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Beg, Steal or Borrow?: the Challenges Faced by Borrowing the Failure Mode and Effects Analysis Method to Elicit the Unintended Consequences of Implementing Elearning in the Higher Education Context

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BEG, STEAL OR BORROW? THE CHALLENGES FACED BY BORROWING THE FAILURE MODE AND EFFECTS ANALYSIS METHOD TO ELICIT THE UNINTENDED CONSEQUENCES OF IMPLEMENTING ELEARNING IN THE HIGHER EDUCATION CONTEXT

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Abstract

Effective project management, change management and risk management are key to the successful implementation of elearning. Connected to risk is the notion of unintended consequences, and it is with the issues and concerns surrounding the borrowing of the Failure Mode and Effects Analysis method for a research study to elicit the unintended consequences of the processes and policies put in place at one higher education institute in Ireland to facilitate the roll out of elearning there, that this paper is concerned.

The Law of Unintended Consequences holds that any action undertaken can result in desirable and undesirable, as well as anticipated and unanticipated outcomes that fall beyond those originally intended. There is no research method readily available to the education researcher that is designed specifically to elicit this type of information, however, the Failure Mode and Effects Analysis (FMEA) method, native to the field of engineering, is a systematic and disciplined method designed to highlight the unintended or unanticipated consequences of all identifiable aspects of a system, design, process or service, thereby making it possible for procedures to be put in place to counteract, eliminate or plan ahead for the occurrence of any identified consequences, ultimately leading to increased success and quality.

There is no set pattern to 'borrowing', and it is a common practice amongst researchers. However, it does bring with it many challenges as the researcher struggles to understand that which they wish to borrow in its traditional context in order to maintain its integrity as they adapt it and render it useful for an alternative context. This is not an impossible task, but one that requires a great deal of epistemological reflexivity on behalf of the researcher as they prepare for and execute the process. This paper will discuss issues surrounding 'borrowing' in general before going on to describe specifically the practical issues and concerns that arose when modifying the FMEA for use in the educational context.

Keywords

elearning, risk management, unintended consequences, borrowing, interdisciplinary research, Failure Mode and Effects Analysis, reflexivity

1. INTRODUCTION

> Setting a problem establishes boundaries by naming the things that will be attended to and framing the context in which this occurs. [1]

And so, let this paper begin by suggesting that implementing elearning is a very complex task and one that needs to be tackled in a very comprehensive and systematic way so as not to lead to total chaos. In essence, effective project management, change management and risk management are seen to be key to the successful implementation of elearning.[2] While there is much literature available on both

project management and change management, relatively little work appears to have been done in relation to risk management and the implementation of elearning in the higher education context. However, as elearning initiatives grow and education markets become more open it is vital that risk assessments of all aspects of an elearning initiative are undertaken and management procedures put in place so as to help ensure the quality of the elearning opportunities on offer.

Connected to the notion of risk is that of unintended consequences. [3] The Law of Unintended Consequences holds that any action can result in desirable and undesirable, as well as anticipated and unanticipated outcomes that fall beyond those originally intended. And, seeing as it is generally accepted that the introduction of information and communication technologies into the learning environment "is not a neutral activity without consequences", [4] considered reflection on the *unintended* consequences in particular should be, I would suggest, a vital element of any risk management process undertaken on elearning and its implementation. And, being in possession of this type of information would enable the institution to go on to identify and capitalize on any positive unintended consequences that had occurred while also putting in place procedures to counteract any negative ones.

Of interest to me in particular is the exploration of any unintended consequences of the implementation processes and policies that third level institutions choose to put in place in order to rollout elearning at their institutions. The first difficult step in addressing such an issue, however, is determining the most appropriate tools to use in order to elicit effectively this very specific type of information. [5] Knowing what I needed the tool to achieve led me to realise that there was no method or methods at my disposal native to the field of education that would enable me to investigate this issue as rigorously as I had hoped. And so, with reference to the quote above, my problem has been set. It became necessary for me to look beyond the field of education with a view to possibly borrowing a method from another discipline that would better suit my needs.

