



# Problem Based Learning for SMEs A Handbook



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## About this handbook

The purpose of this handbook is to help SMEs understand Problem Based Learning (PBL) and how it can be used in their companies. The handbook is supported by an ICT platform and learning material which is being developed between September 2015 and January 2016. This is freely available from the website [www.archimedes2014.eu](http://www.archimedes2014.eu). This handbook can be used as a reference guide for those considering using Problem Based Learning within their company. An accredited facilitator and learning course will also be available from September 2016. It is targeted at owners and managers in SMEs. The handbook explains:

- What is PBL
- The Benefits of Problem Based Learning(PBL)
- Implementing PBL - a guide
  - How to prepare your company for PBL
  - Selecting a problem for PBL
  - The PBL process
- The roles in PBL
- Supporting the PBL process
- The use of ICT in supporting PBL.

The handbook is a product of the Archimedes project which is funded by the European Commission under the Erasmus plus framework. It has been developed as a result of extensive research done in early 2015 with over 300 European SMEs.

- 340 SMEs were surveyed,
- 5 focus groups with 66 participants were conducted,
- 5 case studies were constructed
- 11 research projects were reviewed
- Over 70 research papers were reviewed

This research allowed us to identify best practices in the areas of Informal Learning, Problem Based Learning and ICT Based Learning. As a result this handbook was developed to outline a Problem Based Learning approach to help meet the training needs of SMEs throughout Europe while leveraging best practice in the field.

# 1. What is Problem Based Learning?

Problem Based Learning (PBL) is an approach that requires learners to construct their own knowledge and has been widely used in higher education. It is applied particularly in medical and nursing education. Students learn through experience (Dewey 1916). Experiential learning is widely used in SMEs (Armstrong, 1992).

The traditional approach to education is to master content and then present a problem to the learner. However, with PBL, the learner encounters a problem and then constructs the relevant knowledge to address the problem. (Jonassen, 2011)

Problem Based Learning (PBL) is a learner centered approach in which a teacher facilitates the activity by guiding the learner in a process of inquiry. Thus the teacher plays the role of a mentor. It is known to positively affect learning outcomes and develop the skills that are critical in today's workplace, namely problem solving, logical thinking, creative thinking. (Sendag 2009)

In PBL rather than a tutor speculating the content the learner needs, teaching this to them and assessing students with specific problems, the learner identifies or is presented with a complex business problem. The learner then undertakes a process to identify and apply the relevant material required to solve this problem. A trained mentor or facilitator guides them through this process. Thus the learner is self directed and motivated. They are actively involved in the learning process and the learning is immediately related to their needs as well as the needs of the company. PBL is known as a constructivist approach to learning as the learner constructs their own knowledge.

Within an educational context PBL learners are provided with a library of resources as they undertake learning in a specific subject area. However, in a company context there will be no library of resources, it will be the responsibility of the learner to search for these resources. Thus the student must be taught the skills on how to search for and apply relevant knowledge and guide them where to search for this information. The Archimedes project is developing learning material to assist this.

The success of PBL is largely reliant on successful mentoring. The role of the mentor or facilitator is key to the success of the PBL process. The mentor acts as a motivator and a guide. They do not need to be an expert in the subject area but do need to be aware of the PBL process and how to support learners. The rest of this handbook details the pros and cons of using Problem Based Learning and guides the reader through the process. There is also online learning material and accredited courses available to support the handbook (this is being developed between September 2015 and January 2016). More information is available at [www.archimedes2014.eu](http://www.archimedes2014.eu)

## 2. The Benefits of Problem Based Learning (PBL)

Several studies have shown the positive effect of Problem Based Learning

- PBL facilitates deep learning, rather than the memorisation of material. Learners reflect on what they have learned and how it can be applied to new situations (Newble and Clarke 2009)
- The learner is more likely to retain and remember what they have learned (Schmidt et al 2011;Dolmans and Schmidt 1996)
- Problem solving skills are developed (Schmidt et al 2011;Dolmans and Schmidt 1996)
- Increased critical thinking (Sungur 2006)
- Learners are more intrinsically motivated to achieve their goal. (Sungur 2006)
- Learners place a higher value on tasks as they can see the benefit of these (Sungur 2006)
- The learner takes control of their own learning (self regulate) (Sungur 2006)
- PBL encourages students to reflect on what strategies to apply to address a problem (meta cognition) (Sungur 2006)

PBL can provide a number of benefits to SMEs.

