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## Papers



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## Announcement

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## Announcement

# Best Practice Focused Occupationally-Directed Education, Training and Development Practice Prospects Linked to Workplace E-learning

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***Abstract*—Currently, South Africa offers learning that is credit bearing and directly linked to workplace based learning programs and qualifications. However, e-learning in South Africa is under-developed, and information is not readily available on how universities and colleges are dealing with the advent of e-learning, and how it is linked to occupational learning based qualifications.**

**Learning has changed over the years, but it is assumed that the e-learning model is aimed at people who are technologically more knowledgeable, and who wish to interact electronically with the learning experience.**

**Considering the various challenges linked to all types of learning, providing critical research on the success of implementing an e-learning approach is required. In addition to this, it is necessary to identify the efficacy of such a model in specific industries.**

**Challenges are identified but not limited to:**

**a) The profile of the learner**

**b) Computer literacy of learners**

**c) Socio-economic status of learners**

**d) Collecting evidence from workplace**

**e) Learner motivation and its management**

**Occupationally Directed Education Training and Development Practice is an innovative opportunity to create e-learning opportunities that are contextualized to industry specific needs. In addition to this, e-learning is no longer linked to a computer but all forms of devices that enable user interaction. Enabling learning to be shared through phones and tablets provides continuous opportunities for improvement of education and access to such education.**

**In response to these needs, the e-learning model will attempt to offer learners support specifically for those in an industry where there are time constraints.**

**This research attempts to clarify the debates that industry and academia are engaged with surrounding the efficacy of e-learning and how to create opportunities that are linked to the socio-economic status of a country. Furthermore, it provides a practical analysis of a learning intervention in which skills and knowledge are conventionally passed through workplace-based specific e-learning opportunities.**

## I. Introduction

Information technology is becoming an essential part of society, and is being utilised within various sectors, most notably education and within the workplace. The use of technology within these contexts allows for a competitive and efficient scope. This, in turn, facilitates the participation of a much broader sector within education. It is therefore necessary to adapt and enhance skills to become involved within this process of societal change that is circumscribed by technology. By incorporating e-learning and work integrated learning (WIL) the service delivery encompassed is challenging traditional instructional delivery of education that has been utilised by tertiary institutions for a long time [5], [1]. E-learning is found in every part of the world, and as such is palpable within skills development beyond that of the classroom. Additionally, the use of technology involves those who are unable to accommodate certain expectations of a contemporary student or employee and as such, opens a path for larger diversity and inclusion [2]. This paper discusses findings that resulted from the data triangulation of a small focus group's interpretation on current, future, and perceived e-learning compared to m-learning. The initial findings present the participants perceptions, credibility, and the perceptions of the quality of the platform.

## II. Literature Review

The role of work integrated learning, and more specifically, opportunities to link the workplace to learning, have been debated and noted as current challenges from 2002 in higher education in South Africa. This literature review considers work integrated learning theory, practice and framework, as well as the positive and negative impact associated with it. It also examines how e-learning based work integrated learning is considered and its distinct perception and applications in South Africa.

Bender [3] notes that the need to link learning to relevance in a consideration of the role of universities and workplace must, "seek ways to be more relevant, to bring their knowledge base to bear on social, cultural and economic problems, and to offer leadership in society consistent with their core values of openness, integrity and inclusion".

### *A. WIL learning theory, concept and framework*

WIL is the integration of the requirements for the educational programs and the workplace expectations; which is an important framework in that there is an expanding disparity between a student's employment readiness, generic skills, and the expectations that are

required within industry [7]. Engelbrecht [6] states that higher-order learning is necessary, which can be accomplished through e-learning, which in turn allows learners to become accountable for their own learning. Project oriented learning, a principle of engagement theory, is classified as an instructional framework through which exposure and managing authentic problems is incorporated into learning [5]. Daemonse [5] thus indicates that the manner in which South African learners will become competitive and efficient within industry is the adoption technology into the education domain.

