE EFFECTIVENESS OF ERROR AVOIDANCE, ERROR MANAGEMENT AND TEAM-BASED LEARNING PROGRAMS FOR SAP SOFTWARE TRAINING

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## Abstract

The implementation of large enterprise software systems introduces changes to business transactions and processes that have to be communicated and trained. SAP is one of the leading enterprise systems in the world, and is currently being implemented at NORDAM in Tulsa, Oklahoma. The traditional SAP training method is an error avoidance (EAT) approach, which is based on scripted exercises that guide participants to the correct solution. This has for the most part successfully equipped people with the procedural knowledge to process transaction scenarios that were presented in the training materials. The effectiveness of this method with regards to analogical and adaptive transfer has had questionable results for NORDAM. Recent studies suggest that error management training (EMT) and/or team-based learning (TBL) would be more effective and appropriate training approaches for analytical and adaptive knowledge transfer. Using a sample of 69 employees, this study compared the effectiveness of EAT, EMT and TBL for SAP related procedural and adaptive knowledge transfer as well as business performance. Results suggest that for the NORDAM population a TBL training approach would be more effective than either EAT or EMT for procedural performance and adaptive knowledge transfer. Findings also revealed that an EMT training approach would be more effective than either EAT or TBL for declarative knowledge transfer. A better knowledge of training approaches and their effects on learners and business performance will help NORDAM in the design and implementation of efficient and cost effective training programs for future SAP deployments.

# Comparing the Effectiveness of Error Avoidance, Error Management and Team-based Learning Programs for SAP Software Training

NORDAM (Northeastern Oklahoma Research, Development and Manufacturing Company) is a medium sized privately held aerospace repair and manufacturing company based in Tulsa, Oklahoma. It employs 3,000 people in 7 facilities in the US, Wales, and Singapore. One of the components in the strategic plan to position NORDAM to compete more effectively and efficiently in the global marketplace was to update the business systems technology. This would not only allow NORDAM to interface and integrate with the advanced business systems of their larger customers and vendors, but would provide more timely and accurate information on manufacturing/repair logistics, costs, and profitability. In 2004, NORDAM made a decision to replace all the various business systems in use at all their facilities with a single enterprise resource planning (ERP) software system called SAP. SAP is a large complex ERP software system that integrates all business functions (Finance, Human Resources, Sales, Purchasing, etc.). It is one of the most commonly used ERP systems for large manufacturing concerns worldwide, and is also the most common system in use by NORDAM's larger customers and vendors.

NORDAM is currently involved in implementing SAP at each of its seven facilities. Three domestic facilities and two international facilities in Wales and Singapore have been deployed. The remaining domestic facilities are planned for deployment no later than 2012. End user training is an important component for each deployment, and the training goal for each deployment is to have stakeholders sufficiently trained on the operation and concepts of SAP so that only minimal support would be required from the deployment team after implementation.

The training program for each deployment to date has been based on an error avoidance training (EAT) model, which is designed using scripted exercises that guide participants to the correct solution. This has for the most part successfully equipped people with the procedural knowledge to process transaction scenarios that were presented in the training materials. The training materials included some of the most common business scenarios and transactions that an end user would encounter. This training approach is efficient in that it allows the dissemination of a large amount of relevant knowledge to many people in a short amount of time. The downside to this approach is that it fosters passive learning in that people are told what to learn and how to learn it. The effectiveness of the EAT design with regards to self-sufficiency has had questionable results for NORDAM due to the continued dependency on the deployment team and length of time business metrics for the deployed facilities have remained in decline.

Recent studies suggest that error management training (EMT) and/or team-based learning (TBL) would be more effective and appropriate training models for the analytical and adaptive knowledge transfer that is required to support a self-sufficiency goal (Keith, 2008; Rassuli & Manzer, 2005). EMT training promotes active exploration, where the participants are not guided to correct task solutions but work to find solutions on their own. In addition, EMT training explicitly encourages making errors stressing their positive learning function and also provides the participants with error management instructions designed to reduce potential frustration when errors are encountered. TBL provides the opportunity to apply complex concepts and promotes communication and interpersonal and team skills (Michaelsen, Knight, & Fink, 2004). The purpose of this research is to determine if an EMT and/or TBL training model would be more effective for NORDAM than the existing EAT model for SAP related training.

To gain an understanding of the challenges faced by an ERP system training design, it is important to understand what an ERP system is, why an organization would want to implement one, and what the implementation challenges are. The following section will provide an overview of the evolution of ERP systems and their organizational benefits and challenges. This overview will then be followed by a review of current training models and methods and their applicability to an ERP system training design.

*ERP Systems*

An ERP system is defined as an integrated, multi-dimensional system that is used to manage and coordinate all resources and functions of an organization, including planning, control, and supply chain using state of the art information technology tools (Jarrar, Al-Mudimigh, & Zairi, 2000). It is a suite of software modules that links intra-organizational accounting, human resource, and planning functions in the front-office to warehouses, manufacturing facilities, and transportation functions in the back-office (Bingi, Sharma, & Godla, 1999). It also links inter-organizational supply chain business processes with customers and suppliers as well (Wah, 2000).

ERP systems are designed to provide cost and productivity efficiencies as well as improved quality of information, which for an organization can translate into a market advantage, or at minimum maintenance of their current market share (Hitt, Wu, & Zhou, 2002; Kalling, 2003). To maintain market competitiveness the implementation of ERP systems has been a growing trend for both large and mid-sized organizations over the last two decades. German based SAP is the leader and has been the largest ERP software provider in the world for over a decade. The top three ERP software companies generated $18.1 billion in sales revenues in 2008, and of that group SAP led the market with $10.5 billion in revenues. US based Oracle was in second place at $6.1 billion in revenues, and UK based Sage was in third place with $1.5 billion in revenues (van Kooten & Verbeme, 2009).

ERP system implementations are challenging not only because of the complexity of the ERP software itself, but also because of the complexities of converting existing business processes and data into the new ERP system design. Business processes have evolved over the years to take advantage of computer hardware and software. Systems were designed and constructed around various parts of an organization to promote efficiencies, cost savings, and provide more timely and accurate information. These systems are often referred to as “legacy systems”. People within each department of the organization were generally only familiar with the part of the system designed for and used within their department. Information was passed between functional department systems in the form of a periodic load known as an interface. These systems optimized functional silos of processes and information, but were not integrated in a manner that optimized end-to-end business processes or the organization as a whole (Jarrar et al., 2000).

Material Resource Planning (MRP), a software system that was introduced in the 1960s, was the first generation system focused on an integrated end-to-end business process. It was designed to help manufacturing companies plan their activities and track materials through their plants. MRP systems calculated material needs based on a forecast or actual customer orders. It provided management with the ability to tie purchasing and production activities to future demand. MRP, which was limited to only materials planning, eventually evolved into MRP II, which added critical resources such as people, machines, and warehouse space to the planning equation. MRP II systems tracked and managed information that supported requirements planning, which included customer order management, inventory control, production control, purchasing support, product data management, finance, and accounting (Klaus, Rosemann, & Gable, 2000).

ERP systems are the most current generation of integrated systems, and were introduced during the early 1990s. This includes all of the MRP and MRP II features, plus additional modules that support marketing, sales, and field service (Mraz, 2000). ERP systems bring together separate processes throughout the organization so that they will function in concert to produce the desired output (Landauer, 2000). For example, the placement of a customer order using an ERP system will trigger the allocation of the finished product against the order, delivery, and billing. It will determine whether the product should come from current finished goods in a warehouse, in-process goods, scheduled production, or new production. It will set the order up for shipment based on information from either the customer or the customer master record, and, when the order is shipped, prepare an invoice and an accounts receivable entry (Laughlin, 1999).

ERP systems can be distinguished by the following characteristics (Klaus et al., 2000):

1. ERP systems are complex software requiring large investments of money, time and expertise to implement (Davenport, 1998).
2. ERP systems may require changes in business processes and procedures, may induce customization, and may require vendor support for maintenance and updates (Klaus et al., 2000).
3. ERP implementations must be managed as a program of organizational change rather than a software implementation (Markus, Axline, Petrie, & Tanis, 2000).

The Benefits of ERP Systems. When properly implemented, an ERP system can provide efficiencies in time and quality of information flow, reduce data redundancy and synchronization issues, and simplify system maintenance and support. A customer order, for example, can flow through and be monitored in the system electronically, rather than routing a paper form to be keyed into multiple systems. Each time this order is entered into a different system or travels through inter-company mail, processing time increases as well as the risk of errors and information loss (Macvittie, 2001; Slater, 1998). The customer order is also linked to customer specifications, manufacturing, and purchasing which helps the organization plan the purchase of raw materials according to its production plan. Using this information, the organization can obtain better prices for raw materials and minimize inventory by scheduling the receipt of the required raw materials as close as possible to the date it is needed (Bingi et al., 1999; Gefen & Ragowsky, 2005).

ERP systems also provide sharing of information across domestic and international units of an organization regardless of language and currency differences. To effectively manage and achieve a competitive advantage and synergy across national boundaries and product lines, organizations must implement standard business applications and consistent data definitions across all business units. ERP systems are designed to provide this "common language" throughout an organization (Bingi et al., 1999). From an information technology perspective, maintaining and supporting a single integrated ERP system, would also be less complicated than maintaining legacy interfaces, coordinating software releases, and negotiating contracts with multiple vendors for individual application systems (Hitt et al., 2002).

The Challenges of ERP systems. According to Davenport (1998), one of the most notable challenges of an ERP system is that it imposes its own logic on a company's strategy, culture, workflow, and organizational alignment, usually forcing a company to change the way it conducts business. ERP systems are delivered with many configuration options for each business process based on industry best practices. This delivered functionality may not fit the existing business processes of the organization, which generally causes the organization to re-engineer its business processes to conform to the available ERP system options (Davenport, 1998; Yakolev, 2002). The resulting change may be a significant challenge to the organization, causing stakeholders to create new work relationships, share information that was once closely guarded, and make business decisions they never were required to make (Appleton, 1997). Laughlin (1999) describes organizational resistance as a common but intangible foe and a frequent source of "train wrecks" in ERP implementations.

Implementation Success Factors. Before critical success factors (CSF) can be defined for an ERP implementation, a determination of what is meant by a successful implementation must be explored and determined. Markus et al. (2000) stated that the definition of success varies between ERP implementations and is dependent upon the group measuring it. Project managers and consultants often define success in terms of completing the project on time and within budget. In contrast, people whose job it is to adopt ERP systems and use them to achieve business results tend to emphasize having a smooth transition to stable operations, achieving intended business improvements, and improved decision making capabilities. Freeman and Beale (1992) provide a good example of views of project success as held by different individuals who contribute to a project. An architect may consider success in terms of aesthetic appearance, an engineer in terms of technical competence, an accountant in terms of dollars spent under budget, a human resources manager in terms of employee satisfaction, and chief executive officers rate their success in the stock market. Jarrar et al. (2000) believed that successful ERP implementations should be measured on a larger scale, in terms of their effects on the product, people, and processes of an organization. Davenport (1998) believed a strategic perspective should be taken when measuring successful ERP implementations arguing that organizations that derived the greatest benefit from ERP were the ones that viewed ERP projects from strategic and organizational perspectives rather than from just technical perspectives.

Carson (2005) identified seven factors that were most commonly cited as critical post-implementation success factors. Table 1 lists these post-implementation CSF's and the number of times they were mentioned in the literature he reviewed.

Table 1

*Post-implementation Critical Success Factors in Literature*

| Critical Success Factors Description | Mentions |
|---|---|
| 1. Effective knowledge transfer to end-users | 11 |
| 2. Development of monitoring/performance measurement system | 5 |
| 3. Go-live only when implementation is complete and correct | 2 |
| 4. Develop a plan for ongoing support and maintenance | 2 |
| 5. Obtain appropriate documentation and tech support from the vendor | 1 |
| 6. Join/participate software vendor user groups | 1 |
| 7. Proper documentation of the system | 1 |

Knowledge transfer and development of performance measurements were the most frequently listed project success factor in the post-implementation category. Effective knowledge transfer to end-users was noted as the tenth most overall mentioned CSF in literature reviewed in a similar study conducted by Allen, Kern, and Havenhand (2002). Bingi et al. (1999) found that without proper training and transference of project knowledge a significant number of staff level employees were not able to use a new system. Carson (2005) concluded that there was evidence that the successful transfer of knowledge to an end user community was a significant component of a well-constructed ERP implementation plan.

*Training*

Current industry trends show that organizations worldwide have been increasing their investment in training to improve organizational performance and productivity (Kozlowski, Brown, Weissbein, Cannon-Bowers, & Salas, 2000; Velada & Caetano, 2007). In 2006, US organizations spent $71 billion on training related activities and products, up from $66 billion in 2005 (Dolezalek, 2006). With this increase in training expenditure has come the demand for measuring effectiveness and return on investment (ROI). The measurement of effectiveness, or the transfer of trained skills and knowledge back to the job varies between studies, but some have found that only 10% of all training related expenditures actually result in knowledge transfer (Kozlowski et al. 2000, Fitzpatrick, 2001). Linking training effectiveness to organizational performance and productivity outcomes has been a challenge due to the difficulty in isolating the effects of training treatments from external variables such as trainee and environmental factors (Kirkpatrick & Kirkpatrick, 2006; Miller, 2002).