- Provides immediate return on investment
- Is low cost
- Is on the job training, thus the learning is highly contextualised and situated
- Is practical and related to the SME's needs
- Encourages innovation and independent thinking
- Provides a greater understanding of a topic due to active learning and engaging in the material
- Requires an increased motivation to learn thus helps develop a learning culture
- Develops skills in critical thinking, leadership, communication and problem solving

However, there are a number of limitations associated with this form of learning. The transition from traditional learning to Problem Based Learning can be difficult. Learners search for and apply new knowledge on a continuous basis in their own personal lives. However within a learning context they find this difficult to do. To reduce problems with the transition it is important to educate learners of the PBL process and guide them through this. (Hmelo Silver 2004;Huang et al 2003;Jost et al 1997;Fiddler and Knoll 1995) . The Archimedes project has developed learning material to assist this.

The success of PBL is largely reliant on sufficient guidance from a mentor. Facilitators need to be educated on the PBL process and their role. Furthermore for SMEs expertise may not always be in-house and they may need to leverage from external experts through networks and communities. Between September 2015 and January 2016 the Archimedes project is creating a facilitator learning course and a learner network to support PBL..

### 3. Implementing PBL in your company – a guide

To ensure the successful adoption of PBL in your company there are a number of elements that must be considered

- 1) Preparing your company for PBL – This section looks at how to ensure an open and self directed learning culture favourable to PBL
- 2) Selecting the correct problem for PBL – This section guides companies on how to choose the correct problem
- 3) How to implement PBL – This section examines the 9 steps to implementing PBL

#### 3.1 Preparing your company for PBL

In order for PBL to succeed in your company learners must be encouraged and supported. A culture of learning needs to be fostered. Senge, 1994, defined a learning organisation as a place "where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning how to learn together."

In our research many SMEs expressed the desire to implement a culture of learning and self motivation (or self directedness as it is known in the field of learning). The project reviewed literature and best practices in fostering a learning culture. To do this a number of elements must be considered. (Duden, 2012; Gill, 2009; Gaile, 2013; Senge, 1994; Garvin, 1985)

- 1) **Trust, communication and support** – learning must be seen to be valued in the organisation and learners must be encouraged to explore new ways of doing things (in a structured manner) and apply what they have learned. Managers and trainers must communicate in an emphatic manner the importance of taking initiative and encouraging the employee to try new approaches and sharing these. Employees should be motivated to look at the organisation and what skills need to be developed for it to be improved. To do this all staff should not see suggestions as criticism but opportunities, this must also be emphasised within the organisation. Rather than criticising people, staff should appraise and evaluate work practices. New efforts should be recognised and made public within the organisation. To build trust managers must look at reducing the perception of a 'blame culture'. This may be done through the use of mental models.
- 2) **Mental models and transparency of information for decision making** – lack of trust in organisations may often be due to a perception of a 'blame culture'. Employees or management may be seen to make irrational decisions when often a lot of thought may have been put into reaching this decision. Or employees and management make negligent decisions with little thought. Sometimes when these decisions go wrong it can lead to severe consequences and lack of trust.

Mental models involve the learner explaining their thought process around making particular decisions or their thought process about how the solution will work and why. It is basically articulating how and why they made a particular decision or implemented a solution in a particular way. Often it is not the final decision but the approach taken to reach that decision which is the most beneficial. For example a company might decide to set up a distribution center in a particular location. The thought process behind how and why they made that decision and implemented it can be applied to another similar instance within

the company in the future.

Another example may be if a machine operator has low defect rate and high output due to the machine settings they choose the benefit is not what machine settings they use but why they choose to set the machine in that way at any given time. Similarly for a service environment if an insurance broker has a low churn rate of customers without offering excessive discounts how does this broker interact with existing customers.