The rest of this paper sets out to look briefly at the notion of borrowing and what issues it raises for the researcher generally, before going on to discuss the specific challenges raised by borrowing the Failure Mode and Effects Analysis (FMEA) method from the field of engineering to elicit the unintended consequences of the particular elearning implementation process chosen at one Irish higher education (HE) institute. The adaptations made to the method will also be detailed and the reasons for those adaptations given. Whether or not borrowing the FMEA for use in this specific context was an appropriate choice, or not, is not the focus of this particular paper. The adapted FMEA method is being applied currently and the data generated cannot be analysed so as to answer that question until all the steps in the method have been executed.

2. BORROWING

Disciplines frame and shape our understanding and our education, and put structure on our professional lives, as well as providing the framework within which knowledge is passed onto the following generations. However, the reordering of these disciplines and their boundaries is of much interest to academics and policy makers currently [6], so much so that interdisciplinarity is seen now as a "seat of innovation" given that shifts in traditional thinking have been attributed to researchers crossing disciplinary boundaries. [7] It is often motivated by a desire to answer complex practical problems which either traditional research approaches have failed to help answer, or which require specific knowledge and expertise from more than one discipline to solve; [8] research questions that are considered to be open-ended, multidimensional, ambiguous, and unstable, wicked and messy! [9]

At the opposite end of the scale to the large interdisciplinary research projects are a plethora of less visible interdisciplinary activities that are quite commonplace amongst academics and which play an important role in knowledge production. Such activities include team teaching, informal clusters and networks, learning communities, shared interests, collaborative research, and, of course, borrowing. [10]

When researchers 'borrow' from another discipline it tends to be methods, approaches, tools, concepts, theoretical constructs and models that they take and adapt for their own use. [11] In other words, borrowers tend to pick and choose what suits them rather than embrace the lending discipline in its entirely, and this situation can cause a lot of problems for the borrower. For example, borrowed

material can be misunderstood, distorted and used out of context, or indeed, material no longer considered valid or reliable in its original context can be adopted inadvertently, resulting in the data generated being questionable at best. Klein suggests that in order to avoid these problems borrowers must assume what she terms 'the core responsibility of borrowing', that is, that the borrower must acquire at least a basic understanding of how the material to be borrowed is used in its original context before its adoption, adaptation and use. [12] Boix Mansilla *et al* have agreed with this assessment and many years later extended the notion stating that the act of borrowing generates three very specific challenges for the potential borrower, i.e. that which is to be borrowed must be identified, before being understood in its original context, and finally, assessed in terms of its viability and role in the borrowing discipline. [13]

2.1 Borrowing the FMEA

Technology is often turned to as a means for enabling change, especially in relation to learning and teaching practices,[14] and in this instance, a huge interest in elearning and the use of Virtual Learning Environments (VLEs) has emerged. This is precisely because these technologies and associated pedagogies have the ability to exceed time and space barriers allowing the flexibility users need to learn from anywhere at any time, completely changing the way knowledge is accessed and collaborative interaction and dialogue is carried out. This also makes it an ideal and innovative way of providing and supporting flexible education options and responding to the contemporary challenges of widening participation and equity of opportunity. [15] In fact, elearning is the most recent innovation in higher education to be receiving so much attention and investment at institution level. [16]

The Irish government and associated agencies have published a wide variety of papers and implemented many policies in the last decade, all focusing on the need to continue investing in our HE system, believing that "the success and strength of the higher education system will make a vital contribution to Ireland's future economic growth and competitiveness".[17] This flurry of activity has been influenced heavily by the fact that Europe set for itself the strategic goal of becoming, by 2010 "the most competitive and dynamic knowledge-based economy in the world…" [18], leading individual governments to be very concerned with strengthening their own economies, and buying into the popular notion that investment in better education and training is one way of reinforcing economic prosperity and success. [19]

In any case, despite the obvious purposeful drive on behalf of the Irish government to revolutionise the higher education system in Ireland and support the development of flexible learning arrangements, elearning has not yet realised its full potential here. In fact, the use of elearning and VLEs is still very much in its infancy. The integration of ICTs in education in Ireland has been rated only as 'average' to 'good', while our usage of ICTs for commercial purposes is excellent with the percentage of enterprise income coming from eCommerce being one of the highest in Europe. [20]

While this is an unsatisfactory, and at times discouraging, situation, it is nonetheless the most ideal stage of development at which to carry out an analysis of elearning implementation processes, the results of which could feed into an overall risk assessment of the implementation of elearning in general.