In a recent meta-analysis of training studies over the last decade, zu Knyphausen-Aufseß and Smukalla (2009) identified 13 categories of variables that have been shown to influence learning transfer, of which only three were directly related to training activities. The authors further analyzed each category with respect to how much influence the organization can have (sphere of control) and if the impact of the variable is worth the financial investment (cost-value ratio). The goal of this analysis is to identify the variables that provide the greatest learning impact that an organization has the ability to influence. The results of their analysis (figure 1) show that organizations should primarily focus on social support and training content variables as they can be influenced by the organization itself and have a high cost-value ratio or ROI. At the opposite end of the spectrum, ability and personality variables can only be influenced marginally and require a large investment of organizational resources, providing a low ROI.

| Cost-value ratio | - | 0 | + |
|---|---|---|---|
| + | • Goal orientation | | • Social support<br>• Training content factors |
| 0 | • Learner readiness | • Job/career variables<br>• Perceived content validity<br>• Valence/expectancy | • Opportunity to use<br>• Post-training factors |
| - | • Ability variables<br>• Personality variables | • Organizational culture<br>• Situational variables | |

Sphere of control

*Figure 1.* Training transfer categories - Cost-value vs. Sphere of control

Consequently, the following paragraphs will discuss current training models, their use with ERP systems and how they support transfer variables that have been shown to provide the highest cost-value ratio within an organization's sphere of control. These variables include social support, training content factors, opportunity to use, and post-training factors.

*Training Models*

For the purposes of this paper, the training model is defined by the desired knowledge-level outcome of the training. In an ERP training model framework described by Coulson, Shayo, Olfman, Tapie, and Rohm (2003), six levels of knowledge were identified (Table 2).

Table 2

*Knowledge Level Outcomes for ERP System Training*

| **Knowledge Level** | **Focus** | **ERP System Focus** |
|---|---|---|
| Command Based | Syntax and semantics | Learning the nuances of the system interface |
| Tool Procedural | Combining commands to complete tasks | Learning the steps to enter and recall transaction data |
| Business Procedural | Application of tool procedures to a task | Learning to complete an entire business process (i.e., procurement) |
| Tool Conceptual | The big picture of what to do with the tool | Understanding workflow of the whole process and the organizational impacts |
| Business Motivational | Reason to use | Business purpose of the system (i.e., integration, competitive, necessity) |
| Meta-Cognition | Learning to learn | Continuous learning cycle-ways to approach learning the system |

A command-based training model focuses on providing instruction on the ERP system commands, command structure and meaning of the commands. Tool procedural refers to grouping the individual commands to perform a specific task. These first two levels, which Coulson et al. (2003) refer to as skill-based outcomes, focus on the ability to use the ERP system. The business procedural, tool conceptual, and the business conceptual levels focus on cognitive outcomes or the awareness and judgment of the user. A business procedural training model focuses on applying the ERP tool to business processes. Tool conceptual focuses on the big picture or the overall purpose and structure of the ERP system.

The traditional end-user training model provided by ERP vendors is designed for a general audience and is primarily focused on the first two knowledge levels (i.e. the interface and procedures to complete transactions). Occasionally, tasks required to complete a business process will be included (Coulson et al., 2003). In terms of the knowledge-level outcomes, traditional ERP training focuses on more skill-based than cognitive-based outcomes. Given the complex, integrated nature of ERP systems, several studies proposed and found evidence that a more conceptual training model would be more appropriate and lead to more effective system usage (Coulson et al., 2003; Gupta & Bosstrom, 2006).

*Training Methods*

Training methods are the materials and activities designed to transfer knowledge to the trainee (Gupta & Bosstrom, 2006). Training materials consist of documentation provided to the training participants and training activities focus on the instructional procedures followed in conducting training. The following sections will review current research on traditional training methods currently used by ERP implementations and also training methods that are focused on more cognitive-based learning outcomes. These methods will then be compared and reviewed for appropriateness and potential effectiveness for an ERP implementation.

Error Avoidant Training. Error avoidant training (EAT) is a guided instructional method that provides information that fully explains and leads students through concepts and procedures to be learned (Kirshner, Sweller, & Clark, 2006). This method provides students with worked examples that guide in a structured manner to correct answers for course problems. A worked example is a fully worked-out solution of a problem that sequentially demonstrates all individual solution steps (Kissane, Kalyuga, Chandler, & Sweller, 2008). Guided instruction is efficient in that it can quickly disseminate information and lead students through the course material. The provided examples and solutions also reduce the potential for students to make errors and become lost, frustrated, and confused. Proponents of this method argue that confusion can lead to misconceptions and disorganized knowledge that will hinder the student's ability to solve future problems (Mayer, 2001; Paas, Renkl, & Sweller, 2003; 2004; Sweller, 1999, 2004; Winn, 2003). Opponents of this method argue that too much guidance may impair later problem solving performance (Bernstein, Penner, Clarke-Stewart, Roy, & Wickens, 2003).

Comparisons of guided instruction to minimal instruction using worked examples have been conducted and replicated in studies using a variety of students and materials since 1985 (Carroll, 1994; Mayer, 2001; 2004; Miller, Lehman, & Koedinger, 1999; Paas, 1992; Paas et al., 2003; 2004; Paas & van Merriënboer, 1994; Pillay, 1994; Quilici & Mayer, 1996; Sweller & Cooper, 1985; 1987; Trafton & Reiser, 1993). The first study conducted by Sweller and Cooper (1985) found that students studying algebra worked examples produced higher test scores than students that were given equivalent problems to solve on their own. Sweller and Cooper suggest that studying a worked example reduces or eliminates the problem-solving search and directs attention to learning the essential relations between problem-solving moves. Students learn to recognize which moves are required for particular problems which is the basis for developing and expanding their problem-solving abilities (Kirchner et al., 2006).

More recent studies have found that studying worked examples has a higher effect for students with less experience, while the effect reverses as students' expertise increases. For an experienced student, studying a worked example is an inefficient and redundant activity when compared to generating a known solution (Kalyuga, Chandler, Tuovinen, & Sweller, 2001; Kalyuga, Ayres, Chandler, & Sweller, 2003; Reisslein, Atkinson, Seeling, & Reisslein, 2006). The experienced students were able to efficiently solve problems by drawing on their experience, then quickly select, and apply the best procedures for solving the problem.

Exploratory Training. Exploratory training is an active learning approach that gives students control over their own learning (Bell & Kozlowski, 2008). This approach promotes an inductive learning process, in which individuals must explore and experiment with a task to infer the rules, principles, and strategies for effective performance. The exploratory learning approach goes beyond simply "learning by doing" and focuses on elements that influence how people focus their attention and direct their effort. Interest in active learning approaches developed, in part, from the realization that task expertise developed through passive guided training approaches could be a liability in the flexible and constantly changing work environments in organizations (Hesketh, 1997). Research has shown that individuals with task expertise often have difficulty adapting their knowledge and skills when concepts or processes change in their environment (Devine & Kozlowski, 1995; Sternberg & Frensch, 1992).

Although exploratory learning has been shown to offer many benefits, researchers have noted limitations of unstructured exploration. If learners are given too much freedom to explore, they may fail to assimilate all the targeted material to be learned, so it is important to supplement exploratory learning with guidance that helps focus trainees' cognitive and behavioral activities in productive directions (Bell & Kozlowski, 2002; Debowski, Wood, & Bandura, 2001; Mayer, 2004). Current studies have researched effects of learner's cognitive, motivational, and emotional variables on active learning training outcomes (Bell & Kozlowski, 2008; Gully, Payne, Koles, & Whiteman, 2002; Heimbeck, Frese, Sonnentag, & Keith, 2003).

Bell and Kozlowski (2008) conducted a study comparing the effects of proceduralized and exploratory learning on analogical/adaptive transfer outcomes. Analogical or near transfer involves the application of trained skills to problems similar to those encountered during training, whereas adaptive transfer refers to the ability to transfer skills to more difficult or new problems. The study found that trainees who received exploratory learning, as opposed to proceduralized instruction, performed more poorly during training but demonstrated significantly higher levels of both analogical transfer and adaptive transfer after training.

The benefits associated with exploratory learning were shown to be the most pronounced for adaptive transfer, which is consistent with the argument that active learning approaches are best suited for developing adaptive skills and helping individuals to recognize and respond to changes in task conditions. This finding also supports that active learning approaches, although not necessarily associated with better outcomes during training, produce superior transfer compared to traditional proceduralized instruction (Heimbeck et al., 2003; Keith & Frese, 2005).

The study also analyzed the effects of error framing and emotion control strategies on learning. Participants who received the error-encouragement instructions demonstrated higher levels of adaptive transfer than did trainees exposed to error avoidance instructions, suggesting that encouragement to make and learn from errors can aid in the development of adaptive expertise. A number of researchers have argued that becoming an active learner is a difficult and stressful process, and therefore it is important to consider emotion-control strategies when adopting an active learning approach (Debowski et al., 2001; Kanfer & Heggestad, 1999; Keith & Frese, 2005). In summary, the results of the study demonstrated that guided exploratory learning with error-encouragement instructions was more effective for promoting adaptive as opposed to analogical transfer.

Error Management Training. Error Management Training (EMT) is based on the premise that making errors is a natural and important part of active learning (van Dyck, Frese, Baer, & Sonnentag, 2005). Errors provide feedback when students are engaged in learning tasks. If errors are viewed negatively, students will be frustrated by their errors, avoid further exploration, which results in decreased learning. To control for this, EMT instructions are designed to convey a positive view of errors. When errors are framed as a natural, instructive part of the learning process and performance evaluation is de-emphasized, students are more likely to focus on learning to master the task (Ivancic & Hesketh, 1995). EMT is similar to exploratory training in that they both emphasize the importance of allowing the student to actively explore ideas and to test them.

However, there are two characteristics of EMT that differentiate it from pure exploratory training approaches. First, in contrast to exploratory training, EMT exercises and tasks are more difficult right from the start which exposes students to many error situations (Heimbeck et al., 2003; Hesketh & Ivancic, 2002). EMT exercises and tasks are also designed to have clear objectives, where exploratory training often lacks this kind of structure (Mayer, 2004). The second characteristic of EMT is related to emotion control. Students are explicitly informed about the positive function of errors during training and are provided with error management instructions to reduce potential frustration when errors occur (Dormann & Frese, 1994; Frese, 1995). Error management training is not expected to affect all types of learning outcomes at any time. First, error management training aims at improving performance after (as opposed to during) training.

A study by Heimbeck et al. (2003) highlighted the crucial role of error management instructions in error management training. EMT was superior not only to EAT but also to exploratory training without error management instructions. The participants in this study were trained individually on a spreadsheet program (Excel 7.0 for Windows) in one of three training conditions; EMT, exploratory training, and EAT. All participants received three manuals describing the important functions of the program being taught, and a set of tasks to complete after the manuals were read. EMT condition participants received instructions at the beginning of the training that emphasized the positive role of errors during training and how to learn from them. EAT condition participants received detailed written instructions that guided them step by step through the training tasks. After each participant completed the training tasks, they were given a performance test which consisted of tasks that were more complex but similar to the training tasks. The participants did not have access to training manuals or instructions during the performance test. Approximately one week after training, the participants were given another performance test with more difficult tasks. Again, the participants did not have access to training manuals or instructions. Results of the study showed that EMT produced better transfer results than exploratory training and EAT, and that the results were maintained over time. An analysis by Keith and Frese (2005) also found that EMT resulted in higher levels of adaptive transfer than EAT. They suggested that EMT is more effective for adaptive transfer because trainees learn to deal with unexpected problems.

EMT is unlikely to work equally well for everyone because it encourages students to explore and learn from mistakes. In this sense, EMT is similar to exploratory training which involves active experimentation to infer and learn the rules and strategies for effective performance (Smith, Ford, & Kozlowski, 1997). Both EMT and exploratory training approaches are less structured than traditional EAT approaches because the specific purpose of the training is to explore and experiment. Some important individual differences to consider in training approaches include cognitive ability, conscientiousness, or openness to experience (Gully et al., 2002). In a study that examined the effectiveness of EMT for participants with different levels of cognitive ability, openness to experience, and conscientiousness, Gully et al. (2002) found that high-ability individuals acquired higher levels of skills when they were encouraged to explore and make errors than when they were instructed to avoid errors. The results of the study suggested that EMT is most effective for higher ability individuals and least effective for lower ability individuals whereas EAT is most effective for lower ability individuals and least effective for higher ability individuals.

Keith and Frese (2008) conducted a meta-analysis on the effectiveness of EMT to identify moderators that could account for variances. When compared to EAT, the effect of EMT is more pronounced for post-training and adaptive transfer than it is for within-training and analogical transfer. Due to the encouragement of errors and increased exploration time in solving tasks, EMT performance results may even be worse than EAT for within-training tests. Keith and Frese also found that the combination of active exploration and error management instructions components maximized the effect of EMT. They suggest that EMT is useful whenever the materials to be learned cannot be covered completely during the training resulting in the need for students to "learn to learn" when confronted with new tasks. When the task/topic to be trained covers a relatively small amount of material that is highly structured, however, EAT is probably a more economical approach to teach the correct strategies directly because exploring and learning from errors may be too time-consuming. When tasks are very complex, EMT should be combined with elements of guided training (Bell & Kozlowski, 2002) because, given the low level of structure and guidance in EMT, participants may run the risk of developing incorrect conceptualizations of the training content (Frese, 1995; Mayer, 2004). Clear task feedback is an important component for EMT because errors can serve as informative feedback only when the participant can readily detect and correct the error.

Team-based Learning. Team-based learning (TBL) is an instructional method developed in the early 1990s by Professor Larry Michaelsen at the University of Oklahoma's Business School (Michaelsen et al., 2004). TBL, like exploratory training, is an active learning approach which places emphasis on applying concepts as a means to learn. However, unlike exploratory training and traditional approaches, the TBL approach shifts the student workload for reading and understanding the concepts to before class time. The main objective during class time is to test the understanding of concepts, and to apply those newly acquired concepts on increasingly complex problems.

Research has found that TBL improves comprehension, critical thinking, and retention (McInerney, 2003). People learn in different ways, and team activities promote active learning in that they involve discussions about different approaches to problems, which benefit people that do not memorize well and need to apply and understand concepts in order to learn. Instructors have also noted that TBL promotes a more learning-centered focus on their interactions with the students in that their conversations are more about concepts and critical thinking than on grades or a specific problem (McInerney, 2003). Research over the last decade has shown that TBL is associated with positive learning outcomes (Dunaway, 2005; Koles, Nelson, Stolfi, Parmelee, & DeStephen, 2005; McInerney, 2003), increased learner engagement and preparedness (Haidet & Fecile, 2006; Kelly, Haidet, Schneider, Searle, Seidel, & Richards, 2005), improved problem-solving skills (Hunt, Haident, Coverdale, & Richards, 2003; Kelley et al., 2005), and better communication processes and teamwork skills (O’Malley et al. , 2003; Thompson et al., 2007). TBL has been used primarily in medical colleges; however, a few other disciplines have recently started to successfully introduce TBL in their curriculum, such as engineering (Ostafichuck & Hodgson, 2007), business (Robert, 2007), and computer science (Lasserre, 2009; Whittington, 2007).