### *B. WIL and positive and negative impact*

An advantage of the WIL is clear prospectus on employment opportunities indicating a strong link between WIL and generic skills [7]. The identified benefits of utilising WIL e-learning also accommodates staff, parents/guardians, and other interested persons in surrounding communities that do not have access to the immediate institutions geographical location [2]. The technological trend is being adopted by both developed and developing countries. This allows for the holistic transformation of education. Additionally, Barker et al. [2] states that there are various uses for different technologies within a platform to create more convenience for the user. This impacts motivation, showing an increase in autonomy and enthusiasm in the learning process [2]. Furthermore, aligning with the principles of WIL programs, Jackson [10] identifies that on-the-job training aided the students in understanding the application of technology within their fields.

However, Senge et al. [13] identifies that initiation would be a primary challenge within e-learning. In contrast, Barker et al. [2] indicates that potential barriers are present, but do not impact the learning process drastically. It is noteworthy in this respect that aspects such as the screen size, charging devices, and the cost of software are potential barriers. Barker et al. [2] and Sife et al. [14] stress the need for educator training as a necessity, as well as accessing support and synchronicity of various devices. Freudenberg et al. [7] shows that there is a criticism with WIL e-learning as to whether tertiary institutions would have the capability and commitment of being able to fund and continue the process of WIL e-learning. Overton and Hills however, stress that the costs involved have clear value and are justified due to the efficiency of utilising technology, time-efficiency, and improvements across the learning process [12].

### *C. WIL e-learning*

The combination of WIL and e-learning has indicated positive responses, such as job readiness and motivation [7], [2]. South Africa's job market is expanding and becoming largely a technological environment [8]. As such, WIL e-learning could equip students with more attractive skills for employers [8]. Therefore, for any institution to become more competitive, the incorporation of WIL e-learning is imperative as WIL e-learning is becoming a large resource for both educational institutions and the workplace [8].

### *D. WIL e-learning South Africa*

e-learning within South Africa is identified as a positive aspect because of the versatility and flexibility with interactive learning, therefore indicating that WIL e-learning can be useful with students with varying backgrounds. Brown [4] contrasts between first and third world learners who have access to mobile devices and identifies both as ideal for the m-learning target markets. Moreover, by incorporating WIL e-learning into curricula, the individual will be able to learn skills that will better equip them within countries and workplaces contextualized by the rapid growth of technology. E-learning is a platform that can aid individuals to study from remote areas by utilising technology such as the internet, thus allowing for broader education and increasing diversity [5], [3]. However, the South African government is restrained by socio-economic problems and may struggle to implement the requirements pertaining to e-learning.

The success of WIL e-learning also depends on the educator's ability to integrate mobile technologies and contemporary learning into a pedagogical framework [4]. The role of enforcing WIL e-learning into South African education also needs to consider the communities and the wealth of knowledge that is found beyond the classroom. Thus, service-learning aligns with the South African curriculum national goals, involving local communities [9]. The learner should be equipped with abilities to discover and evaluate information and applying this into their existing knowledge [4]. The role of e-learning in South Africa is not only to afford access to learners but also to expand the infrastructure for information and communications technology which in turn would enable South Africans to access technologies readily [4], [15].

## III. RESEARCH METHODOLOGY

The research was undertaken using both qualitative as well as quantitative methods which produced both a theoretical interrogation as well as practical outcomes that were defined and measurable. Qualitative research into the model helped to define the quantitative research required of the more statistical data.

The initial phase of the research included a literature survey to consider current practice used both nationally and internationally. Findings from this research were then considered for selection of the most appropriate models for evaluating e-learning and m-learning perceptions and credibility.

Following this, qualitative research was conducted using small focus groups (internal stakeholders and the project management team). This qualitative research focuses on current, future and perceived interpretation of e-learning versus m-learning; outlining an interest in meaning, perspective and understanding; focusing on process; and combining inductive analysis with grounded theory.

The standard methods of qualitative research were applied, which included: observation, interviews, sampling and written material. Due to the nature of the research problem and key outcomes indicated, a limited range of expert participants were able to provide the bulk of relevant high level inputs.

Data was then reviewed based on key outcomes noted for research purposes and collected through evaluation of survey data completed through large platforms in South Africa in which occupationally directed education, training and development practitioners participate.

A range of inputs was solicited from key experts as indicated above. All participants were voluntary, and were advised both in writing and verbally that their informed consent to participate would be required and that each participant was free to withdraw from participation.

