The South African Institute for Computer Scientists and Information Technologists

ANNUAL RESEARCH AND DEVELOPMENT SYMPOSIUM

23-24 NOVEMBER 1998
CAPE TOWN
Van Riebeeck Hotel in Gordons Bay

Hosted by the University of Cape Town in association with the CSSA,
Forestry Bursary University for CHE and
The University of Natal

PROCEEDINGS

EDITED BY
D. PETKOV AND L. VENTER

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The South African Institute for Computer Scientists and Information Technologists

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PROCEEDINGS

EDITED BY
D. PETKOV AND L. VENTER

SYMPOSIUM THEME:
Development of a quality academic CS/IS infrastructure in South Africa

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FOREWORD

The South African Institute for Computer Scientists and Information Technologists (SAICSIT) promotes the cooperation of academics and industry in the area of research and development in Computer Science, Information Systems and Technology and Software Engineering. The culmination of its activities throughout the year is the annual research symposium. This book is a collection of papers presented at the 1998 such event taking place on the 23\textsuperscript{rd} and 24\textsuperscript{st} of November in Gordons Bay, Cape Town. The Conference is hosted by the Department of Information Systems, University of Cape Town in cooperation with the Department of Computer Science, Potchefstroom University for CHE and and Department of Computer Science and Information Systems of the University of Natal, Pietermaritzburg.

There are a total of 46 papers. The speakers represent practitioners and academics from all the major Universities and Technikons in the country. The number of industry based authors has increased compared to previous years.

We would like to express our gratitude to the referees and the paper contributors for their hard work on the papers included in this volume. The Organising and Programme Committees would like to thank the keynote speaker, Prof M.C Jackson, Dean, University of Lincolnshire and Humberside, United Kingdom, President of the International Federation for Systems Research as well as the Computer Society of South Africa and The University of Cape Town for the cooperation as well as the management and staff of the Potchefstroom University for CHE and the University of Natal for their support and for making this event a success.

Giel Hattingh, Paul Licker, Lucas Venter and Don Petkov
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QUALITY LEARNING, LEARNING QUALITY

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Abstract

The purpose of this paper is to describe the Learning Model and related concepts. In the context of this paper, the following principles are discussed:

• What do we need to learn?
• How must we learn it?

These two questions are fundamental to building a quality learning system. I will cover problems with learning and propose relevant solutions.

Learning models cannot be implemented without providing frameworks or guidelines for operation. Once populated, learning can facilitate process improvement and innovation.

The implementation of models and frameworks rely heavily on people capability. There must be a rhythm whereby communication within a business takes place, allowing everybody to learn from each other’s experiences.

The learning model itself is just another process that fits into the organisational framework. The learning model gives a clear path whereby experiences are evaluated in context of the bigger picture. By having a formalised learning process, enhancing maturity and quality aspects of the business are not as difficult as they seem. The learning model can be implemented with industry standard capability and assessment models.

Section 1: Introduction

Quality learning principles are fundamental in learning quality. As humans we learn concepts in many different ways. Because every individual is unique, it is essential to have processes in place to cater for these differences. There are two primary time zones when looking at learning i.e. learning before doing and learning by doing. Learning before doing involves all aspects of conceptual understanding, while learning by doing is the application of the understanding. A common set of techniques is needed to make these processes practical.

This paper investigates the process of deploying a quality culture by providing direction through learning. Both learning before doing and learning by doing is covered throughout this paper.

Section 1 is this introduction.

Section 2 discusses some problems with learning in the context of an institution or organisation.

Section 3 puts the Learning Model in perspective with a high level overview.

Section 4 explains the concepts behind the process of gaining experiences. Various facets of gaining experiences are covered.

Section 5 covers the three aspects of the evaluation process namely; the investigation of the current state of affairs, the definition of the desired state and the actioning process.

Section 6 explains the concepts behind the education process. This process is a medium by which new and innovative facets of the business are communicated.

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Section 7 discusses ways in which this model may be managed. Essential aspects of deployment and alignment are covered.