The Failure Mode and Effects Analysis method, native to the field of engineering, is a systematic and disciplined method designed in such a way as to highlight the unintended or unanticipated consequences of all identifiable aspects of a system, design, process or service, and intended specifically as a way of providing information for making risk management decisions. It is most effective when run early in the development cycle of the system/design/process or service in question as the type of information gathered makes it possible for procedures to be put in place to counteract, eliminate or plan ahead for the occurrence of any identified consequences, ultimately leading to increased success and quality. The FMEA method seemed an ideal choice for identifying the unintended and unanticipated consequences of the elearning implementation processes chosen at the institution in question (hereafter known as the IIQ) to implement elearning there. While the IIQ has a team dedicated to overseeing and facilitating all aspects of the implementation of elearning at the institute, and the VLE in use there is one of the institute's most heavily accessed applications available on campus, elearning is still considered to be in its earlier stages of implementation but with a lot of development work planned for the very near future.

2.2 Understanding the FMEA in its original context

Borrowing a method from one discipline and applying it in another is not as straight forward an activity as it might seem initially. Understanding a method in its borrowed context means more than just becoming familiar with the steps that the method might follow, the type of data it generates, and how that data is usually analysed and results presented. Rather, it also requires the researcher to acknowledge their own epistemological assumptions and endeavour to understand the epistemic dimensions of the lending discipline. As each discipline has their own epistemic dimensions each will differ on what counts as acceptable data, units of measurement, and validity and reliability of results for example. Furthermore, epistemic values are adopted unavoidably when borrowing, and "serving two masters in this way is not without its challenges".[21] This has huge implications for borrowers as they adapt the borrowed method and render it useful, and indeed acceptable for use, in their own discipline. It requires a lot of epistemological reflexivity on their behalf throughout the whole process.

In this case, the FMEA hails from the field of engineering where science research is underpinned by a positivist epistemology. From this perspective, all knowledge is seen to be universal and quantifiable implying that reality is the same for everybody. Furthermore, it is held that through research conducted "systematically, sceptically, and ethically", meaning in a controlled, objective and value-free manner, [22] this shared reality can be identified, observed, and measured. In addition, it is seen as the responsibility of the researcher to maintain objectivity by putting aside their own biases and beliefs, and observe the world as it really is, so as not to influence the data collected and any subsequent results produced in any way.

On the other hand, educationalists involved in research in the area of learning and teaching tend to reject all beliefs held by positivists and would consider themselves post-positivists. Such researchers would argue that peoples' view of the world is influenced by their educational, political, and cultural experiences etc. and that, as a result, there is no *one* perception of the world that can be observed, measured or analysed. Furthermore, researchers themselves are considered naturally biased by their experiences too, and that those biases are brought to the research, meaning it is not possible to separate the researcher from the research. In other words, the total objectivity sought by positivists is believed to be impossible by post-positivists. And so, research methods that "…accept and value the role of the subjective rather than the objective…" are deemed essential, requiring "…a major epistemological shift away from empiricism towards constructionism and the development of different parameters of investigation". [23]

This last issue alone threw up huge challenges for me, and my decision to borrow the FMEA. I am a post-positivist, and more specifically, a constructivist. I believe reality to be subjective rather than objective, and so the type of risk analysis that I wish to carry out requires a qualitative research tool that will allow me to gather in-depth descriptions that can be mixed with people's perceptions, opinions and feelings. However, although the FMEA appears on one level to be a qualitative tool with a quantitative element its focus is totally on defining, measuring, ranking, and reporting knowledge that it considers tangible and constant and that can be represented on flow charts. I had to alter the parameters and focus of the method so as to collect the data I require while still following the steps of the traditional FMEA, remaining true to its overall objective, and maintaining its integrity as a tool.

I also disagree with the overall purpose or function of a team as understood by the traditional FMEA. While Stamatis refers to the notion that team formation is underpinned by the theory of synergy where it is accepted that two heads are better than one, or that the sum of the total is greater than the sum of its individual parts, [24] he also states that a function of the cross-functional and multi-disciplined team is to help eliminate any biases from the research by saying "under no circumstances should any FMEA be done with a single individual…[as]…there will be built-in biases in the single perspective of the individual conducting that FMEA". [25] In my view the sole purpose of a team is to "…provoke one another's thinking and arrive at original insights together that neither one could achieve independently", [26] and this will be the only ethos driving the team formation for the purposes of this study.