Confidentiality and anonymity were offered to all participants and maintained through the use of a coded database. However, due to the nature and purpose of this research, as well as the methodology, most participants did not use this option. Data was analysed through data extracted from a database.

In order to enhance the credibility of this research, every attempt was made to identify, encourage and support the participation of key stakeholders and experts. Wherever possible organisational support and input were sought, and where necessary appropriate alternative individuals and/or organisations were identified and approached.

Independent checks were put into place in which data was cross-referenced and audited to ensure that all findings produced were error free.

The findings noted are presented and the analysis of the data according to the categories of data field are shared.

50 participants were invited to participate in the survey. This was based on subject matter experts in the field of workplace integrated learning and occupationally directed education, training and development practice. This was controlled in part.

## IV. Initial Findings

### A. *Participant perceptions of e-learning and m-learning*

The first area of research questions provided the learning specialization areas, work specific sector based learning as well as instances to validate the interaction with types of platforms — namely e-learning vs m-learning.

Participants were from multiple focal areas in terms of the learning specializations – the majority of participants were from credit bearing occupationally directed, education, training and development practice (62%) as well as higher education (32%). Only 6% of the participants were from non-accredited learning. This helps to formalize the requirements of quality assessment and moderation practice associated with the instruments and resources used in the assessment process.

Specifically, those in occupationally directed education, training and development practice saw themselves aligned to the following sectors:

Education, Service, Emergency Medical Services, Media and Retail Administration. This helps to show the various sectors influenced by credit oriented learning.

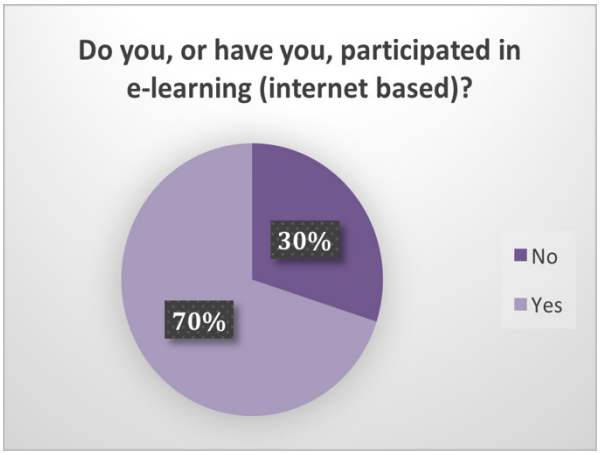


Figure 1.

Figure 1 shows that 70% of participants had participated in e-learning. This shows that the platform has been explored by the majority of participants – specifically through systems with internet access. This helps to focus on the different platforms linked to electronic learning.

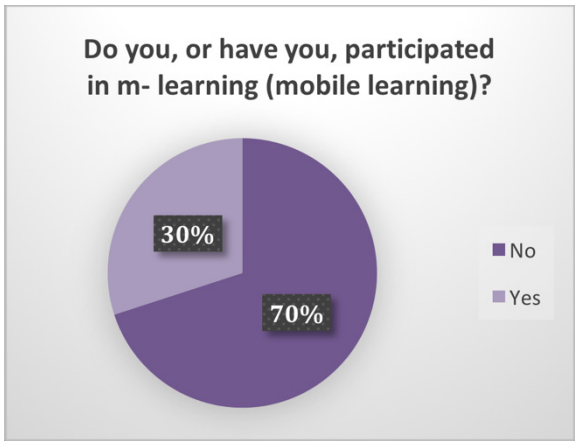


Figure 2.

From figure 2, it is shown that only 30% of participants had participated in m-learning. This shows the large difference in engagement with different types of platforms offered through devices, and more specifically a mobile platform or phone which is part of electronic learning.

Seven criteria were identified and ranked in order from the most challenging to the least challenging.

1 - *The educational organizations staff resources ability and motivation to engage with learners through a mobile platform* was the biggest challenge. This indicates their ability to use the mobile platform, which could be in a personal capacity, with all learners.

The following two challenges were noted as a tie-

2 - *The financial resources of an educational organization to set up, design and maintain a mobile platform.*

*2- The user friendliness of the mobile platform.*

The mobile platform which is not the personal capacity of a staff member is reinforced as a challenge.