To improve trust and reduce the perception of 'blame' staff should be encouraged to reflect on the information they use to make decisions, if this information is reliable, how they can apply it and what process they can undertake to reach decision.

- 3) **Systems thinking** – a holistic view of learning and the organisation. All too often in companies, particularly larger organisations staff are concerned with their own work practices. Each department has their own performance metrics to achieve and functions are concerned with reaching these targets. Employees should be encouraged to examine how their work and practices impact other areas of the organisation. For example a sales department might have a target to achieve a certain number of customers, to do this they might promise the customer the 'sun, moon and stars' however this may not be feasible from a production or financial perspective. Employees must be encouraged to work in cross functional teams to identify what changes could be made to improve their practices and achieve a balance between performance metrics and overall organisational harmony. Problem Based Learning can encourage this.
- 4) **Construction of knowledge** - learners must be encouraged to search for their own knowledge and learning material. As mentioned previously individuals often do this on a daily basis in their personal lives but feel that in a learning or a business context for which other people are responsible that they do not have the expertise or authority to construct or develop new knowledge. Guiding learners to do this with the skills and expertise to enable them to search for and apply the relevant knowledge is key. Starting to delegate small definite tasks can build their confidence. For example, I am looking for information on applying for quality standards, would you mind having a look on the ISO website and see what their application process is?
- 5) **Collaborative learning** – to encourage a holistic view of the organisation and to build trust collaborative learning is required. Learning is a social process and many learning theorists have emphasised this. Without interaction with a mentor, peer or tutor our learning is limited. A learner might read a history book and learn a sequence of events such as that which occurred during the second world war however by discussing with a peer they will receive different interpretations and perspectives other than their own view. There is more than one perspective on a situation. For example, you might have a particular way of doing your job that you think is efficient. However, you might go to your colleague to speak to them about a work issue and notice they have a different way of doing things. You ask them why they do it in this way and learn that it saves more time. You decide to adopt this way of doing the process.
- 6) **Opportunities for reflection and corrective action**– In order for continuous learning to occur it is important that the learner reflects on what they have learned and if it was effective. Using the previous example if you asked the learner to have a look at how to

apply for ISO certification once they give you this information you ask them to reflect on their learning. Did you find it difficult to find the information? Why do you think this is? What was the content like, was it easy to understand why? How would you go about putting the application together or looking for advice about how to put an application together.

- 7) **Self directed learners** – A self directed learner is one which takes responsibility for their own learning. Giving the learners the confidence to identify opportunities for learning and constructing their own knowledge required to learn a new skill is key. Emphasizing the need for employees to look at the organisation and opportunities to develop new skills to improve the company as a whole. It integrates several of the previous points such as trust, communication and support and construction of knowledge.

### 3.2 Selecting a problem for PBL

When identifying a problem for PBL there are a number of considerations which must be made. Firstly we need to consider the learner(s) and their level of learning experience:

- 1) Has the learner done any training or learning?
- 2) Has the learner used PBL previously?
- 3) How self motivated is the learner?

If the learner has not undergone any training or learning previously and has low self-motivation selecting a simpler problem which has more clarity may be appropriate for the initial PBL process. Once the learner has successfully executed this, a more complex problem may be chosen for the next time. If you have a mixed group of learners with various levels of training and self motivation support may come from peers and so a more ambiguous problem may be selected.

Once the level of the learners has been established a problem must be selected for the PBL process. When selecting a problem it must consider:

- 1) Clarity of the problem – How clear is the problem? Depending on the learner, the level of ambiguity of the problem can vary, e.g. How can we develop new business opportunities? or How can we export our product to Asian countries? (Hung, 2009)
- 2) What are the organisational goals for the PBL process? – To ensure that the problem is clear it is important to specify what you want the organisation to have achieved once the PBL process has been completed for example – a new customer base, increased profits, a new market to sell products in?
- 3) Is there sufficient information to allow the learner to solve the problem? - This will depend on the clarity of the problem. Are enough facts known about the problem? For example if the company wishes to attract new customers what past approaches have they tried, what sectors do their main customers operate in? (Hung 2009)
- 4) Can the problem be solved in a reasonable time period?
- 5) Can it be solved collaboratively? PBL is a collaborative process and so the problem must be large enough to allow two to three learners to work together.
- 6) Will the learner have the time to solve this problem on the job?