Furthermore, I will be acting as an insider researcher during this study. Within the constructivist approach it is perfectly acceptable for the researcher to be an integral part of a study, openly admitting their personal connection to it, and, acting quite blatantly on insights that would be difficult, or even impossible, for an outsider researcher to realise due to the intimate knowledge of the context under

research that they possess.[27] This behaviour would not be tolerated from a researcher within the positivist paradigm however, and the results would be seen as skewed and unreliable.

The following section will detail the steps that a FMEA moves through and explain the purpose of each one while also highlighting where when and why adaptations have been made for the purposes of this study.

3. THE FAILURE MODE & EFFECTS ANALYSIS METHOD

Before beginning any FMEA the team must be put in place. Stamatis defines 'team' as:

> a group of individuals who are committed to achieving common organisational objectives; who meet regularly to identify and solve problems, and improve process; who work and interact openly and effectively together; and who produce desired economic and motivational results for the organisation [28]

He also suggests that the ideal number for a team is between five and nine people, and that each team member "…must have some knowledge of group behaviour, the task at hand, the problem to be discussed, and direct or indirect ownership of the problem".[29] It is not envisaged that there will be any changes in personnel in the team during the duration of the FMEA

However, for the purposes of this particular study there will be a change in team composition between the first step and subsequent steps of the FMEA, and this adaptation is essential for the success of the analysis in this specific context. To explain, the FMEA process begins with what is called '**a review of the function'**. Here a detailed assessment of the task that the system, design, process or service in question must perform is set out. For this study, that translates as reviewing the processes and policies in place at the IIQ for the roll out of the elearning initiative at the institute. This situation is very different to that usually analysed by the FMEA. I am not examining a set procedure or service, a static object, or blueprints for a proposed product. Instead, I am investigating a set of processes, policies and plans that have evolved over seven years, so as to elicit any unintended consequences that they might have for the implementation of elearning at the institute going forward. As such, it is necessary to look back on the years gone by in order to understand more fully the current situation, and to ensure that any procedures that have run, and are still running, quietly in the background since the inception of the elearning initiative are not overlooked by mistake. The IIQ have in place a group of seven people dedicated to roll out elearning at the institute and this is the obvious group to undertake the team FMEA. But, not all of the team members are in a position to partake effectively in this first step of the FMEA as they have only been employed by the institute in recent times. And so, only the five team members who were involved since the beginning of the elearning project will attend the first team meeting. The past will be reviewed and a snapshot of the current situation noted where the intended function or value-adding role of each process and policy currently in place is stated clearly. This data will be collated and presented in a visual way to the two other team members for review. Traditionally this data is presented on a flow chart but that particular technique is not suited to the type of qualitative data collected here.

The second meeting will include all seven team members and will begin by reviewing again the current procedures in place. Any necessary amendments to the snapshot detailed during the first meeting will be made before moving on to the second step of the FMEA method.

Step two of the method identifies any **potential failures and failure modes**. In this case, 'failure' refers to any problems, concerns, errors or challenges the team can identify associated with each of the current processes and policies in place at the IIQ as listed earlier. And, 'failure mode' is a description of the way in which each failure just listed could fail to perform its intended function or fail to fulfil its value-adding role as outlined in step one. Then, referring to this list of potential failures and the associated descriptions, the team can move on to step three which proposes potential effect/s or consequence/s of each failure listed. Here the terms 'effect' or 'consequence' represent the impact each failure would have were it to occur.

Once identified, each failure is now traditionally ranked in terms of the risk they hold for the company/institution should they occur, and then a risk priority number is calculated. This ranking process begins with **severity rankings**. These rankings are an indication of how serious it would be

should the individual failures and their associated effects or consequences occur. A ranking of '10' denotes a dangerously high consequence, while a ranking of '1' means the severity of the risk is very low. Following on from this, each failure is revisited and the subsequent **occurrence rankings** assigned are a reflection of how frequently the team think the cause of each failure is likely to occur. This dictates that the causes of each failure must be investigated. An efficient way of doing this is by using the '5 whys' technique. A brainstorming session such as this examines each failure asking 'why' and 'what caused it'. The actual number of 'whys' asked is unimportant once the root cause of the failure is established. Again, a ranking is '10' suggests that the failure in question is likely to occur very frequently or possibly all of the time, while '1' means the occurrence rate is likely to be quite remote. Finally, **detection rankings** identify the procedures already in place for each failure mode evaluating them so as to assess the chances of that failure being detected before coming to the attention of the stakeholders. On the ranking scale '10' means non-detection is a certainly while '1' means detection is certain.