A study by Koles et al. (2005) found that students with lower academic performance may benefit the most from the TBL approach. The participants in this study were 80 undergraduate pathology students (49 females, 31 males) with a mean age of 27 (age range 23 – 43). Students were randomly assigned to 5-6 person teams in a TBL format and a case-based group discussion (CBGD) format. Each student participated in a two-hour pathology lecture and was given a reading assignment to be completed prior to the pathology course module.

At the beginning of the course module, each participant was given a 10-question individual readiness assessment test (IRAT) which was based on the advance lecture and reading assignment. The CBGD groups were then led through 2-3 case studies that contained open-ended questions to stimulate interactive discussion. The instructor was asked to encourage student responses to each question before explaining the answer. The TBL groups were given a group readiness assessment test (GRAT). The GRAT consisted of the same 10 questions used in the IRAT. Each team was permitted to freely converse while achieving team consensus for all 10 questions, but teams were not allowed to consult across team lines or use reference materials. After completion of the GRAT by all teams, the answer key was revealed and any questions were answered.

The brief discussion of GRAT answers was followed by 2 consecutive TBL application exercises, during which teams worked independently to achieve consensus answers. Application exercise questions were designed to be more challenging than the IRAT questions, requiring problem-solving skills beyond the simple recall of relevant information. Accordingly, all teams were permitted to use reference materials while achieving consensus. Each team was required to choose a single best answer for each question. If group answers were not unanimous, students were asked to explain their answers to the entire group. At the end of the course, all students were given a final exam which consisted of questions from both the advance learning assignments and course module content. The scores of the IRAT and final examination were then compared for performance analysis. Although the results of the study did not show a significant difference between TBL and CBGD in the overall student performance, it did show a significant positive impact of TBL for the students in the lowest performance quartile. A post-course student survey also revealed that the students perceived the contributions of peers to be more helpful for learning during TBL than during CBGD.

Another interesting difference between these two approaches was the number of instructors required. Due to the required constant interaction between the instructor and students in the CBGD approach the class size was limited to 13-20 students, therefore 2 instructors were required. The TBL approach was able to effectively support a class size of 40 students, due to the fact that it is based on group interaction and reduces the need for constant instructor interaction. Other studies have also noted that exploratory training places significantly greater resource demands on the training/education department than does TBL (Hunt et al., 2003) with similar student performance outcomes.

SAP Training. SAP Education offers different training curriculum and instructional methods to companies implementing or running SAP. One of the more common instructional methods for companies implementing SAP is the traditional worked example method (SAP Education, 2009; Allen, 2005). SAP Education believes the best training approach to acquire practical SAP skills, is the “See it, Hear it, Do it” approach. This is also the instructional approach that was chosen by NORDAM for its implementation. During the first training phase of the implementation project, the NORDAM project team members attended off-site foundation courses recommended by the SAP Education training curriculum. These courses were organized into multiple sections that each started with a mini-lecture about the process, which was then followed by a demonstration of the subject business transaction(s), and then ended with a short period of time in which the students would work through a problem similar or identical to the example demonstrated. The solution to the problem was provided to the students to use as they worked through the exercise. The NORDAM project team members then developed and delivered in-house courses modeled after the SAP Education courses but customized to the business processes being implemented at NORDAM.

*Learning Transfer Variables*

The meta-analysis by zu Knyphausen-Aufseß and Smukalla (2009) which previously identified training content as a variable that has a pronounced influence on learning transfer, also identified peer/supervisor support, opportunity to use, goal orientation, motivation, and learner readiness as variables having a high influence on training transfer. Studies have also found that the cognitive ability of younger learners is measurably different from that of middle-aged and older learners (Beier & Ackerman, 2005; Chandler & Sweller, 2003). Cognitive abilities that influence learning, such as working memory, generally decline as people age, whereas levels of experience-based knowledge typically increase or remain stable. The problematic aspect of these variables is that they cannot easily be influenced by a training program. For this reason, the majority of current research has treated these as moderators or control variables within the context of training methods that have to be taken into consideration because of their effect on learning transfer. The following paragraphs provide a definition of each of these variables.

In terms of goal orientation, several studies have shown that learning orientation is positively related to the motivation to learn and that performance orientation is negatively related to motivation to learn (Colquitt & Simmering, 1998; Ford et al., 1998). Learning-oriented trainees view training as an opportunity to gain new knowledge and skills, while performance-oriented individuals are afraid of losing out. Chiaburu and Tekleab (2005) also found that performance-oriented individuals when compared with learning-oriented individuals were not only less motivated to learn but also less likely to transfer the learned knowledge and skills to the job.

Many current studies have found peer and, in particular, supervisor support to be of crucial importance for training transfer (Bates, Holton III, Elwood, Seyler, & Carvalho, 2000; Chiaburu & Marinova, 2005; Colquitt, LePine, & Noe, 2000; Cromwell & Kolb, 2004; Kirwan & Birchall, 2006; Seyler, Holton III, Bates, Burnett, & Carvalho, 1998). Studies have also shown that the more upper management makes the effort to facilitate the transfer process, the more trainees will apply the newly learned knowledge and skills (Cromwell & Kolb, 2004; Saks & Belcourt, 2006).

Opportunity to use refers to the extent to which students are provided with or obtain resources and tasks on the job enabling them to use the skills taught in training (Bates et al., 2000). Lim & Johnson (2002) found that the opportunity to use training on the job is the primary reason for high transfer performance and that the lack of opportunity to use is the primary reason for low transfer performance.

Intrinsic motivation refers to the motivation that is driven by an interest or enjoyment in the task itself, and exists within the individual rather than an external influence (Bandura, 1997). Several studies have found that learners with high intrinsic motivation are more likely to transfer knowledge and skills to the job than learners with low intrinsic motivation (Machin & Fogarty, 2004; Naquin & Holton, 2002).

Learner readiness is defined as the extent to which individuals are willing and prepared to enter and participate in training (Bates et al., 2000). Several studies have found that this readiness directly impacts learning transfer (Bates et al., 2000; Devos et al., 2007).

*Summary*

Current and proposed training methods (EAT, exploratory/EMT, TBL) are summarized in the following paragraphs. Table 3 provides a comparison summary of the training structure and outcomes of the training methods reviewed.

Table 3

*Summary of Training Methods*

| Method | pre-training | During training | Post training | Observed Outcomes |
|---|---|---|---|---|
| **EAT** | | • Lecture<br>• Review worked examples<br>• Practice examples individually | Performance test | • Quick dissemination of material.<br>• Has higher effect for students with less experience.<br>• Least effective method for analogical and adaptive transfer. |
| **Exploratory** | | • Training objectives (order basic to complex)<br>• Practice examples individually | Performance test | • Higher effect for students with more experience.<br>• Takes longer to disseminate material.<br>• Can be difficult and stressful to students.<br>• More effective than EAT for analogical and adaptive transfer. |
| **EMT** | | • Error management instructions<br>• Clear objectives (order medium to complex)<br>• Practice examples individually | Performance test | • Higher effect for students with more experience.<br>• Takes longer to disseminate material.<br>• More effective than EAT for analogical and adaptive transfer. |
| **TBL** | Pre-course student assignment | • IRAT<br>• GRAT<br>• Discussion of answers<br>• Team exercises<br>• Discussion of answers | Performance test | • Effective for analogical and adaptive transfer.<br>• Less training resources required.<br>• Students with less experience may benefit the most. |

Traditional end-user training provided by SAP is an EAT method that is designed for a general audience and is primarily focused on the first two knowledge levels (i.e. the interface and procedures to complete transactions). In terms of the knowledge-level outcomes, the EAT method focuses on more task-based than cognitive-based (analogical and adaptive) outcomes. Due to the directive nature of the design, it is an efficient method to quickly disseminate task level information and it has been shown to be effective for people with low experience. The social interaction of this design is between the instructor and student. This method has appeal to NORDAM due to the volume of training to new and inexperienced users that has to occur just prior to an SAP deployment. Unfortunately, this method has not proven to be effective for preparing users to work adaptively through process issues not specifically addressed during training. This learning gap has resulted in the requirement for additional post-implementation training and support.

Interest in exploratory methods developed, in part, from the realization that task expertise developed through EAT methods could be a liability in the flexible and constantly changing work environments in organizations (Hesketh, 1997). Consistent with results experienced by NORDAM, research has shown that individuals with task expertise have difficulty adapting their knowledge and skills when concepts or processes change in their environment (Devine & Kozlowski, 1995; Sternberg & Frensch, 1992). Exploratory training has been shown to provide significantly higher levels of both analogical and adaptive transfer performance, although it has also been shown to be less effective for inexperienced users (Heimbeck et al., 2003; Keith & Frese, 2005). The exploratory approach is less structured than the EAT approach because the specific purpose of the training is to explore and experiment, and this lack of structure can be difficult, stressful, and counter-productive for learners, especially inexperienced learners (van Dyck et al., 2005).

Several studies have also shown that if learners are given too much freedom to explore, they may fail to assimilate all the targeted material to be learned. It has also been found that it is important to supplement exploratory learning with guidance that helps focus trainees' cognitive and behavioral activities in productive directions (Bell & Kozlowski, 2002; Debowski et al., 2001; Mayer, 2004). EMT is a variation of the exploratory approach and is designed to convey the purpose and positive view of errors as part of the learning process. The intent of this emotion control strategy is to reduce frustration in the exploration process which would result in increased learning (Debowski et al., 2001; Kanfer & Heggestad, 1999; Keith & Frese, 2005). Research has shown that conceptual learning outcomes are higher using EMT as compared with an exploratory approach, but is still less effective than EAT for inexperienced learners (Keith & Frese, 2008). Exploratory and EMT approaches are more useful whenever the material to be learned cannot be covered completely during the training resulting in the need for students to "learn to learn" when confronted with new tasks. When the task/topic to be trained covers a relatively small amount of material that is highly structured, EAT may be a more economical approach to teach the correct strategies directly because exploring and learning from errors may be too time-consuming. The social interaction of this design is also between the instructor and student. Within the context of an SAP implementation at NORDAM, due to the inability to completely cover all the material and processes during training and superior conceptual transfer outcomes, it would appear that an exploratory EMT approach would be more appropriate than an EAT approach. However, when taking into consideration the number of inexperienced learners involved during a SAP deployment and that EAT has been found to be more efficient/effective for inexperienced learners, the better approach becomes less apparent.

TBL is similar to the exploratory approach except that it shifts the student workload for reading and understanding the concepts to before class time. Team activities promote active learning in that they involve discussions about different approaches to problems, which benefit people that do not memorize well and need to apply and understand concepts in order to learn. Research has shown that TBL is associated with positive learning outcomes (Dunaway, 2005; Koles et al., 2005; McInerney, 2003), increased learner engagement and preparedness (Haidet & Fecile, 2006; Kelly et al., 2005), improved problem-solving skills (Hunt et al., 2003; Kelley et al., 2005), and better communication processes and teamwork skills (O'Malley et al., 2003; Thompson et al., 2007). In addition to the social and conceptual learning outcomes from TBL, it has also been found that inexperienced learners may benefit the most from the TBL approach (Koles et al., 2005). Other studies have also noted that exploratory training places significantly greater resource demands on the training/education department than does TBL (Hunt et al., 2003) with similar student performance outcomes. The research suggests that TBL could deliver the conceptual learning advantages of the exploratory approaches for a broader population of learner experience levels and be more efficient for the training/education department than an EAT approach. In terms of a SAP deployment at NORDAM, it appears that TBL would provide the advantage of superior conceptual transfer and also be effective for inexperienced users. As an added benefit, TBL has also been found to require significantly less resource demands on the training/education department than exploratory training (Hunt et al., 2003) with similar student performance outcomes.

Learning is highly influenced by peer/supervisor support, an opportunity to use, goal orientation, motivation, and learner readiness (zu Knyphausen-Aufseß & Smukalla, 2009); however, these variables are not easily within the control of a training program. For this reason, the majority of current research has treated them as moderators that should be taken into consideration when studying training methods.

*Hypotheses*

This research proposes to analyze how training delivery and format will affect performance over time, and which variables influence training effectiveness. The following hypotheses were formulated:

*Hypothesis 1:* Subjects in the TBL condition will have higher overall performance gains within training than subjects in the EMT condition, and subjects in the EMT condition will have higher overall performance gains within training than subjects in the EAT condition.

*Hypothesis 2:* Subjects in the EAT condition will have better declarative knowledge performance within training than subjects in the TBL condition, and subjects in the TBL condition will have better declarative knowledge performance within training than subjects in the EMT condition.

*Hypothesis 3:* Subjects in the TBL condition will have better adaptive procedural performance within training than subjects in the EMT condition, and subjects in the EMT condition will have better adaptive procedural performance within training than subjects in the EAT condition.

*Hypothesis 4:* Subjects in the TBL and EMT conditions will have better knowledge retention performance within training than EAT.

*Hypothesis 5:* Subjects in the EAT condition will have better knowledge application performance within training than subjects in the TBL condition, and subjects in the TBL condition will have better knowledge application performance within training than subjects in the EMT condition.