**Section 2: Problems with Learning**

**Problems in Context**

One of the biggest problems with learning is the attitude of humans towards accepting new concepts. "When things work, don't change it" is a common response when new ideas are suggested. A process is needed whereby change is ingrained in all aspects of the environment. People hardly ever learn from their mistakes. The software industry still has late delivery on projects, poor quality and products that don't satisfy intended users. A holistic view is needed where lessons learnt from other environments can be reviewed and incorporated into your own. With the implementation of new principles, people don't understand what they don't know. It is essential that a systematic change process is followed. Awareness is one of the fundamentals in implementing learning methods.

Dynamic complexity makes learning from mistakes difficult. Dynamic complexity is the relationship between cause and effect in a complex environment. This means that when there are changes in the environment, you cannot link it directly to an increase in productivity or better product quality. Complexity is reduced when all the facets of the environment are considered in a holistic view.

**Solutions in Context**

Knowledge is the point where we can apply, in context, the learning experiences of a journey. In software engineering, some of the fundamental elements are: Setting strategies, that include all aspects of how the environment should function to achieve goals.

- Efficiency and effectiveness of processes, all processes needed to deliver products or services including roles and skills.
- Building of mature people, processes and technology architecture.

**The Knowledge vs. Learning Problem**

![Learning and Knowledge Curves](image)

*Figure 1 Learning and Knowledge Curves*

Observations and tests have shown that there are two learning related issues to deal with when people operate in an environment. Knowledge does not increase at a significant rate during extensive learning. Knowledge increases only when individuals start applying (learning by doing) concepts.

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1 From *Theory to Practice: Research Territory, Processes and Structure at the MIT Center for Organizational Learning*, July 17, 1995 George L. Roth, Peter M. Senge
2 Research performed by Jay van Zyl in the context of the Trial and Error programs since 1992. No published material is available yet.
It is found that it is virtually impossible to have a combined learning and knowledge curve. This means that there is always a grey area, where understanding related to specific topics is lacking.

When individuals become comfortable with the environment and concepts that are needed to perform their individual roles, the risk of making mistakes are as high as a rookie. There is always something more to learn about a subject. The time frame between the "comfortable" and "wake-up call" states must be shortened, and people must understand that this is going to happen. If a systematic process of re-alignment is implemented the risk of not achieving goals is significantly reduced. The learning model addresses the re-alignment process.

Section 3: Learning Model

The Learning Model is used as a tool to help the process of "learning from your mistakes." The basic principle of this model is "Is there a better way of doing things?" Understanding your own learning patterns will assist in increasing your knowledge and in return influence everybody in your environment. This is one of the most important aspects of process improvement and maturity.

![Learning Model Processes](image)

The learning model is implemented at various levels in an organisation or institution. The cycle of evolution is slower for direction setters than for the more focused and detail oriented environments.

The process normally starts with the recording of project experiences in ways that make future analysis possible. These experiences are used during the evaluation process to determine where things can be improved without losing sight of the "bigger picture". The evaluation process produces work-products that will be used to enhance, improve or re-engineer education or communication programs. This facilitates re-alignment of processes, people and technology. At this point, new training candidates can benefit from the experiences, and existing staff can go through cycles of re-training. The re-training concentrates on new innovations and the areas that change.

There is a reverse spiral that indicates the continuous feedback needed for the process to operate effectively. Experiences are based on what was taught during the education process. Evaluation is based on the experiences over a time frame.

Finally, the learning model is a high level process that encapsulates, or co-exist with many other models, architectures and frameworks.
4.1.1.2 Learning Model and Architecture

Figure 3 shows that the learning model has a longer cycle of execution at strategic level than at specialist level. Goals and objectives, roles, skills, etc. apply to all levels in the environment. The vision and purpose is a guide to everything that happens.

The different spirals happen independently, but there is a direct link to the strategic direction provider (vision and purpose). Each cycle focuses on the current issues.

The next sections cover the four major Learning Model elements; experience, evaluation, education and management of the cycle.