Once a problem has been selected it is important to classify the problem as the appropriate problem type. The reason for this is that to solve the problem there are different support materials and different approaches (or scaffolds) a facilitator can use. The responsibility of the SME is to understand the problem type and categorise it. Jonassen (2011) stated that there were eight problem types. From our research on the common problems faced in SMEs, four of these problem types are appropriate to SMEs. See table 1 for problem examples:

<b>Problem Type</b>	<b>Example of Problem</b>	<b>Instructional material (schema)</b>	<b>Scaffolds</b>
<b>Troubleshooting</b> – this is mainly aimed at technical problems and highlights faults with a system or an approach and identify a solution	How to fix a machine on a production line. Fixing a bug in an IT software system	<ul style="list-style-type: none"> <li>- <b>Worked examples</b> of similar problems and how it was solved</li> <li>- <b>Case studies</b> an analysis of how a learner solved a problem and what if scenarios</li> <li>- <b>Prior experiences</b> – Learner’s story of how a similar problem was solved</li> </ul>	<p><b>Causal Reasoning</b> - Getting the learner to understand the causes of the problem and the relationship between them to infer a solution or diagnosis, e.g. Why does a decrease in price not result in increase in customers? The use of causal maps may help.</p> <p><b>Argumentation</b> - requiring the learner to articulate why decisions were made (argumentation)</p> <p><b>Modelling</b> - the components of a problem and how they relate the use of concept maps may help</p>
<b>Decision making</b> These problems require learners to decide on which solution to pursue out of a number of different alternatives. It is complex and depends on a number of factors	To increase the number of customers should a company export to a different country, increase marketing activities or reduce prices?	<ul style="list-style-type: none"> <li>- <b>Worked examples</b> of similar problems and how it was solved</li> <li>- <b>Case studies</b> an analysis how a learner solved a problem and what if scenarios</li> <li>- <b>Prior experiences</b> – Learner’s story of how a similar problem was solved</li> </ul>	
<b>Strategic performance</b> This is a complex problem which may require a number of approaches to solve an overall problem.	To improve cash flow a company may need to use forecasting methods to reduce over ordering stock, collaborate with customers to improve forecasting accuracy and negotiate with suppliers regarding credit terms	<ul style="list-style-type: none"> <li>- <b>Prior experiences</b> – Learner’s story of how a similar problem was solved</li> <li>- <b>Alternative Experiences</b> - Stories from different perspectives (people in different roles) of how a problem was solved</li> </ul>	
<b>Design problems</b> – associated with how to design a product, business or a process within a company.	To break into a new market a product may need to be redesigned taking into consideration the customer requirements.		

**Table 1: Jonassens (2011) problem classification, instructional schema and scaffolds**

### 3.3 Implementing PBL

Once the problem has been clearly defined and the problem type identified, then it is possible to start the Problem Based Learning process. Problem Based Learning consists of nine steps. At each stage the learner can refer to the appropriate instructional material which is being developed by Archimedes and the facilitator can use the appropriate scaffolds to help the learner through the process.

Below is an outline of the 9 step Problem Based Learning process:

- Step 1: Identify and clarify unfamiliar terms presented in the problem scenario.**  
This ensures that the problem is well understood – the learners read and review the problem presented by the facilitator and they then note what terms they do not understand. Other learners and/or the facilitator outline or clarify what each of these terms mean.
- Step 2: Define the problem in terms of what needs to be understood**  
This involves giving a title to the problem and asking questions such as “what do we know about the problem”, “what is going on here?” Any data that is known about the problem is gathered and put into the problem definition.
- Step 3: “Brainstorming”**  
Here the learners identify possible solutions or hypothesis on basis of prior knowledge; learners draw on each other’s knowledge and identify areas of incomplete knowledge. The learners look for causal relationships between data and develop hypothesis or solutions based on this. Causal maps and mind maps can be used. Where data is incomplete this is highlighted for further exploration.
- Step 4: Review steps 2 and 3 and arrange feasible explanations –**  
The learners reflect and analyse the results of the brainstorming they think about the relationships between different concepts and build a conceptual framework or model of the proposed solution.
- Step 5: Formulate learning objectives**  
The group reaches consensus on the learning objectives. The learning objectives should be concerned with addressing the problem. The facilitator ensures learning objectives are focused, achievable, comprehensive, and appropriate, i.e. What the learner needs to achieve in the self-study.
- Step 6: Private study**  
All learners gather information related to each learning objective. The learner is required to collect, evaluate (the reliability) and apply material to a practical solution. To do this the learner needs to keep the learning objectives in mind and ensure the information they gather is related to one or more learning objectives.
- Step 7: Synthesis**  
The group shares results of private study (learners identify their learning resources and share their results). These are synthesised into a final solution which is applied to the problem.
- Step 8: Reflection**