## Methods

### *Design*

This study employed a repeated measures design to assess the effect of the training format on performance. The training format (EAT, EMT, TBL) was manipulated as the independent variable, and performance was measured as the dependent variable using declarative and analytical tests. Peer/supervisor support, opportunity to use, and age group were assessed as moderating variables. To ensure representation of each functional business area in all the training groups, participants were first stratified by business function, and then randomly assigned to one of the three training groups. The research compared the effects of EAT, EMT and TBL training on individual performance metrics. Three measurement points (pre-training, within-training, post-training) were conducted during each training course. All training classes for this project occurred during January/February 2011. Differences in participant attitudes/perceptions, performance and actual business metrics were assessed through the comparison of test results prior, during, and after the intervention at the three measurement points described above.  Figure 2 depicts an outline of the experiment.

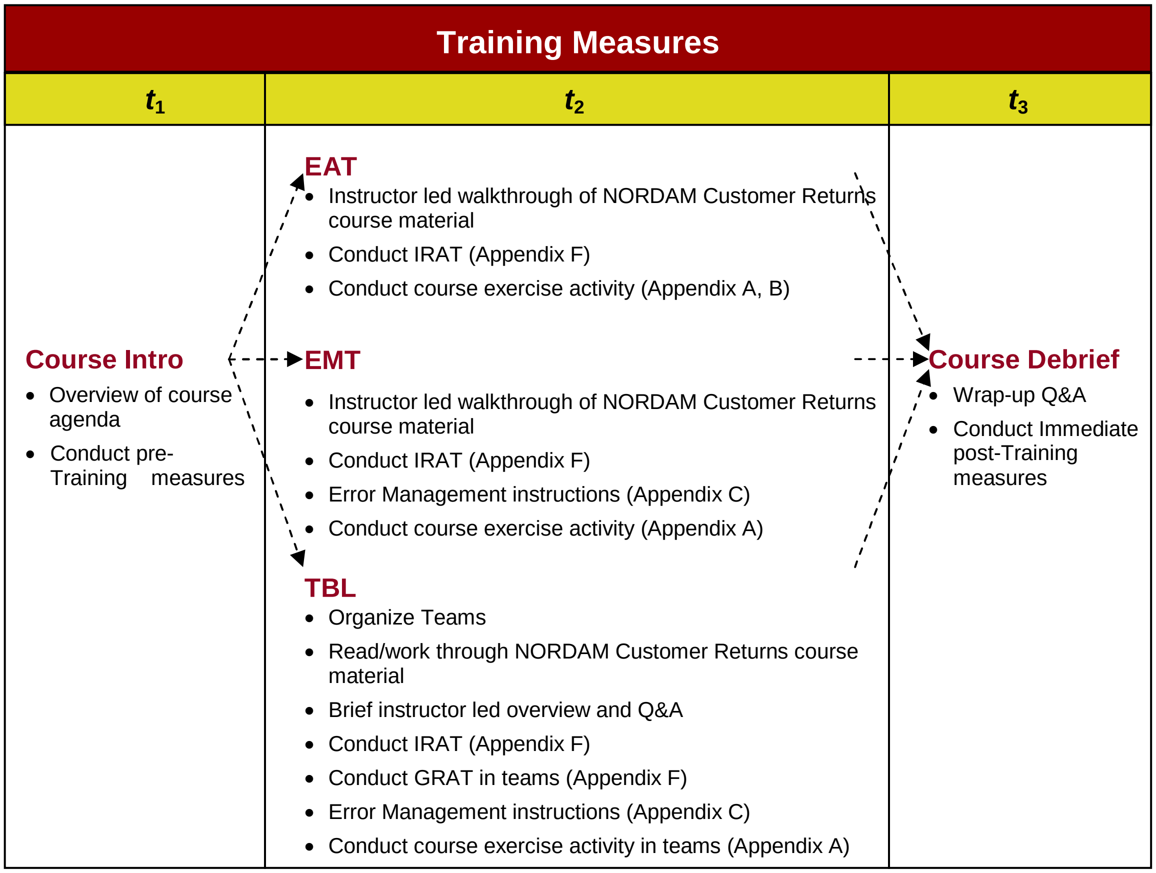



*Figure 2*. Outline of the experiment

*Procedures*

Participants were trained to create and interpret Customer Return Turnaround Time (TAT) reports from the SAP Business Warehouse.  The Training Phase was comprised of three training course designs: EAT, EMT, and TBL.  Each of these courses was designed and administered with the same course introduction and course debrief sections and pre- and post- training measures.  The manipulation between the three experimental groups occurred during the actual delivery of the training material.

At the start of the training session during the course introduction, participants were informed about the experiment and completed pre-training measures. After completion of pre-training measures, participants in all training groups received a NORDAM reference document that contained general navigation and report building information about the SAP Business Warehouse. Each participant received the same NORDAM reference document to assure task knowledge was constant across all training conditions. During the training, participants were given three exercises to complete (Appendix A). The first exercise required the participants to access a standard BI report and location specific information about a customer return. The second exercise required the participants to modify a standard BI report to identify the tasks and task status for a specific customer return. The final exercise required the participants to find the individual department and total turnaround time for a particular customer return and identify delay points in the process. Participants completed the training exercises in one of three training conditions: EAT, EMT or TBL.

EAT participants began by watching the instructor explain the NORDAM Customer Returns course material and demonstrate each exercise. The participants then completed an Individual Readiness Assessment Test (IRAT) to measure baseline knowledge (Appendix F). After completing the IRAT, the participants were provided with written step-by-step directions and solutions to complete the three course exercises (Appendix B). The participants were then instructed to carefully follow the instructions to complete the task and informed that it would help them learn the key functions in the shortest amount of time (Appendix C).

EMT participants began by watching the instructor explain the NORDAM Customer Returns course material and demonstrate each exercise. The participants then completed an IRAT to measure baseline knowledge (Appendix F). The participants in this group were then asked to complete the course exercises (Appendix A) without any written step-by-step directions. Instead, they were given error management instructions that encouraged them to explore and make errors and learn from them (Appendix C).

TBL training was divided into two sections. During the first part of training, the participants were divided into groups in a manner that ensured that each group had representatives from multiple functional business areas. The participants were then asked to individually complete the pre-training assignment which was to read and work through the NORDAM Customer Returns course material. The instructor followed with a quick overview of the course material and answered questions as necessary. The participants individually completed an IRAT to test individual learning (Appendix F). For the second part of the training, each group was asked to complete a Group Readiness Assessment Test (GRAT) as a team. The GRAT was identical to the IRAT not only for experiment measurement purposes, but also intended to stimulate team interaction while providing immediate feedback to the participants on what they had learned individually. Following completion of the GRAT exercise, each group was given the course exercises to complete as a team (Appendix A). They received error management instructions that encouraged them to explore and make errors and learn from them (Appendix C).

All training courses were concluded with a question and answer period followed by the administration of immediate post-training measures.

*Participants*

Eighty-four NORDAM employees represented the entire population of individuals that were involved with the business process targeted for training. Fifteen participants were unable to attend the training classes, resulting in a final sample size of 69. The participants were from different functional work areas (accounting, customer service, receiving, production) residing in Tulsa, Oklahoma. The age distribution of the participants in the sample was: age group 1 (20-29 years) = 5.97%, age group 2 (30-39 years) = 25.37%, age group 3 (40-49 years) = 29.85% and age group 4 (50+ years) = 38.81%.

The reported computer experience ranged from 5 to 40 years with a mean of 20.08 years (SD = 6.93). Almost all participants reported using a computer daily (98.5%); however, 79% reported that they had never created a BI report with the reporting software targeted for training. To ensure representation of each functional business area in all the training groups, the participants were first stratified by business function, and then randomly assigned to one of three training groups. A training notification with a specific date and time was sent to each participant resulting in 23 participants assigned to each course. Re-schedule requests were received from 10 participants and of those five were able to attend a different class of their originally assigned training group. The remaining five participants were only available on a specific day so one was reassigned from EAT to EMT, and four were reassigned from EAT to TBL. Schedule conflicts and re-schedule requests resulted in the following distribution of participants to each condition: EAT (N=18), EMT (N=24) and TBL (N=27).

*Variables*

Declarative and procedural performance, as the dependent variables, were measured at the individual participant level using declarative and analytical tests. As covariates, age, peer/supervisor support, and attitudes towards team work were included.

*Measures*

Attitudes toward team work were measured via self-report surveys conducted at the beginning and at the end of training. Performance was measured through comparison of declarative and analytical test questions on the subject training material that was conducted before training, during training, and at the end of training.

<u>Dependent Variables</u>. Performance was assessed using NORDAM developed exercises and test questions. To accommodate measurement of conceptual and adaptive learning in this study, declarative and analytical test questions throughout the course were designed to be more progressively complex at each test point. This design has been used in several studies to measure problem-solving skills beyond the simple recall of relevant information (Heimbeck et al., 2003; Keith & Frese, 2005; Bell & Kozlowski, 2008).

Individual performance was assessed two ways. First, to assess declarative and adaptive transfer, baseline declarative and analytical tests were conducted at the beginning of training (Appendix H) and compared to more difficult tests at the end of training (Appendix I). The baseline pre-training test was comprised of four declarative questions (definition of terms) to measure their knowledge of the tool and two analytical questions (“How many invoices are currently past due for Hawker Beachcraft?”) that measured their existing ability to use the tool. The questions were low to medium complex. The post-test was completed individually by the participants and consisted of three declarative and three procedural questions of medium to high complexity. To measure adaptive learning and retention, this test was designed to be more complex than the pre-training performance test.

Second, to assess within training transfer (knowledge retention), an IRAT (Appendix F) was conducted during training at the point between the review of course materials and repeated after working the course exercises (knowledge application) (Appendix A). To measure adaptive learning, the IRAT was designed to be more complex than the pre-training test and consisted of seven procedural questions of medium to high complexity. As part of the TBL course, a GRAT was also administered. The GRAT was identical to the IRAT and was used to assess training transfer changes due to the team-based design of the course. The course exercises were comparable to the IRAT and consisted of six procedural questions of medium to high complexity.

Covariates. Peer/supervisor support and opportunity to use were assessed using the work environment subscale adapted from Holton et al.’s (2003) Learning System Transfer Inventory (LTSI). The subscales assessed were peer support (“My colleagues encourage me to use the skills I have learned in training”, 4 items, $\alpha = .80$), supervisory support (“My supervisor shows interest in what I learn in training”, 6 items, $\alpha = .92$) and opportunity to use (“The resources I needed to use what I learned was available to me after training”, 4 items, $\alpha = .70$). Participants responded to each item using a 5-

point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*) (Appendix E).

Attitudes toward team work were assessed using the Value of Teams survey developed by Baylor College of Medicine (FIPSE, 2003) which measures a student's appreciation of learning within a group with 13 items ("I have a positive attitude about working with my peers "). The tool was developed and tested with participants of the FIPSE team-based learning project and has been used in numerous TBL studies to measure attitudes towards team work (Kelly et al., 2005; O'Malley et al., 2003). The data were assessed at the beginning and the end of the course. Cronbach alphas were 0.83 and 0.85 at time 1 and time 2, respectively. Participants responded to each item using a 5-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*) (Appendix G).

Control Variables. As control variables, participants were asked to indicate their age group, prior experience with the training subject, and tenure at NORDAM (Appendix D).

*Data Collection*

Data were collected with questionnaires, performance ratings from the participants and existing business process performance metrics. Three measurement points $t_1$ to $t_3$ were conducted during the training event. Table 4 provides a timeline and description of the measurement points for each variable in the study.

Table 4

*Data Collection Timeline and Measurement Points*

| | | During Training | | |
|---|---|---|---|---|
| | | Intro | Train | Debrief |
| **Variable** | **Measurement Tool** | **$t_1$** | **$t_2$** | **$t_3$** |
| Individual Performance | NORDAM declarative & analytical test questionnaire | X | | X |
| | NORDAM Readiness Assessment | | IRAT GRAT* | |
| | NORDAM Course Exercises | | X | |
| Perception of peer/supervisor support | Holton et al. LTSI Work environment subscale | X | | |
| Experience and Background | Experience and Background Survey | X | | |
| Attitudes toward team work | Baylor Value of Teams Survey | X | | X |

*Only conducted for TBL training groups

Participant Baseline Measurements. Initial questionnaires conducted at the beginning of the training event at $t_1$ were used to assess participant experience. A pre-training performance test was also administered at $t_1$ to each individual participant prior to training to measure knowledge and performance on the subject training material.

Manipulation Check. A questionnaire was conducted at the beginning of training ($t_1$) and at the end of training ($t_3$) to assess changes in attitudes towards teamwork.

Within Training Measurements. A performance test (IRAT) to assess learning progress was conducted during training ($t_2$) between reviews of course materials and working the course exercises.

Post Training Measurements. Questionnaires conducted at the end of the training event at $t_3$ were used to assess changes in attitudes towards teams. A post-training performance test was also administered at $t_3$ to each individual participant to measure changes in knowledge and performance on the subject training material.

## Results

### *Data Analysis*

Due to the difference in complexity between each performance test (pre-training performance test, IRAT, post-training performance test), each question was assigned a complexity factor (1=low, 2=medium, 3=high) prior to calculating the test score. Each response was coded 1 (correct response) or 0 (incorrect response). Responses were multiplied by the question complexity factor then summed to obtain total test points. Total test points were divided by the total possible points to obtain the weighted test score that was used to compare performance test results.

Descriptive statistics were calculated to understand the distribution and correlations between the variables (Appendix J). Reliabilities of measures were assessed by Cronbach alpha. To reduce the number of analyses to be conducted, only those variables that were significantly related to the dependent variable were included in subsequent analyses. The patterns of correlations were consistent with previous research and revealed significant positive correlations between value of teams (Kelly et al., 2005; O'Malley et al., 2003) and supervisor/peer support (zu Knyphausen-Aufseß & Smukalla, 2009) to training outcomes. Age was negatively correlated with IRAT scores (the point during training where material had been presented but not practiced), but not with post-training scores. This was consistent with prior research findings that older students tend to require application and practice for learning (Beier & Ackerman, 2005; Chandler & Sweller, 2003).