Section 4: Experiences

Experiences are the happenings of a process. The project is executed, based on pre-defined criteria. It is the journey.

When people embark on a project they bring with them a set of skills, but also preconceived ideas and an attitude towards the new endeavour. The learning model is a vehicle to remove unwanted issues by creating common criteria through which work is performed. This means that experiences are recorded in the context of the environment and its facets, as follows:

- Vision, mission, goals and objectives, the abstract view of the environment. These provide direction and a sense of belonging.
- Process is the how. Work-products and other artefacts are produced. There are two types of processes; primary processes and secondary (support) processes. Primary processes contribute directly to the vision and purpose, while secondary processes support primary processes. Primary processes in software engineering include:
  - Software development process.
  - Product delivery life cycle.
  - Supply process.
  - Purchasing processes.
Secondary processes include:
  - Quality assurance.
  - Quality control.
  - Testing processes.
  - Documentation processes.
- Organisation, the organisational structure that was used over a period of time. Structures are designed to fit processes and strategies. This area requires careful design.
- Roles, skills and positions are the skills grouped by roles and implemented with organisational positions. Skills are developed over time, normally with a particular role in mind. Experiences assist us in knowing how skills can best be applied. It may result in new roles and even positions.
• Infrastructure is the environment that is used. People need comfortable environments where learning can take place easily.
• Technology is the enabler or inhibitor in delivering solutions. Technology architecture is the primary area of focus. All designs over the life cycle of a product are tied to a particular architecture. This means that architectural change may result in major changes in all other facets of product delivery. Technology as an inhibitor is where certain concepts cannot be implemented for effective use.
• Objects are relevant elements, vital during the process of gaining experiences.

With the experiences recorded against each of the facets, measurement and metrics may be applied to provide input into the evaluation process. Effective learning cannot take place unless there are baselined metrics to work from. Maturing people, process and technology aspects can only happen with a proven measurement system.

Forum Management

Forums are used to manage by process. It is a concept that is used to eliminate layers in decision making and direction setting. A forum has a number of crucial ingredients:
• Direction. The direction setters set direction. This does not entail management, but means that goals and objectives for a specific purpose must be clearly defined.
• A leader and facilitator. The leader provides direction and is normally part of an executive team.
• Members. People are invited to the forum based on their skills, background and the positive contribution to meeting the goals and objectives. Once allocated to the forum, ownership lies with the individual to deliver in both the existing role and the forum role.
• Time factor. Some forums live longer than others. Forums that are not useful should cease to exist and should be closed with the normal forum wrap-up process.
• Process. The forum must have a process or processes that are used to deliver results.
• Projects are used to implement the process and to satisfy the direction setting.
• Rhythm. This is the cycle through which communication takes place amongst the forum members.

Data collected during the existence of a forum is vitally important to the evaluation process. It is needed to implement the forum management concepts with discipline.

Forums are used, partly to:
• Implement learning model cycles.
• Investigate process innovation or process changes.
• Set standards for new technologies.

Beyond Experiences

During the initial time frame of the learning model implementation, many changes will occur. Experiences will be based on different concepts with each iteration. Changes to concepts will be less drastic as the environment matures over time.

The best way to learn from your mistakes is to have a process whereby all aspects of what went wrong or right may be analysed. The comment “Hindsight is an exact science” is often used by project leaders looking back at projects, but how often do they actually learn from their mistakes?

Section 5 : Evaluation

We often find ourselves being sucked into situations, without looking at the overall picture. It is important to stand back and evaluate all the issues - including the general state of the environment. Innovation cannot take place unless a rethink is done at key points in the life cycle. We have to force the learning curve to happen. It makes us more aware and careful.

The three key component in the evaluation process are:
• Assessing the current state, in context of experiences.
• Definition of the desired state. This must be in line with capability and long term development.
• Actioning of changes to the environment to achieve the desired state. This provides input into the education process and sets the framework of operation for experiences to follow.
Assessing the current state

Each facet of the environment must be assessed. This entails collecting data during the experiences, which may then be used in context.