The learner reflects on what they have learned about the process and the problem and identifies what they would do differently if faced with the same problem again. They articulate why they made particular decisions and the reasons for implementing them in a particular way.

**Step 9: Further application**

The learner thinks about how what they have learned can be used again or in other areas in the business.

Table 2 illustrates the Problem Based Learning process applied to a sample problem.

<b>Sample Problem</b>
<p>Company X has problems with cashflow. Some months there is a shortfall and they find it difficult to pay suppliers, other months there is no problem and there is sufficient funds to pay suppliers and other debts. It is becoming more difficult to receive overdrafts from the banks due to new financial rules. In the past 12 months our overdraft has reduced by 20%. In the past year they have had to rely on overdrafts for 8 out of the 12 months. As a result of the Problem Based Learning process we would like to</p> <p>1) Reduce our dependence on overdraft facilities from 8 months to 2 months</p>
<b>Step 1: Clarify Terms</b>
<ul style="list-style-type: none"> <li>• Cashflow – this is the money flowing into and going out of the business. It depends on income and expenditure. When a deficit occurs there is more money going out (expenditure) than coming in (income)</li> <li>• Income – our income comes from business and domestic customers</li> <li>• Expenditure - Our main costs are rent, light, heat and we have a large amount of staff costs, the main staff costs are sales representatives. The main non staff costs are stock.</li> </ul>
<b>Step 2: Define Problem</b>
<p>The problem could be occurring for one of five reasons (or a combination of these)</p> <ul style="list-style-type: none"> <li>• Sales – our sales from the domestic market are only 20% of our business. Our competitors receive 40% of their sales from the domestic market. Therefore there is a potential to attract more domestic customers boosting our overall sales. Domestic customers do not require credit and so would bring in immediate cash to the business</li> <li>• Carrying excess stock when the demand is not there in a particular period – each month we carry the same stock despite the fact that sales can vary from month to month. This is because it is difficult to estimate sales as they can vary. Some months we have a short fall and have to order stock from the warehouse because these are in small batches we cannot avail of discounting.</li> <li>• Credit terms operated for our business customers – we offer our business customers a 35 day credit. This is why we have such a high volume of business customers compared to our competitors. However we pay our suppliers every 30 days.</li> <li>• Excess costs in certain parts of the business (perhaps sales) – due to the high volume of business customers we have a large number of sales representatives to allow us to foster a close relationship with our customers. This is an extra cost</li> <li>• Poor sales forecasting which leads to excess stock</li> </ul>

### Step 3 and 4 : Brainstorm solutions and review results

#### Proposed solutions

- Identify new approaches to forecasting sales to reduce excess stock
- Collaborate with customers to determine potential orders
- Reduce costs (implement a sales management system to allow customers to self order and reduce sales staff)
- Increase the number of domestic customers which do not require credit
- Apply to the bank for an overdraft
- Reduce credit offered to business customers

#### Review of results

The main reason for the company's success in attracting business customers are the close relationships between sales representatives and their customers and the credit rate offered to the business customers thus the solution to reduce credit terms and sales staff is not feasible.

The bank cannot increase its credit terms more than it has and this avenue has already been pursued.

Increasing domestic customers takes a significant amount of marketing the company has no marketing expertise and marketing consultants can be extremely expensive.