There were no significant differences between the training groups (EAT, EMT, TBL) on peer/supervisor support ($F(2,66) = 1.8$, $p = .17$), value of teams' perception ($F(2,66) = 1.63$, $p = .20$), years of computer experience ($F(2,65) = .35$, $p = .71$), experience with BI ($F(2,66) = .51$, $p = .60$), tenure ($F(2,66) = .03$, $p = .97$) or age group ($F(2,66) = .02$, $p = .98$). The average pre-test scores for the EAT ($M = 46.67$, $SD = 24.73$) condition were higher than EMT ($M = 37.50$, $SD = 21.11$) and TBL ($M = 36.67$, $SD = 21.12$); however, due to the small sample size this difference is not significant (F(2,66) = 1.27, $p = .29$). The mean value of experience with BI relative to the maximum possible value (2.58 out of 5) from the Experience and Background survey indicated the participants believed they had an intermediate level of BI experience. However, the mean value of pre-test scores relative to the maximum possible value (39.57 out of 100) indicated that the participants actually had a lower than average knowledge of BI.

The re-assignment of participants from the EAT condition to the EMT and TBL condition was analyzed to determine potential effects. Performance test means and standard deviations for the EMT and TBL training conditions were compared with and without the re-assigned participants. Since differences were negligible, all participants were included in the analysis (compare Appendix K).

A statistical power analysis was conducted using the observed means and standard deviations to determine if the obtained sample sizes were sufficient to proceed with an ANCOVA analysis. The observed differences in standard deviations for mean scores were higher than anticipated ($M_{diff}$ = 11.11, *SD* = 26.16), resulting in an observed power < .27. For the observed mean difference and standard deviation, a sample size of 70 participants in each of the three training groups would have been required for power = .60. Power was then calculated to see if sample sizes were sufficient to proceed with a two-sample and pairwise t-test analysis. This resulted in an observed power < .30 and a required sample size of 56 participants in each training group for power = .60. Therefore, due to the lack of observed power, the analyses for this pilot study was for the most part limited to a simple comparison of pre/post training means and effect sizes. Effect sizes were calculated using Cohen's d with values less than *d*=.21 indicating a small effect, greater than d=.79 a large effect, and results between *d*=.20 and *d*=.80 a medium effect (Cohen, 1988). The results presented start with the manipulation check, then follow the general order of the hypotheses.

Manipulation Check. The mean ratings for the pre-training ($t_1$) and post-training ($t_3$) value of teams survey for each independent variable (EAT, EMT, TBL) were calculated and compared as reflected in figure 3.

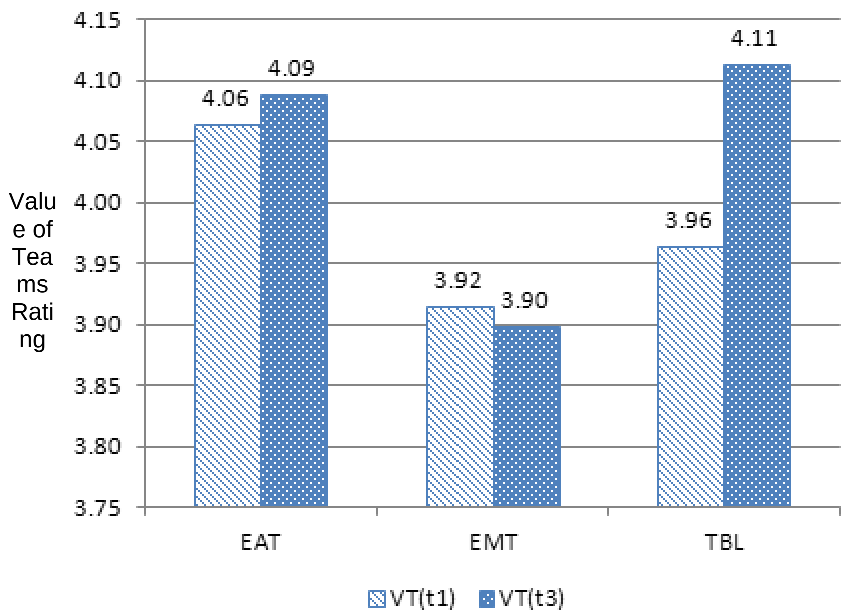



*Figure 3*. Pre-/post training value of teams (VT) mean rating comparison

As expected, attitudes toward the value of teams improved the most for the participants in the TBL course. For each independent variable (EAT, EMT, TBL) a paired-samples t-test between the attitude ratings of the value of teams pre- and post-training survey (dependent variable) was used to verify the manipulation effect. The paired-samples t-test for both the EAT group ($t(17)=.21$, $p=.84$, $d=.07$) and EMT group ($t(17)=.17$, $p=.87$, $d=.04$) indicated no effect. A significant change, however, was observed for the TBL group ($t(24)=1.53$, $p=.14$, $d=.35$). Even though mean scores improved and a moderate effect was observed as expected, the lack of power fails to statistically support this manipulation check.

<u>Hypothesis 1 (H1)</u>. To analyze the effect of training method (independent variable) on overall performance improvement (dependent variable), average post-training performance test scores were calculated and compared to average pre-training performance scores for each training group (EAT, EMT, TBL) as reflected in figure 4.

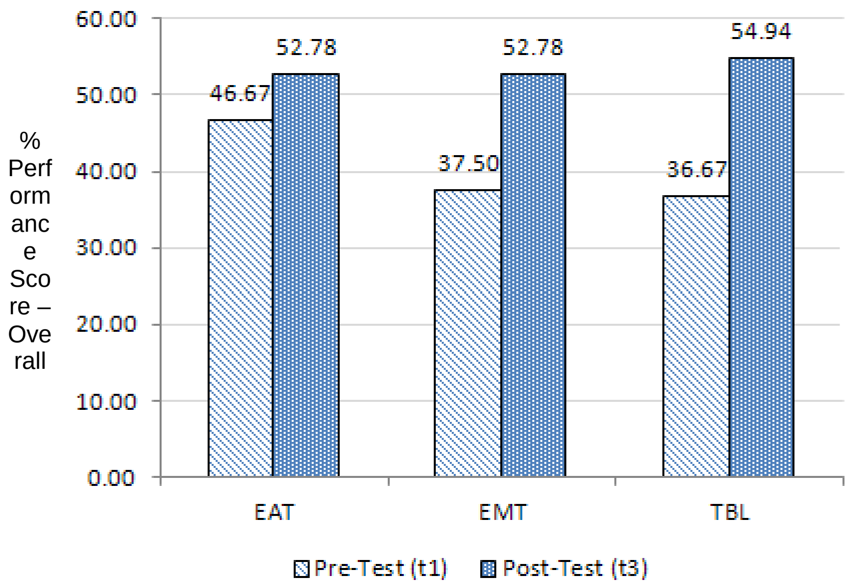



*Figure 4*. Pre-/post performance test mean score comparison (all test questions)

This resulted in an overall performance improvement between ($t_1$) and ($t_3$) of 13% for EAT participants, 41% for EMT participants and 50% for TBL participants. Training effects were analyzed using a paired-samples t-test between pre-test ($t_1$) and post-test ($t_3$) performance scores. The EAT group did not exhibit a significant difference but there was a medium effect ($M_{Pre}$=46.67, $SD_{Pre}$=24.73, $M_{Post}$=52.78, $SD_{Post}$=26.35, $t(17)$=.80, $p$=.43, $d$=.27). EMT revealed a significant difference and a medium effect ($M_{Pre}$=37.5, $SD_{Pre}$=21.11, $M_{Post}$=52.78, $SD_{Post}$=26.77, $t(23)$=1.27, $p$=.03, $d$=.37). TBL showed a significant difference and had a large effect ($M_{Pre}$=36.67, $SD_{Pre}$=21.12, $M_{Post}$=54.94, $SD_{Post}$=29.17, $t(26)$=3.4, $p$=.002, $d$=.94). TBL training had a higher overall performance gain effect than EMT training and EMT had a higher overall performance gain effect than EAT which supports H1.

Hypothesis 2 (H2). To analyze the effect of training method (independent variable) on declarative performance improvement (dependent variable), average post-training performance test scores were calculated and compared to average pre-training performance scores (declarative questions only) for each training group (EAT, EMT, TBL) as reflected in figure 5.

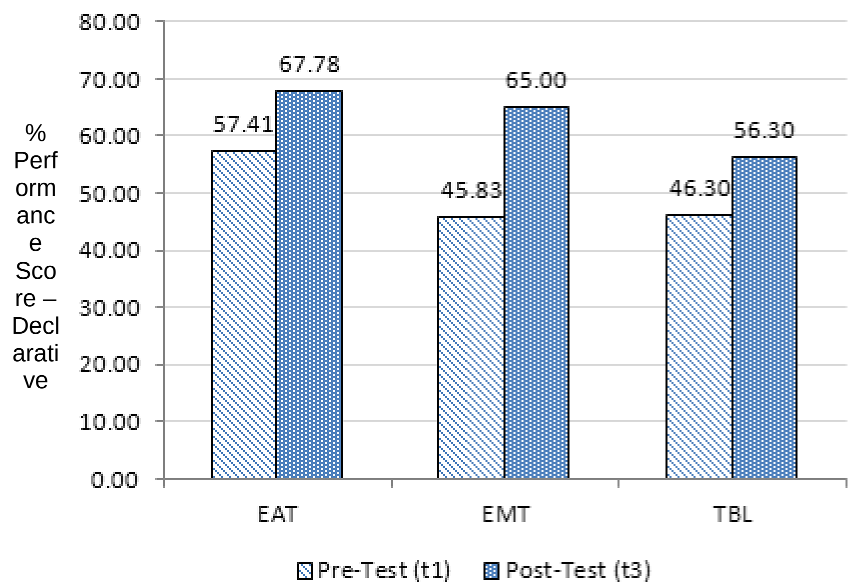



*Figure 5*. Pre-/post-test mean score comparison (declarative questions only)

The training improved declarative performance 18% for EAT participants, 42% for EMT participants and 22% for TBL participants. Power was sufficient enough for within training effects to be analyzed using a paired-samples t-test. The EAT condition did not show a significant difference but had a medium effect ($M_{Pre}$=57.41, $SD_{Pre}$=28.71, $M_{Post}$=67.78, $SD_{Post}$=31.54, $t(17)$=1.68, $p$=.111, $d$=.58). EMT revealed a significant difference and a large effect ($M_{Pre}$=45.83, $SD_{Pre}$=25.18, $M_{Post}$=65.00,

$SD_{Post}$=30.79, $t(23)$=3.13, $p$=.005, $d$=.92). TBL showed there was not a significant difference but did have a medium effect ($M_{Pre}$=46.3, $SD_{Pre}$=28.24, $M_{Post}$=56.3, $SD_{Post}$=35.96), $t(26)$=1.65, $p$=.11, $d$=.46). EMT training had a significant declarative knowledge performance effect, while both EAT and TBL training had not, which does not support H2.

Hypothesis 3 (H3). To analyze the effect of training method (independent variable) on procedural performance improvement (dependent variable), average post-training performance test scores were calculated and compared to average pre-training performance scores (procedural questions only) for each training group (EAT, EMT, TBL) as reflected in figure 6.

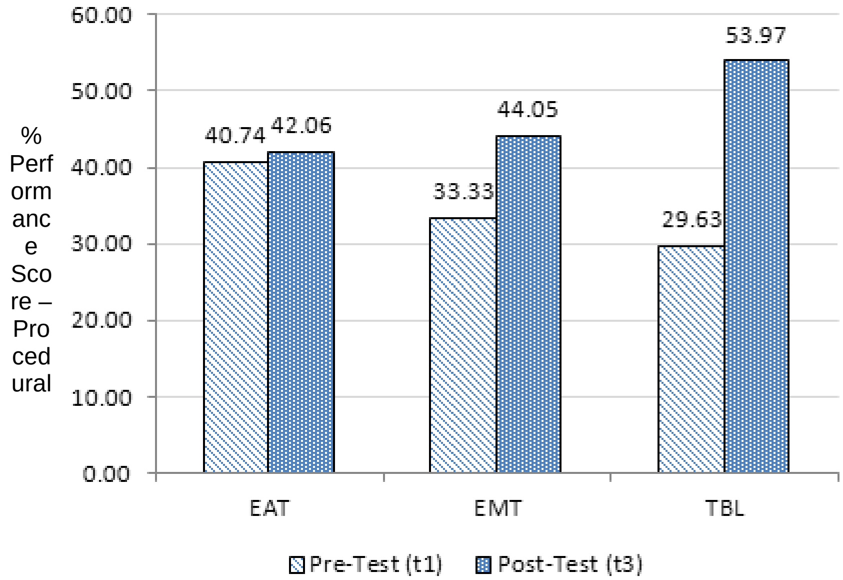



*Figure 6*. Pre-/post-test mean score comparison (procedural questions only)

The training improved procedural performance 3% for EAT participants, 32% for EMT participants and 82% for TBL participants. Training effects were analyzed using a paired-samples t-test. The EAT condition did not show a significant difference and had a small effect ($M_{Pre}$=40.74, $SD_{Pre}$=40.51, $M_{Post}$=42.06, $SD_{Post}$=34.81, $t(17)$=.09, $p$=.93, $d$=.03). EMT also did not show a significant difference but had a medium effect ($M_{Pre}$=33.33, $SD_{Pre}$=35.44, $M_{Post}$=44.05, $SD_{Post}$=41.26, $t(23)$=.92, $p$=.37, $d$=0.27). TBL showed a significant difference and a medium effect ($M_{Pre}$=29.63, $SD_{Pre}$=40.65, $M_{Post}$=53.97, $SD_{Post}$=38.07, $t(26)$=2.46, $p$=.02, $d$=0.68). Results show the TBL training had a more significant procedural performance effect than the EMT training group which partially supports H3, and EMT had a moderate overall performance gain effect while EAT did not, which also supports H3.

<u>Hypothesis 4 (H4)</u>. To analyze the effect of training method (independent variable) at the point when training material had been reviewed but not yet applied

(knowledge retention), the performance improvement (dependent variable) on average IRAT ($t_2$) scores were calculated and compared to the average pre-test ($t_1$) scores (procedural questions only) for each training group (EAT, EMT, TBL) as shown in figure 7. Since the IRAT was strictly comprised of procedural type questions, the analysis did not include the declarative questions contained in the pre-test.