With all the data just collected a **risk priority number** (RPN) is calculated for each failure and is done by multiplying the three figures generated above for each failure mode. The higher the resultant RPN the higher the potential risk indicating immediately where intervention is needed. It is envisaged that at this point the team devises an action plan, the objective of which is to reduce the RPN of certain failure modes. This plan should detail who is going to do what and by when, and the idea is that interventions made will target a particular ranking of a failure mode and reduce it.

Quite a bit of literature is gathering at the moment detailing some of the setbacks of the FMEA in its traditional setting, and there is a lot of debate in particular surrounding the calculation of the RPN. The scales used in ranking the occurrence, severity and detection are different (both linear and non-linear scales are used) and so this has created the situation where the RPN does not satisfy the usual requirements of measurement. As a result the RPN multiplies them as no sensible rules of algebra can be applied in this situation.[30] When the figures are multiplied it creates the additional problem that three different sets of factors can create the same RPN i.e. 2x3x6 produces the same RPN as 6x3x2, but each situation has very different implications, and the RPN does not allow for this very important distinction. Many researchers are looking at this problem and are suggesting ways in which to solve it. Fuzzy logic and grey theory are but two concepts being proffered currently.

Within the context of this particular study however the generation of quantitative data is redundant and so using numerical ranking scales and calculating an RPN is irrelevant. Instead, influenced by my reading on fuzzy logic and the generation of fuzzy rules, I have written my own rule base for the evaluation of riskiness, providing me with a much more subjective method of ranking risk. This rule base will be made available for the FMEA team and any necessary adaptations can be made until consensus is reached. Each of the three variables severity, occurrence and detection has been assigned the five terms 'remote' 'low' 'moderate' 'high' and 'very high' for describing them. To aid the assignment of these terms to the potential failures and failure modes identified earlier in the process, each one has an associated description attached indicating what that term means specifically in relation to severity, detection and the probability of occurrence. Once each failure has been 'ranked' in this way in terms of its severity, probability of occurrence and likelihood of detection, the results are then subjected to the fuzzy rule base developed. These rules are if-then rules, an example of which would be 'if the failure probably is low, the severity is high, and the detectability is low, then priority for attention is high'. Each failure can be assessed in this way and table generated indicating clearly the failures that need immediate attention etc.

Following this process a **plan of action** is generated. This plan will indicate which failures the team has chosen to address first, what they propose to do, who is responsible for that, and by what date procedures will have been put in place. The final two steps are **implementing the plan** and subsequently the re-evaluation of riskiness of the failures and failure modes. In the traditional FEMA this re-evaluation is done by **recalculating the RPN**.

All data gathered during the FMEA is documented in what is known as an FMEA worksheet. While there are sample worksheets available there is no one standardized one giving loads of room for it to be adapted to suit context specific needs. Following the completion of the initial FMEA, the document generated is referred to as a living document simply because it is never really complete. The idea here is that it will be updated as often as necessary to ensure the continued quality of the design, system, process or service in question.

4. CONCLUSION

The field of elearning research is still very young and quite eclectic in nature, and, as a result, a great deal of the research undertaken in the field to date has been criticised as being too anecdotal and lacking theoretical underpinning. [31] Therefore, it is vital that if the findings of any elearning research that necessitates the borrowing of methods or tools from another discipline, are to be of any real value to the field, the research results must be able to withstand close scrutiny, the chosen methodological approach and research methods must be deemed appropriate, and they must have been executed in a rigorous manner. This puts a huge responsibility on the researcher to accept, and face, the three challenges mentioned earlier that undertaking interdisciplinary research poses.

This paper addressed the first two of those challenges, explaining how the FMEA came to be chosen for use, as well as attempting to understand the FMEA in its traditional context while indicating where and why certain adaptations were made. The next step in this research study is to use the adapted method to elicit the unintended consequences of the implementation processes and policies that the IIQ choose to put in place in order to rollout elearning there, and to evaluate the results. This phase of the study is due to start in January 2009.

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