The company has an excellent relationship with business customers and so collaborating with these customers to forecast potential orders is a feasible solution and should be pursued.

### Step 5: Learning objectives

1. Identify approaches to forecasting both from other companies (e.g.do our customers use it) and textbooks/internet
2. Identify the forecasting approaches the company uses
3. Identify what data is required to forecast orders
4. Determine what kind of sales data our customers have
5. Determine if our customers will share this data
6. Examine the tools used for forecasting, how expensive they are and how they can be used.

### Step 6: Self study

#### Learning objective one and two

##### *Forecasting used in other companies*

I spoke to three customers to find out what forecasting approaches they use. One customer does not use any.

A second customer uses an excel spreadsheet to track the forecasted sales and actual sales for the period. Where there is a shortfall the customer adjusts the forecasted sales for the following month. The company does not find it reliable

A third company tracks its forecasted sales and actual sales over 12 months. They noticed that in some months there is more of a demand for the product than in others so they used a seasonal indices and find it is more accurate than the previous approach.

*Forecasting approaches our company uses*

I spoke to the procurement team and they said that they use the previous months order to make the next order. This is naive forecasting.

*Forecasting approaches from textbook/internet*

Resources

<http://www.poms.ucl.ac.be/etudes/notes/prod2100/cours/Part%206-Forecast.pdf>

<https://hbr.org/1971/07/how-to-choose-the-right-forecasting-technique>

<http://www.smetoolkit.org/smetoolkit/en/content/en/416/Demand-Forecasting>

<https://www.youtube.com/watch?v=g9LhOIF7rpo>

From my research forecasting is based on statistics there are some very mathematical resources but others that explain them in a simplified format. I found that there are four main forecasting methods:

- Naive – basically where you use the previous months sales to make an order for the next month
- Weighted average moving – where you weight the most recent sales higher than earlier sales and get an average for these
- Exponential smoothing – where a smoothing factor is applied to most recent sales to make a more accurate estimation. It is useful where changes in sales are not random but dependant on factors such as seasons
- Seasonal indices – an index is calculated for each month and applied when calculating the sales for future business periods

In addition there is a number of methods of measuring the accuracy of these forecasts. This will allow us to evaluate how accurate the forecast is. The main methods are mean average percentage error and mean absolute deviation.

### **Learning objectives three, four and five**

*What data is required*

The only data that seems to be required is forecasted demand and actual demand for a 12 month period to increase the accuracy of the forecast. Other information can be derived from formula.

*What sales data do our customers have and will they share it (how can it be shared)*

All customers have data on their sales. Most customers have a database of the orders received each month, customer data of who made the order, number of sales returns and the reason they returned these. Three customers have given us a sample of their records and this data can be used. (see attached)

*Sharing of data*

The companies cannot share the data from their own customers due to data protection laws, however they are prepared to share the number of our products they sell every month over the past year. However it is not in excel format but can

- Be entered manually by a member of the PBL team. This will be time consuming.
- Some companies have said that they can export the information from their database to a pdf file.

## Learning objective 6

*Examine the tools used for forecasting, how expensive they are and how they can be used.*

Excel can be used as a simple tool for forecasting. It is cheap and easy to use. This is what customer 3 uses. The Analysis tool pack in excel contains functions for exponential smoothing and moving average. A number of example templates are available online

Exponential smoothing - <https://www.utdallas.edu/~metin/Ba3352/Excel/exposmoothing.xls>  
<http://people.duke.edu/~rnau/411outbd.htm>

Seasonal indices - <https://www.utdallas.edu/~metin/Ba3352/Excel/seasonalforecast.xls>  
[www.youtube.com/watch?v=uWvSnJ6rbs](http://www.youtube.com/watch?v=uWvSnJ6rbs)

## Step 7: Sythesis

As forecasting requires very little data and once the data is entered the formula can be applied to several periods. Initially two types of forecasting will be used exponential smoothing and seasonal indices. We will measure the forecast using MAPE (as it is the easier of the two to calculate).

Sales and order (from procurement) data for the past year will be entered into an excel spreadsheet and will be used to calculate the forecast for the next period.