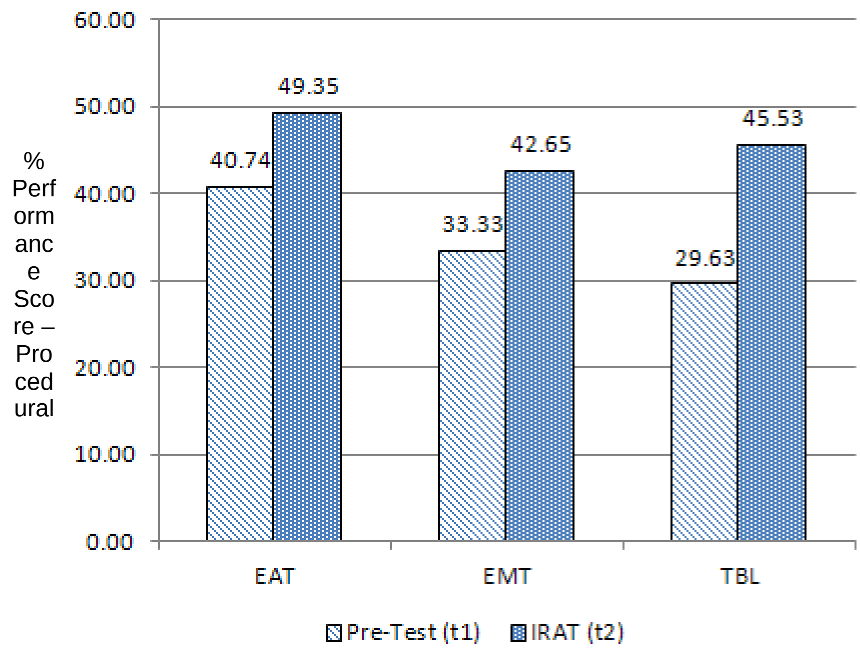



*Figure 7*. Pre-test / IRAT mean score comparison (procedural questions only)

The course material review phase of the training improved performance 21% for EAT participants, 28% for EMT participants and 54% for TBL participants. Training effects were analyzed using a paired-samples t-test. The EAT did not show a significant difference but had a medium effect ($M_{Pre}$=40.74, $SD_{Pre}$=40.51, $M_{IRAT}$=49.35, $SD_{IRAT}$=25.05, $t(17)$=.73, $p$=.47, $d$=.25). EMT also did not show a significant difference and had a medium effect ($M_{Pre}$=33.33, $SD_{Pre}$=35.44, $M_{IRAT}$=42.65, $SD_{IRAT}$=27.66), *t*(23)=1.1, *p*=.28, *d*=.32). Likewise, TBL did not show a significant difference and had a medium effect ($M_{Pre}$=29.63, $SD_{Pre}$=40.65, $M_{IRAT}$=45.53, $SD_{IRAT}$=19.95, *t*(26)=1.85, *p*=.076, *d*=.51). This analysis did not show significant improvement differences within any of the training groups, but did show a moderate effect for each of the groups. This analysis fails to support H4.

Hypothesis 5 (H5). To analyze the effect of training method (independent variable) after the course exercises had been worked (knowledge application), the performance improvement (dependent variable) on average Exercise ($t_2$) scores were calculated and compared to the average IRAT ($t_2$) scores for each training group (EAT, EMT, TBL) as shown in figure 8.

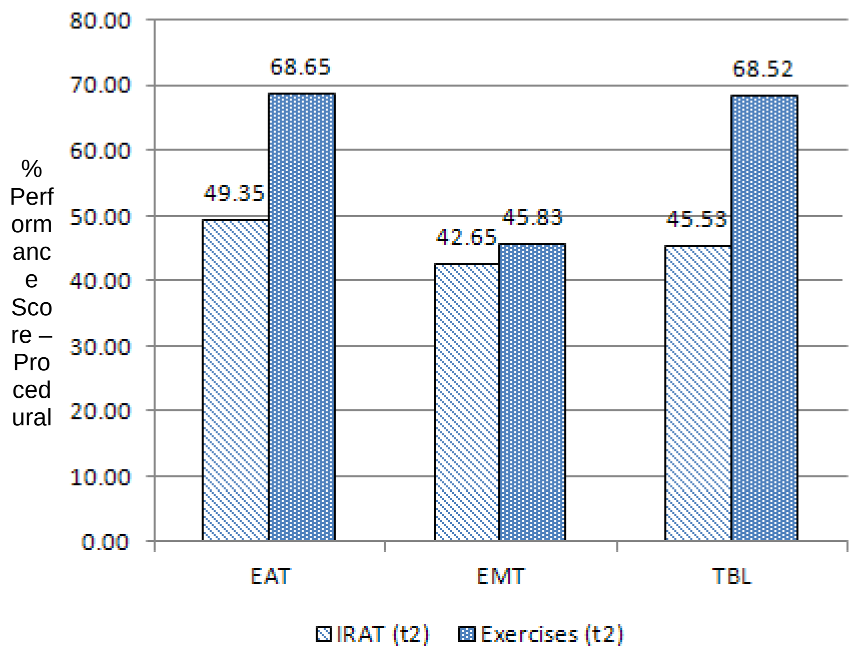



*Figure 8*. IRAT/Exercise mean score comparison (procedural questions only)

The course material application phase of the training improved performance 39% for EAT participants, 7% for EMT participants and 50% for TBL participants. Training effects were analyzed using a paired-samples t-test. The EAT condition showed a significant difference and had a large effect ($M_{IRAT}$=49.35, $SD_{IRAT}$=25.05, $M_{Exercise}$=68.65, $SD_{Exercise}$=31.20), $t(17)$=4.22, $p$=.001, $d$=1.45). EMT did not exhibit a significant difference but did show a moderate effect ($M_{IRAT}$=42.65, $SD_{IRAT}$=27.66, $M_{Exercise}$=45.83, $SD_{Exercise}$=33.23), $t(23)$=1.02, $p$=.32, $d$=.30). TBL showed a significant difference and had a large effect ($M_{IRAT}$=45.53, $SD_{IRAT}$=19.95, $M_{Exercise}$=68.52, $SD_{Exercise}$=19.64, $t(26)$=6.7, $p$=.000, $d$=1.86). Knowledge application performance is significantly lower in EMT than both EAT and TBL which partially supports H5.

# Discussion

NORDAM currently uses an EAT approach for SAP training. This training approach is efficient in that it allows the dissemination of a large amount of relevant knowledge to many people in a short amount of time. The effectiveness of the EAT design with regards to self-sufficiency has had questionable results for NORDAM due to the continued dependency on the deployment team and length of time business metrics for the deployed facilities have remained in decline. Recent studies suggest that EMT and/or TBL would be more effective and appropriate training models for the analytical and adaptive knowledge transfer that is required to support a self-sufficiency goal (Keith, 2008; Rassuli & Manzer, 2005). The purpose of this research is to determine if an EMT and/or TBL training model would be more effective for NORDAM than the existing EAT model for SAP related training.

When new software and/or processes are implemented at NORDAM, training is generally delivered to instruct affected employees how to use the new software. The time available to train employees is constrained by the amount of time that employees are able to be away from their jobs and EAT has traditionally been used as an efficient delivery approach that minimizes time spent away from the job. EMT training promotes active exploration to improve analytical and adaptive knowledge transfer. The TBL approach attempts to rapidly deliver course content and also model real-world learning at NORDAM in that when faced with a problem on the job, people tend to work together to learn how to solve it. This study proposed that a TBL or EMT approach would lead to better post training performance at both individual and business level outcomes than the traditional EAT approach being used.

Due to the diversity in workforce age, experience, and skillset at NORDAM, it was difficult to predict mean scores and standard deviations to make an adequate sample size determination. The observed standard deviation for the difference in mean scores (pre-/post overall tests) were higher than anticipated ($M_{diff}$ = 11.11, $SD$ = 26.16) which negatively impacted the power required to statistically test the results of this pilot study; therefore, data is interpreted with reference to the NORDAM employee population only. When examining effects using small sample sizes, significance testing can be misleading because it is subject to Type II errors. It is important to note that statistical significance is not a direct indicator of size of effect, but rather it is a function of sample size, effect size and p-level. In situations where the sample size is small, effect sizes can be more informative in terms of training effectiveness than significance testing especially in business applications (Neill, 2008; Valentine, 2003). Although the results of this pilot study cannot be generalized beyond the NORDAM population, the observed effect sizes are significant enough to provide insight for both future studies and NORDAM business training development and will be the primary measurement focused on during the following discussion.

*Individual Outcomes*

Subjects came into the study with varying degrees of knowledge about the software. Scores on the $t_1$ pretest averaged around 40 percent. Given the complex, integrated nature of ERP systems, several studies proposed and found evidence that a more conceptual training model would be more appropriate and lead to more effective system usage than a guided training model (Coulson et al., 2003; Gupta & Bosstrom, 2006). Active learning approaches such as EMT or TBL have been found to be more effective and appropriate training models for the analytical and adaptive knowledge transfer required for a system usage goal (Keith, 2008; Rassuli & Manzer, 2005). To accommodate measurement of conceptual and adaptive learning in this study, test questions throughout the course were designed to be progressively more complex at each test point. This design required participants to use problem-solving skills beyond the simple recall of relevant information. As expected, $t_3$ post-test average scores improved the most for TBL participants (50% improvement) followed by EMT participants (41% improvement) and EAT participants (13% improvement) with an effect size most pronounced for TBL training ($d$=.92). When broken down by type of knowledge, TBL participants scores, as expected, improved the most for adaptive procedural questions (TBL 82%, EMT 32%, EAT 3%) with a medium effect size for TBL ($d$=.68) and a very small effect size for EAT ($d$=.03). For declarative knowledge it was expected that EMT participant scores would improve the most followed by TBL then EAT. EMT scores did improve the most for declarative questions (EMT 42%, TBL 22%, EAT 18%) with a large effect size ($d$=.92); however; the improvement in scores for TBL and EAT were about the same. In summary, comparisons of pre-/post-training scores reveal that subjects in the TBL group had the greatest overall improvement in their scores, especially on adaptive procedural questions. The EMT group scores improved more for declarative questions.

Due to the guided structure, it was expected that EAT participants would have better within training application performance (Heimbeck et al., 2003; Keith & Frese, 2005). During training sessions at $t_2$, the IRAT was conducted after the training content was delivered. The average IRAT scores were fairly close (EAT 49.35, TBL 45.53, EMT 42.65) with the TBL group having the highest score improvement and effect (TBL 54%, *d*=.25; EMT 28%, *d*=.32; EAT 21%, *d*=.51). Course exercises were conducted after the IRAT was completed. EAT participants were provided guided instructions to complete the exercises individually, EMT participants completed the exercises individually without instructions and TBL participants completed the exercises in teams without instructions. As expected, the average score improvement for EAT participants was higher than EMT participants; however, the score improvement and effect for TBL turned out to be higher than EAT (TBL 50%, *d*=1.86; EAT 39%, *d*=1.45; EMT 7%, *d*=.3). This suggests that the TBL format may compensate for the lack of guided instructions.

Unsolicited negative feedback was received by the researcher via email from two of the participants receiving the EMT condition (S. Morin, personal communication, March 16, 2011; M. Pryor, personal communication, March 16, 2011). These participants did not feel that the unguided individual-based format of the course was "fun" or "productive". EMT is unlikely to work equally well for everyone because it encourages students to explore and learn from mistakes and this can be frustrating for some individuals (Debowski et al., 2001; Kanfer & Heggestad, 1999; Keith & Frese, 2005; Smith et al., 1997). EMT is less structured than EAT because the specific purpose of the training is to explore and experiment. EMT also does not provide the team support structure of TBL training. Some important individual differences to consider in training approaches include cognitive ability, conscientiousness, or openness to experience (Gully et al., 2002).

Unsolicited feedback about the different course formats was also received from the second instructor (A. Cox, personal communication, April 4, 2011). This instructor noted a much higher level of participant interaction and interest in the TBL format. She preferred this format over the other two (EAT, EMT) and indicated she was interested in converting some of her other courses to the TBL format. As shown in the manipulation check, attitudes towards teams also improved for participants in the TBL course which suggests that the participants enjoyed the experience. Research over the last decade has shown that TBL is associated with positive learning outcomes (Dunaway, 2005; Koles et al., 2005; McInerney, 2003), increased learner engagement and preparedness (Haidet & Fecile, 2006; Kelly et al., 2005), improved problem-solving skills (Hunt et al., 2003; Kelley et al. 2005), and better communication processes and teamwork skills (O'Malley et al., 2003; Thompson et al., 2007).

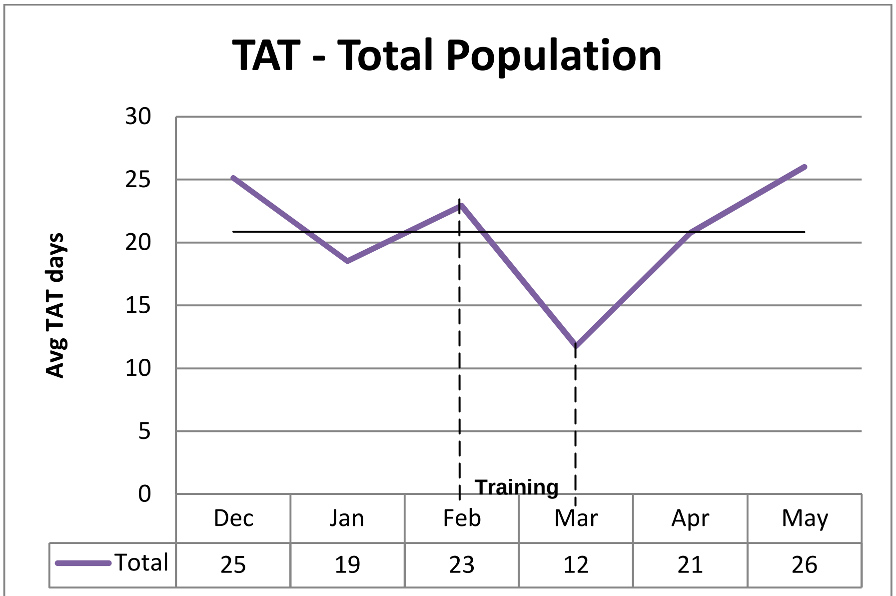
*Business Outcomes*

Linking training effectiveness to organizational performance and productivity outcomes has been a challenge due to the difficulty in isolating the effects of training treatments from external variables such as trainee and environmental factors (Kirkpatrick & Kirkpatrick, 2006; Miller, 2002). Although the resulting business performance effects were not statistically measureable for this study due to these external factors, they were of interest to NORDAM.