Process assessment tools such as SPICE (Software Process Improvement and Capability dEtermination) can be used to assess process capabilities against international standards. The QAI (Quality Assurance Institute) has a maturity model that is focused on process and people maturity. Assessment tools, once implemented, should be used for a long period of time to have effective benchmarking information.

People assessment can take place against models such as the SEI’s PCMM (People Capability Maturity Model) or the RPMM (Rubico People Maturity Model). The RPMM has an assessment mechanism that is independent of the process maturity model. It revolves around the individual and team based development. This model will be covered later.

Technology Architecture assessments may be done in accordance with the SEI3 Software Architecture assessment models.

Knowing your customer is fundamental in defining strategies to take product to market. There is a link between what the business or institute does and how the customers perception of how things are done.

Customer and supplier surveys are vital to understanding the current state of affairs. Previously baselined surveys are used to assess the capability of the environment to implement customer focused processes.

Define the desired state

Everything must be carried out in accordance with the vision and purpose of the business or institute. People are the biggest obstacle to achieving the desired state. Aspects of people change management are covered during the education process.

The desired state must include definite direction for attaining what the culture should be. Since this is a slow and tedious process, care must be taken regarding the values, principles and philosophies that are communicated. The direction setters must “walk the talk”. Examples of cultural aspects:

- Open door policy. Most people do not realise the implication of this. Very hierarchical based environments cannot handle this. Having people “going over your head” can cause political problems.
- Ownership. Total ownership means that nobody is responsible for your actions but you.
- Customer centric. This customer is not necessarily an outsider, internal processes can rely on your work-products and other deliverables.
- Flat structure. This is a buzzword of the 1990’s. Statements such as “it is flat as long as you’re on top” are made regularly by people in an environment where it’s preached but not practised. Only mature and educated people are able to work in this type of environment.
- Admit to mistakes and do not penalise others when mistakes are made. This is one of the most difficult disciplines to implement. It requires people to admit when they do something wrong, most people can not do this.

Statistical methods can be a useful tools when making decisions about changes. Sampling concepts will depend on the criticality of the facet.

Action changes

Before changes can be actioned, a careful study must be performed whereby the impact on the environment is assessed. There are two processes that must take place:

- Horizontal gap analysis. This is the process whereby all aspects of the current environment are analysed and compared against the future desired state. This may involve major redesign or minor changes to a process.

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3 Software Engineering Institute.
• Vertical gap analysis. This is the process of making sure that the facets that describe the environment are aligned. There might be goals and objectives that have no process/es assigned, meaning that there will never be a set of deliverables to satisfy these goals and objectives.

Standards and patterns must be defined before changes or innovations can be rolled out.
• Standards are absolute rules through which innovation is implemented.
• Patterns are the variations to the standard that are allowed in the target environment. Patterns are a lot more dynamic than standards and evolve a lot faster.

Feedback into the education process is one of the vital links in this model. It is the first major step in getting process and people effectiveness enhanced.

The work-products produced during the evaluation phase will be used as one of the inputs when designing new and re-developed education programs.

Some of the steps to finalise the evaluation phase are as follows:
• Perform completeness and correctness checks on all work-products.
• Evaluate the relevancy of the suggestions made.
• Produce lists of key performance areas that need addressing.
• Perform impact analysis.
• Execute the process improvement cycle.

Section 6 : Education

Is education only about teaching people new skills?
No. Education is about the successful transfer of knowledge and attitude. Education is about communication and respect. It is one of the cornerstones of modern society. Education is about breaking old habits and accepting new paradigms because knowledge is power!

People must have the right tools to execute processes effectively. This process of the learning model concentrates on what is needed to effectively deploy innovation. It is essentially the learning before doing phase. On-going and consistent cycles of learning are very important. They facilitate the development of individuals into confident professionals.

People, not processes or other facets in the environment, make things happen. That is why this process should be considered a critical performance area. It should be a strategic weapon.