Also the number of products sold by each of our customers will gathered from the relevant customers to get a picture of how much of each product was sold over the 12 month period and we can derive seasonal indices. Exponential smoothing and seasonal indices will be used again to predict how much each customer will order and we will speak to our customers to determine if this is accurate or not. Sales people will be responsible for contacting customers a month in advance to determine if they expect the forecast to be accurate or not.

The MAPE will be measured for each forecasting approach and the one with the lowest MAPE will be chosen for the primary forecasting method of the company.

## Step 8: Reflection

### What I learned specific to the problem

- The different forecasting methods
- What data is required for forecasting
- How to calculate a forecast using these methods
- How to use excel to implement these forecasting methods

### What I learned which was not specific to the problem

- How to collaborate with customers
- How to find information to help me solve a problem
- How to apply this information to a business problem

### Rational for decisions made

I chose two methods of forecasting as once the data is gathered and input into excel the formulae are fairly easy to apply. Also the accuracy of the forecasting techniques can vary depending on the company. As we are not sure if the change in sales is due to seasons or other factors I decided to

use two approaches and measure the accuracy of the most appropriate one.

I chose excel as there is no cost associated with it as we have it here in our company. Also there are a lot of templates and guides in how to use this software for forecasting. There would be no benefit in purchasing specific software for this function.

I decided to include collaboration with the customers in addition to the quantitative methods of forecasting as there may be other factors that quantitative data may not be able to capture which may influence the forecast.

**What I would do differently**

If I was to do this process again. I think I would approach the customers differently. I only managed to get a response from three customers. I think I would perhaps accompany one of the sales people as they have more experience in dealing with the customers. I would have all of my information gathered before I would speak to anyone externally so I appear more organised and professional.

**Step 9: Reapplication**

I found a number of self-study resources that provided a lot of learning material that could be applied in other areas. For example, the SME toolkit contained a lot of resources. For example I found some resources on low cost market research that might enable us to increase our domestic customers fairly easily. Perhaps this could be the next PBL project!

**Table 2: Sample company problem addressed using the PBL process**

## 4. The roles in PBL

Within PBL there are a number of roles (Woods, 2003)

- **The tutor or facilitator** – whose role is to guide and scaffold the learning process and ensure the group remains focus and achieves their learning objectives. The role of the facilitator is that of a mentor who encourages the learner to justify their thinking and verbalize their reflection through appropriate questioning (Hmelo Silver 2003).
- **The scribe or recorder** – whose role is to record the group perspectives and maintain up to date records. They also synthesise the brainstorming discussion and can request help from other members
- **The chair or discussion leader** – whose role is the lead the PBL process, encouraging all members to participate and maintaining constructive group dynamics.
- **The group member** – whose role is to actively participate in the PBL process, suggest solutions, conduct self study and share findings with the group.

The learner can undertake the scribe or chair and group member role. The facilitator should assign each learner a role and explain what is required from each of the learners in this role.

## **5. Supporting the Problem Based Learning process**

The success of PBL is based on a supportive, collaborative, open learning environment. A number of approaches can be used to guide the learner through the alternative learning experience. The initial stages can be quite daunting for the learner, so it must be made clear to the learner at each stage what is required for them and how they can achieve it. In addition each person's opinions must be respected and people should be encouraged to share their knowledge. To do this:

- 1) Internal facilitators need to be trained on the PBL approach so they can champion PBL internally and guide learners through the PBL process. Between September 2015 and January 2016 Archimedes is developing a YouTube channel with freely available learning material for facilitators. A facilitator course is also available. Please see the Archimedes website for more information.
- 2) Learning material needs to be developed to inform learners of what is required in PBL and of the PBL process. At each stage of the PBL process the learner should have access to learning material to guide them on how to complete each step. In particular learners will need information how to conduct the self study stage of the PBL cycle, where to source information, how to evaluate and apply it in a PBL context needs to be guided as much as possible. An accredited course for facilitators and learners will be available from September 2016.
- 3) Learner network – in some cases the company may not have the internal skills to address a particular problem. To facilitate this there is a network of PBL learners available. Please see the Archimedes website for more information.
- 4) Scaffolds – as discussed in the problem selection stage scaffolds such as case studies, analogies and sample problems need to be made available to PBL learners to provide them with examples of similar problems and how PBL allowed learners to address these. These are available on the Archimedes ICT platform
- 5) ICT platform – an ICT platform is being developed between March 2015 and January 2016 the learning material, scaffolds and instructional material. In addition it allows the scribe to record each stage of the process. This will provide a database of PBL problems that have been addressed and will assist scaffolding. It is available at [www.archimedes2014](http://www.archimedes2014).