NORDAM manufactures thousands of aerospace parts for its customers. These parts must meet specific customer and FAA requirements, and be delivered at a specified time. When parts are either damaged or do not meet design requirements, the customer returns the part to NORDAM to either fix or replace. The turn-around-time

(TAT) is an important manufacturing performance metric that measures the time it takes to receive a returned part, fix/replace, and ship it back to the customer. The NORDAM goal is to have returned parts shipped back to the customer in ten days on average or a TAT = 10. The challenge in dealing with returned parts is the path they take through the facility after it is determined how to resolve the return issue. If a part is damaged, it may just need to go to the shop floor to be repaired. If the part was built incorrectly, engineering may need to review part specifications and make corrections. If the part is damaged beyond repair, it may need to be scrapped and a new one shipped out. In each of these and many other possible scenarios, an efficient communication process must occur to ensure that the correct people are immediately notified when they need to perform a task on a returned part. A breakdown in this communication process can cause lost parts and delays in TAT.

The business performance goal of the training program for this study was to teach people how to monitor tasks that have been assigned to them so they would be able to more effectively manage and reduce TAT. To measure the effect of the training program, performance metrics were observed and compared before, during, and after training. Baseline business performance TAT metrics for the total population was extracted prior to training (December and January) from the SAP Business Warehouse and recorded. Metrics were then taken during training (February and March) and after training (April and May). The average TAT was 22 days for the months prior to the training intervention. A substantial reduction in TAT to an average 12 days (approximately 50% reduction) occurred during the months when training was conducted.  The TAT during the months immediately following training returned to a pre-training average of 23 days (figure 9).




| Tasks | Dec | Jan | Feb | Mar | Apr | May |
|---|---|---|---|---|---|---|
| Completed | 74 | 385 | 385 | 408 | 254 | 230 |

*Figure 9*. Average TAT Performance for Total Population

To review effects between training methods, the average TAT for the total population metric was filtered by the people attending each training method.  Task assignments and distributions are a function of the types of customer returns that happen to occur, so cannot be easily planned or controlled.  During this research period, the resulting task distribution was heavily skewed toward the participants in the TBL condition and away from the participants in the EAT condition which reduced the reliability of the measures.  Task counts for each training group are shown in Table 5.

Table 5

*Monthly Completed Tasks by Course*

| Tasks Completed | Dec | Jan | Feb | Mar | Apr | May | Total |
|---|---|---|---|---|---|---|---|
| EAT | 4 | 0 | 8 | 9 | 7 | 2 | 30 |
| EMT | 37 | 144 | 142 | 49 | 6 | 42 | 420 |
| TBL | 151 | 314 | 371 | 227 | 36 | 83 | 1182 |
| No Training | 21 | 14 | 35 | 41 | 11 | 68 | 190 |

The Average TAT for each course was then graphed for the months under review and is shown in figure 10.

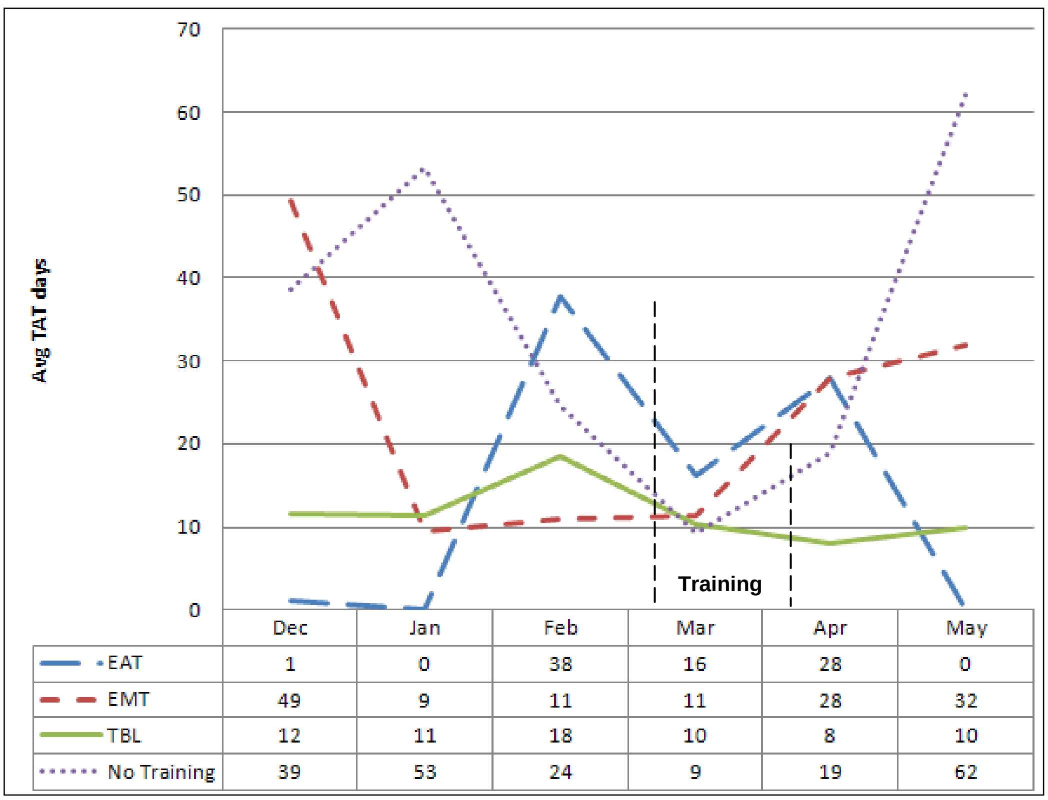



*Figure 10.* Average TAT Performance by Course

Although EAT appeared to experience the greatest average TAT reduction (58%) during the training period, the low volume of tasks (8 – 9 tasks) actually completed by the people in this training group reduces the reliability of any results for this group. The average TAT for the EMT group did not change during the training period (11 days) and subsequently trends upwards during April and May (28 to 32 days) towards December pre-training levels (49 days). The average TAT for the TBL group was reduced by 45% (from 18 to 10 days) during the training period, and was the only group that continued to show and maintain improvement during the months immediately following training (8 days and 10 days). Notably, a 62% reduction in average TAT for the remainder of the population that did not participate in training occurred during the training period, but subsequently trended upwards during April and May (19 to 62 days) exceeding pre-training levels. The "Hawthorne effect", work-group interactions and other motivational factors (Steele-Johnson, 2000) provide an explanation of this improvement.

*Implications*

EAT and EMT studies have been conducted in both academic and business environments (Kalyuga et al., 2001; Kalyuga et al., 2003; Reisslein et al., 2006), whereas TBL studies have been conducted primarily in academic environments with a younger and less diverse population (Lasserre, 2009; Ostafichuck & Hodgson, 2007; Robert, 2007; Whittington, 2007). The information gained from this study has identified alternative and possibly more effective learning approaches for training with analogical and adaptive outcome goals that are important in a business environment that has a multi-generational workforce with different skill levels. Specifically, results suggest that TBL training is more effective than EAT, especially for adaptive procedural learning. It also appeared that TBL training translated into improved continuous business performance more effectively than EAT. The collaborative structure of TBL fosters team skills and achievement which provides a longer term continuous support system for the material and procedures learned during training. Results also suggest that EMT training is more effective than EAT, especially for declarative knowledge goals. The study also provides insight into environmental and demographic variables that can hinder the measurability of success for a training program. Field studies are valuable because they are executed in a business setting (McClave & Sincich, 2008); however, participant availability and variations in actual business data available for use during and after training are difficult to control and ultimately impact statistical measures. Varying degrees of participant knowledge, experience and possibly age can also impact the spread of scores and power of statistical measures. This research shows that training content (declarative vs. procedural) should be taken into consideration during training course design. NORDAM will be able to use this information to re-engineer not only SAP-related courses but also other courses with analogical and adaptive outcome goals into more efficient and cost-effective learning programs.

*Limitations*

Although a fairly stratified representation of a manufacturing business organization for the process targeted for this training experiment, the population was limited to one organization. The study also used a relatively small population and therefore results cannot be generalized with confidence. The study was also conducted in a business environment where the control of most environmental variables was not possible. Measured changes in attitudes and business performance outcomes can therefore not be solely attributed to the effects of the training manipulation but may have been caused by unknown external factors.

The time available for employees to participate in a training study is constrained by the amount of time that they are able to be away from their jobs. The delivery of this course was limited to a three hour time frame which limited the number and type of test questions that could be asked and responded to.

### *Future Research*

The majority of research so far has focused on comparisons between learning approaches in educational environments with younger generation students that have limited work force experience. Knowledge about the effects of learning approaches on older participants in a business environment is lacking. Existing research has also generally been conducted over a relatively short period of time, so a stronger focus on long-term effects is needed. Future research is not only needed in the business environment, but should also focus on linking training outcomes to actual business performance metrics.

## Conclusion

Studying and comparing training approaches is not new to academic institutions, but has largely been ignored in business organizations. NORDAM selected the SAP recommended EAT training approach because it allows the dissemination of a large amount of relevant information to many people in the shortest amount of time. The downside of this approach is that it fosters passive learning by telling learners what to learn and how to learn it. Especially for adult, non-traditional students, this approach has been shown to be not very effective (Carter & Beier, 2010). For NORDAM, this resulted in longer support team requirements and a longer time for business metrics to rebound to pre-implementation levels. This study evaluated the most common training approaches (EAT, EMT, TBL) and found that the TBL approach may be a more effective training approach for NORDAM courses with analogical/adaptive and business performance outcome goals, especially for multi-generational employees with varied skillsets. A better knowledge of training approaches and their effects on learners and business performance will help NORDAM in the design and implementation of efficient and cost effective training programs for future SAP deployments.

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Appendix A

Customer Returns TAT Course Exercises

**Exercise #1:**

According to the SAP Business Warehouse, how many open customer return tasks are there for INS?

**Exercise #2:**

Locate Hawker Beachcraft return number 200030092. List each task associated with the return. What is the current status of each task for the return?

**Exercise #3:**

For Hawker Beachcraft return number 200027819:

a) What is the planned TAT for the return?
b) What is the actual TAT for the return?
c) What is the planned and actual TAT for each task?
d) Describe the activities for each task for this customer return.

## Appendix B

## Solution Guide - Customer Returns TAT Course Exercises

Please follow the steps below to complete the course exercises:

Exercise #1:

Step 1: Open Internet Explorer and select the ESS/MSS button to access the Enterprise Portal.

Step 2: Select the "Reporting" tab to display the available reporting areas. Select Quality.

Step 3: Select the "Open and Closed Tasks by Responsible Person" report from the report selection list.

Step 4: Enter Plant number 2010 in the "Current Selection" field,
Enter 'Y1' in the Notification Type field,
Click Notification Task Status drop-down and add 'Task Released',
And click OK.

Step 5: To simplify the report, drag "Notification Year/Month" column down to Free Characteristics section.

Step 6: To total the report, right click on "Person Responsible" column, select "Properties" then "Characteristics", and change the Display Results field to "Always".

Step 7: Scroll to the bottom of the report, and note the grand total of notifications.

Exercise #2:

Step 1: Close the "Open Tasks by Responsible Person by Month" report window.

Step 2: Select the "Quality Notification Tasks – Ad Hoc" report from the report selection list.

Step 3: Enter 2010 in the "Plant" field,
Enter 200030092 in the "Quality Notification" field, and click OK.

Step 4: Note each task number and the associated task status.

Exercise #3:

Step 1: Right click on 2010 in the “Plant” column of the report,
Select “Properties”,
Select “Characteristic”,
Change Display Results to “Always”,
Click “OK”.

Step 4: Note the Total Planned TAT from the last line of the report.

Step 5: Note the Total Actual TAT from the last line of the report.

Step 6: Close the “Quality Notification Tasks – Ad Hoc” report window.

Step 7: Open the “Quality Notification – Ad Hoc” report window.

Step 8: Enter 2010 in the “Plant” field,
Enter 200027819 in the “Quality Notification” field, and click OK.

Step 9: Scroll over to the “Activity” column in the report to determine the customer return disposition.

Step 10: Find the “Rework” process flow diagram and work instructions from the training materials and note the activities that are defined for each task.

Appendix C

## Error Avoidant Instructions – EAT Group

In the last few minutes you designed your first report by following the instructions provided on the handout.

The next part of the training is structured in a similar way. Your task is to design additional reports to answer business questions about the Customer Returns Process using Customer TAT Reports. Again you will receive instructions concerning the steps leading to the creation of each report. In addition to these instructions you may feel free to consult the BI Navigation Instructions that contains basic information on navigation and report building in the SAP BI system that you were given at the start of the training session. Please work on your reports independently, using the materials provided.

Please follow the written instructions carefully while working on the exercises. The written instructions are designed in a way that ensures that you will be "led" to the most important parts of the report steps within a short space of time. This allows you to train the correct steps in working with Customer TAT Reports right from the start.

In case an error occurs, please notify the experimenter.