People Maturity Model

Individual and team based development takes place in the context of the people maturity model. The model is independent of its content because it provides a framework for human development.
Figure 4 describes the people maturity model. The X-axis and Y-axis indicate two primary roles, management and specialisation respectively. The maturity ratings are depicted between the management and specialist roles; i.e. unaligned (before entering the model), conceptual, managed, leading and visionary. The dashed arrows indicate two optimum profiles. Each element is discussed below.

One of the fundamental concepts used in this model is; people can only participate in improvement programs and provide visionary leadership once they are educated in the methods and techniques used in an environment. This means that people need to understand the concepts before they try and change them. This, in turn, means that everybody must participate in moving from “unaligned” to a desired maturity rating.

The maturity ratings involve the development of individuals and teams:

- **Conceptual:** the focus is on the individual. People will not be able to function in a mature environment if they don’t know their personal strengths and weaknesses. This level focuses on getting people to understand what they don’t know. This is the springboard for further development. People at this level have not crossed the “wake-up” line as per the learning vs. knowledge curve graph as shown in Figure 1.

- **Managed:** the focus is moving towards the team. For teams to function correctly, proper rapport amongst team members and other teams must be established. Individuals become focused on the abilities of others, not just themselves. Individuals now start to participate in improvement programs and assist others in moving up the maturity scale. They now know what they are worth.

- **Leading:** the focus is on cross-team and strategic impact. Individuals at this level can set direction. It can be based on a specialist topic or general management.

- **Visionary:** these are very few individuals that can innovate and lead. Specialists at this level will concentrate on technological innovation, while management at this level provides leadership to people.

The two profiles indicated on the maturity model are just an outline to show that no specialist can function without management properties, and no manager can function without some specialist (technical) knowledge of the environment.

The key hypothesis of this model is that people must do what they enjoy. They must feel wanted in the context of the environment in which they function. It must be possible to breed obsession.

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**Figure 5 Risk Curve**

Risks are managed better as people move up the maturity scale. Practical assignments are used to measure productivity increases. The key emphasis is directed from the individual to the team and lastly to the organisation.

**An Education Concept**

Adults learn by applying theory. The “Trial & Error” training concept allows individuals to get to know the theory and then to apply it in a controlled environment. This facilitates learning by doing. The content of the training material is set during the evaluation process. It is highly specific to the implementation and environment.

Trial & Error programs are used to direct the people in an organisation or institution towards a specific goal.
People entering the programs are normally not aligned with concepts to be taught. The funnel in the graph shows that people have to go through a number of key pain barriers before a satisfactory result can be achieved. The program explained here shows that people are not aligned at all during the induction phase.

At this stage, the ideas supporting the concepts are explained. The content of this paper is an example of this. People are starting to understand the extent of the facets in an organisation or institution by the time the theoretical training is completed. It is only at the end of the Trial and Error project that concepts are fully understood and the context is seen clearly. The final presentation is a medium for the candidates to show what they have achieved. This initial program runs over a three month period.

Ongoing education is carried out, based on required skill updates and as the evaluations are implemented in the environment.

Section 7: Managing the Cycle

In Figure 3 I show how the Learning Model implementations correlate to the facets needed to achieve the vision and purpose. The management of integration amongst the different implementations is vital for continuity. Forums must be used to implement the processes, independent to the organisational structure.

The first cycle is the most difficult and the most important. Concepts are new and people do not always believe in them. That is why this model requires strategic involvement. Learning must be part of the purpose of existence. The first evaluation is normally an eye opener as many things are taken for granted. Second and subsequent cycles are easier as a rhythm is established. Strategic learning should have a longer cycle than specialist learning. Once direction is set, the entire environment should be focused for a fixed period of time to provide stability. Continuous communication must exist between everyone involved in the environment, where the learning model is implemented.

The key elements of focus when managing the cycle are:

- Managing people and individual capabilities.
- Managing processes and process capability.
- Managing core competence.
- Managing innovation. Innovation is the only thing that differentiates competitors.

Conclusion

I found that it is very difficult to operate in an environment where no abstract definition exists. This paper covers the fundamentals of the presented models and is intended to provide you with an abstract and holistic view.

Reference