## 6. Use of ICT to implement PBL

### 6.1 PBL ICT platform

An ICT platform is an excellent method to support PBL in SME staff training. Within the project Archimedes an online platform for problem based learning has been developed and supports the use of this form of learning (this is a draft version until January 2016). It is expected that these approaches will be widely adopted in entrepreneurial education and SMEs. The open source Content Management System (CMS) Tikiwiki, also known as Tiki, was used to create the platform.

The ICT platform has been developed to guide you through the seven steps of the problem based learning process. On this platform there is

- 1) Learning material to guide you through each stage. (Being developed between September 2015 and January 2016)
- 2) A template to allow the learner to record information gathered at each stage (as in the example above). This can be used by your company for future reference. You can choose to publish or keep private the problem.
- 3) Case studies, solved problems and accounts of prior and alternative experiences of the PBL process (to support learners)
- 4) Discussion forums can allow you to acquire the knowledge and expertise of other companies. There are a number of subject dependent discussion forums available.

### 6.2 Open educational resources

To support the gathering of information to allow learners to complete the self study stage of the Problem Based Learning process there are a number of free open educational resources available. These are higher education institutes that make their learning material available at no cost for learning and research purposes. They can vary in size from individual resources, short video lectures to complete courses

#### Resources

Resources such as powerpoint presentations, documents, pictures etc are available on the below websites:

<https://www.oercommons.org>

[www.ndlr.ie](http://www.ndlr.ie)

<https://open4us.org/find-oer/>

<http://www.merlot.org>

<http://cnx.org>

<http://wikieducator.org>

<http://www.jorum.ac.uk/>

#### Complete courses

There are complete courses available on the below websites:

- Stanford, University of Edinburgh and other major universities place some courses on: <https://www.coursera.org/>
- MIT make a select number of courses available on the site <http://ocw.mit.edu>
- Carnigie Melon make a number of courses available at <http://oli.cmu.edu/>

- The open university offers 600 free courses at various levels - <http://www.open.edu>
- Khan Academy offers practice exercises, instructional videos, and a personalized learning dashboard that empower learners to study at their own pace in and outside of the classroom. They tackle maths, science, computer programming, history, art history, economics, and more. <https://www.khanacademy.org/>

## Video

Many lecturers, trainers and universities make learning material, classes and lectures available on you tube.

In addition some universities have dedicated websites with their video lectures freely available to all:

- MIT: <https://www.youtube.com/user/MIT>
- Yale: <http://oyc.yale.edu/>
- Berkley: <http://webcast.berkeley.edu/>

## Further information

Email: [emma.obrien@ul.ie](mailto:emma.obrien@ul.ie)

Website: [www.archimedes2014.eu](http://www.archimedes2014.eu)

Twitter: [@Archimedes\\_2014](https://twitter.com/Archimedes_2014)

A ICT platform to guide learners through the PBL process is available in five languages (draft version until January 2016):

English - <http://archimedes-tiki.eu/>

German – <http://de.archimedes-tiki.eu/>

Lithuanian – <http://lt.archimedes-tiki.eu/>

Portugese – <http://pt.archimedes-tiki.eu/>

Romanian – <http://ro.archimedes-tiki.eu/>

Learning material to teach facilitators how to support PBL and guide learners through PBL is available in English, German, Lithuanian, Portugese and Romanian (being developed between September 2015 and January 2016). This learning material can be accessed from the ICT platform or the project youtube channel - <https://www.youtube.com/channel/UCDyS27x53El22aC2SroOmBA>

Accredited facilitator and learner PBL course (available from September 2016) – please see website for details