## Error Management Instructions – EMT Group

In the last few minutes you designed your first report by following the instructions provided on the handout. You now have some general knowledge of the workings of Customer Returns TAT Reports. The next part of the training session is designed to consolidate and expand your knowledge of Customer Returns TAT Reports. Therefore, it is important that during this next segment you work intensively with the program. You will work independently throughout the rest of the training session because working independently with Customer Returns TAT Reports results in an intensive interaction with the program.

Similar to the first portion of the training it is now your task to design additional reports to answer business questions about the Customer Returns Process using Customer TAT Reports. During this segment of the training you will not receive written information about the steps leading to the solution and you will not receive any instructions from the experimenter. Feel free to consult the BI Navigation Instructions that contains basic information on navigation and report building in the SAP BI system that you were given at the start of the training session.

While working on your own on the exercises you will probably make some errors. This is a good thing and in line with the idea of this training! By making errors you will learn to deal with Customer Returns TAT Reports more effectively. Errors are a natural part of the learning process!

It is worth it to try some of the functions of the program even when you are not sure whether you are on the right track. No matter what there is always a way to leave the error situation.

For example, if you don’t know how to do something ‘right click’ somewhere in the report and see what your options are. Don’t be afraid to try something, you can always “undo”.

In case you make an error, think about the following:

- The more errors that you make, the more you learn!
- Errors tell you about what you still have to learn!
- There is always a way to leave the error situation!
- Errors are a natural part of the learning process!

**Error Management Instructions – TBL Group**

In the last few minutes you designed your first report by following the instructions provided on the handout. You now have some general knowledge of the workings of Customer Returns TAT Reports. The next part of the training session is designed to consolidate and expand your knowledge of Customer Returns TAT Reports. Therefore, it is important that during this next segment you work intensively with the program. You will work in teams throughout the rest of the training session because working together with Customer Returns TAT Reports results in a collaborative understanding of the process.

Similar to the first portion of the training it is now your team task to design additional reports to answer business questions about the Customer Returns Process using Customer TAT Reports. During this segment of the training you will not receive written information about the steps leading to the solution and you will not receive any instructions from the experimenter. Feel free to consult the BI Navigation Instructions that contains basic information on navigation and report building in the SAP BI system that you were given at the start of the training session.

While working in your teams on the exercises you will probably make some errors. This is a good thing and in line with the idea of this training! By making errors you will learn to deal with Customer Returns TAT Reports more effectively. Errors are a natural part of the learning process!

It is worth it to try some of the functions of the program even when you are not sure whether you are on the right track. No matter what there is always a way to leave the error situation.

For example, if you don’t know how to do something ‘right click’ somewhere in the report and see what your options are. Don’t be afraid to try something, you can always “undo”.

In case you make an error, think about the following:

- The more errors that you make, the more you learn!
- Errors tell you about what you still have to learn!
- There is always a way to leave the error situation!
- Errors are a natural part of the learning process!

Appendix D

Items Assessing Experience and Background

1. How long have you worked at NORDAM? _________________________

2. What department do you work in? ________________________________

3. What is your age demographic?

   ☐ 20-29 ☐ 30-39 ☐ 40-49 ☐ 50+

4. How many years have you been using a computer? __________________

5. Do you use a computer at least once a day?

   ☐ Yes ☐ No

6. How would you rate your level of experience using the SAP BI Reports?

   ☐ Very Inexperienced ☐ Inexperienced ☐ Some Experience ☐ Experienced ☐ Very Experienced

7. Have you ever created an SAP BI Report?

   ☐ Yes ☐ No

## Appendix E

Items Assessing Peer / Supervisor Support and Ability to Use

For each of the following items, please indicate your response using the following scale.

| Strongly Disagree | Disagree | Neither Agree Nor Disagree | Agree | Strongly Agree |
|---|---|---|---|---|
| **1** | **2** | **3** | **4** | **5** |

1. ________ My colleagues appreciate my using new skills I have learned in training
2. ________ My colleagues encourage me to use the skills I have learned in training.
3. ________ At work, my colleagues expect me to use what I learn in training.
4. ________ My colleagues are patient with me when I try out new skills or techniques at work.
5. ________ My supervisor meets with me regularly to work on problems I may be having in trying to use my training.
6. ________ My supervisor meets with me to discuss ways to apply training on the job.
7. ________ My supervisor shows interest in what I learn in training.
8. ________ My supervisor sets goals for me that encourage me to apply my training on the job.
9. ________ My supervisor lets me know I am doing a good job when I use my training.
10. ________ My supervisor helps me set realistic goals for job performance based on my training.
11. ________ The resources I needed to use what I learned was available to me after training.
12. ________ There was sufficient technical support available to allow me to use skills acquired in training.
13. ________ At work, budget limitations will prevent me from using skills acquired in training.
14. ________ It was difficult to get materials and supplies I needed to use the skills and knowledge learned in training.

## Appendix F: IRAT/GRAT

### Readiness Assessment

1. What is the average TAT for QN task number 48 at INS for December 2010?
   a. 3.4 days
   b. 2.3 days
   c. -1.12 days
   d. 9.56 days

2. What is the longest actual task TAT for INS QN 200027700?
   a. 40 days
   b. 69 days
   c. 49 days
   d. 4 days

3. What is reason Hawker Beechcraft returned QN 200029015?
   a. Dims undersized
   b. Coating defects
   c. Bent/Twisted/Warped
   d. Delamination

4. Please answer the following questions about customer return QN 200030305:
   a. What is the first open task number?
   b. How long has each task in the process had it?
   c. What is the part number associated with this QN?
   d. What could you do to expedite the processing of this return?

Appendix G

## Value of Teams Survey

Date: ______________________________

| Please circle the number under the phrase that best describes the extent to which you agree with the following statements. | Strongly Disagree | Disagree | Neither Agree Nor Disagree | Agree | Strongly Agree |
|---|---|---|---|---|---|
| 1. Memorization is an important part of learning. | 1 | 2 | 3 | 4 | 5 |
| 2. The ability to collaborate with my peers will be necessary if I am to be successful as a student. | 1 | 2 | 3 | 4 | 5 |
| 3. I have a positive attitude about working with my peers. | 1 | 2 | 3 | 4 | 5 |
| 4. It is a waste of my time to work in groups. | 1 | 2 | 3 | 4 | 5 |
| 5. The ability to work with my peers is a valuable skill. | 1 | 2 | 3 | 4 | 5 |
| 6. In my career, I can be as successful working alone as working with others. | 1 | 2 | 3 | 4 | 5 |
| 7. Collaborating with my peers will help me be a better student. | 1 | 2 | 3 | 4 | 5 |
| 8. Collaborating with my peers will help me in my career. | 1 | 2 | 3 | 4 | 5 |
| 9. Solving problems in a group is an effective way to practice what I have learned. | 1 | 2 | 3 | 4 | 5 |
| 10. Solving problems in a group is an effective way to learn. | 1 | 2 | 3 | 4 | 5 |
| 11. Working in teams in class is productive and efficient. | 1 | 2 | 3 | 4 | 5 |
| 12. Group decisions are often better than individual decisions. | 1 | 2 | 3 | 4 | 5 |
| 13. Solving problems in groups leads to better decisions than solving problems alone. | 1 | 2 | 3 | 4 | 5 |

## Guide to Using the Value of Teams Survey

The Classroom Engagement Survey measures two dimensions of learner engagement: learner participation (LP) and learner enjoyment of class (EC).

The dimension subscales for the CES are as follows:

LP: Items 3, 4*, 5, 7

EC: Items 2, 6*, 8

Distractor: Item 1

*These items should be reverse-scored (i.e., "5" → "1" and "4" → "2").

The item on the CES is designed to reduce students' focusing on the two dimensions of interest, LP and EC, thereby increasing response variability on those dimensions. All operational uses of the CES at Baylor College of Medicine have included this item. Other institutions may have modified or deleted this item; we have no information on the comparative performance of the CES when this distractor item is modified or deleted.

The CES should be administered at the conclusion of a class session, multiple times throughout the course. You should decide in advance which of the dimensions are of interest to you. If you wish to measure more than one dimension, compute a separate dimension subscale score for each student.

## Appendix H: Pre-training Knowledge Assessment Test

1. What does the “BI” in “BI Reporting” stand for?
   a. Business Intelligence
   b. Business Information
   c. Bi-directional reporting
   d. Better Information

2. BI Reports provide “real time” access to transactional data in SAP.
   True
   False

3. What is a Report Variant?
   a. An error message the user receives when the report terminates abnormally.
   b. A “canned” report that has been developed and delived as part of a report category.
   c. A “canned” report that has been modified by the user for one time use (not saved).
   d. A saved set of variables that can be re-used and re-executed.

4. What is a Characteristic?
   a. A field that can be added or removed from a BI report.
   b. The formatting selection of a field or BI report.
   c. The BI report name.
   d. All of the above.

5. Which of the following do you use to set a report filter?
   a. Click the Filter button on the report menu and select the characteristic you want to filter.
   b. Right click on the characteristic you want to filter and choose Filter → Select Filter Value.
   c. Submit a help ticket for IT to set up a filter variant.
   d. Type the name of the characteristic you want to filter in the search box and click the Filter button on the report menu.

6. What date was quality notification 200021276 created?
   a. 08/03/2010
   b. 07/23/2010
   c. 08/09/2010
   d. 08/13/2010

## Appendix I: Post-training Knowledge Assessment Test

1. BI Reports provide “real time” access to transactional data in SAP.
   True
   False

2. What is a Report Variant?
   a. An error message the user receives when the report terminates abnormally.
   b. A “canned” report that has been developed and delived as part of a report category.
   c. A “canned” report that has been modified by the user for one time use (not saved).
   d. A saved set of variables that can be re-used and re-executed.

3. What is a Characteristic?
   a. A field that can be added or removed from a BI report.
   b. The formatting selection of a field or BI report.
   c. The BI report name.
   d. All of the above.

4. What is the average TAT for QN task 04 at INS for March of 2010?
   a. 18.17 days
   b. -4.23 days
   c. 71.64 days
   d. 33.64 days

5. Based on trend reports, what was the total number of QN’s at INS for Dec 2010?
   a. 85
   b. 240
   c. 6
   d. 149

6. What is the reason Hawker Beachcraft returned QN 200020760?
   a. Dims undersized
   b. Installed wrong
   c. Bent/Twisted/Warped
   d. Mislocated

## Appendix J: Descriptive Statistics and Correlation Analysis

**Descriptive Statistics, Reliabilities, and Correlations Between Variables of Interest**

| | Variable | *M* | *SD* | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | PreTgrade Overall | 39.57 | 22.19 | - | | | | | | | | | |
| 2 | IRAT | 45.52 | 23.97 | .14 | - | | | | | | | | |
| 3 | Course Exercises | 60.66 | 29.72 | .08 | .76 * | - | | | | | | | |
| 4 | PostTgrade Overall | 53.62 | 27.25 | .24 | .42 * | .36 * | - | | | | | | |
| 5 | Value of Teams (VT) | 50.22 | 8.29 | .20 | .28 * | .28 * | .28 * | (.83) | | | | | |
| 6 | Peer/Supv Support (PSS) | 48.71 | 9.95 | .26 * | .21 | .30 * | .15 | .58 * | (.90) | | | | |
| 7 | Tenure | 10.08 | 9.18 | -.16 | -.24 | -.06 | -.10 | -.15 | -.23 | - | | | |
| 8 | Age | 3.02 | .95 | -.03 | -.28 * | -.17 | -.09 | -.12 | -.09 | .44 * | - | | |
| 9 | Experience - Computer | 20.08 | 6.99 | .16 | .05 | .03 | .22 | .02 | .03 | -.22 | .29 * | - | |
| 10 | Experience - BI | 2.58 | 1.02 | .16 | .15 | -.01 | .12 | -.12 | .06 | -.02 | .23 | .19 | - |

*Note.* Internal consistency reliablility coefficients (alpha) ar in parentheses on the diagonal when appropriate.

* $p < .05$

Appendix K: Re-assigned Participant Analysis

| | | Re-assigned participants excluded | All participants included | Difference | |
|---|---|---|---|---|---|
| | | | | Mean | Std Dev |
| EMT | IRAT | *M*=42.71, *SD*=28.28 | *M*=42.65, *SD*=27.66 | 0.06 | 0.62 |
| | Post-test Overall | *M*=53.62, *SD*=27.04 | *M*=52.78, *SD*=26.77 | 0.85 | 0.27 |
| | Post-test Declarative | *M*=64.35, *SD*=31.31 | *M*=65, *SD*=30.79 | -0.65 | 0.52 |
| | Post-test Procedural | *M*=45.96, *SD*=41.08 | *M*=44.05, *SD*=41.26 | 1.92 | -0.18 |
| | Pre-test Overall | *M*=37.83, *SD*=21.52 | *M*=37.5, *SD*=21.11 | 0.33 | 0.41 |
| | Pre-test Declarative | *M*=46.38, *SD*=25.6 | *M*=45.83, *SD*=25.18 | 0.54 | 0.42 |
| | Pre-test Procedural | *M*=33.33, *SD*=36.24 | *M*=33.33, *SD*=35.44 | 0.00 | 0.80 |
| TBL | IRAT | *M*=44.25, *SD*=21.05 | *M*=45.53, *SD*=19.95 | -1.29 | 1.10 |
| | Post-test Overall | *M*=54.71, *SD*=29.92 | *M*=54.94, *SD*=29.17 | -0.23 | 0.76 |
| | Post-test Declarative | *M*=55.65, *SD*=35.65 | *M*=56.3, *SD*=35.96 | -0.64 | -0.31 |
| | Post-test Procedural | *M*=54.04, *SD*=39.7 | *M*=53.97, *SD*=38.07 | 0.07 | 1.63 |
| | Pre-test Overall | *M*=37.39, *SD*=21.58 | *M*=36.67, *SD*=21.12 | 0.72 | 0.46 |
| | Pre-test Declarative | *M*=47.83, *SD*=29.86 | *M*=46.3, *SD*=28.24 | 1.53 | 1.61 |
| | Pre-test Procedural | *M*=28.99, *SD*=41.81 | *M*=29.63, *SD*=40.65 | -0.64 | 1.16 |