4 - *The security and privacy settings of the organizations IT infrastructure* is noted as a secondary reinforcement of the challenge as these are not linked to finances and resources but how the technical system is setup.

5 - *My own access to resources* is seen as being partially important but if this was primary would have been placed in the top 4 (not 5 as it is).

6 - *My own preference in learning style* is seen as not being that important and implies that participants feel comfortable with the use of a mobile learning device.

7 - *My motivation and comfort levels to participate in mobile learning* is seen as the least important, which helps to validate that there is a desire to participate and that participants feel comfortable with using a mobile learning device.

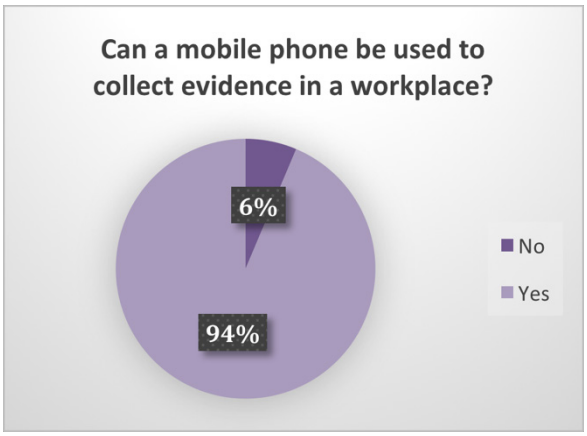


Figure 3.

It is important to note in figure 3 that even though only 30% of the participants had participated in m-learning that this does not influence the perceptions of the credibility of using mobile phones to collect evidence in a workplace. 94% of participants were comfortable with the collection of workplace evidence using a mobile phone. This is a significant trust in the platform itself.

*B. Credibility of m-learning*

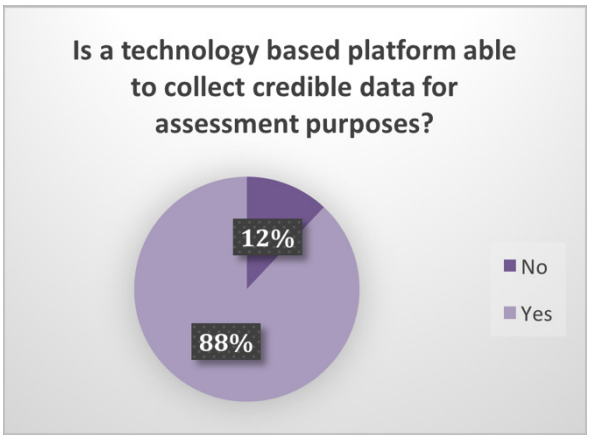


Figure 4.

Similarly, figure 4 shows that 88% of respondents noted trust in the use of a mobile phone, to collect credible data for assessment purposes. This reinforces the idea that the actual instrument itself is validated. This is the overview statement linked to the platform and the credibility of the data collected therein. This is further interpreted based on the types of data collection opportunities and perceptions thereof which still indicate 12% believing the credibility element of the platform.

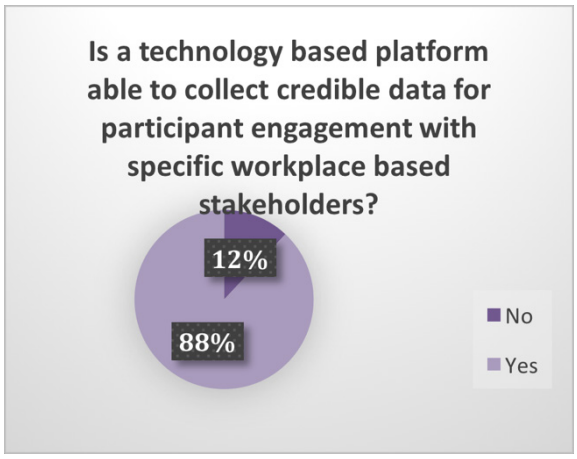


Figure 5.

The same findings are noted in figure 5 for the engagement with the participant using the platform and workplace based stakeholders. The interaction indicates that the engagement between the two parties produces evidence and that this engagement or record thereof is what provides the credible data. 88% of respondents trust that the evidence produced from this engagement is credible data and only 12% believe that it is not.

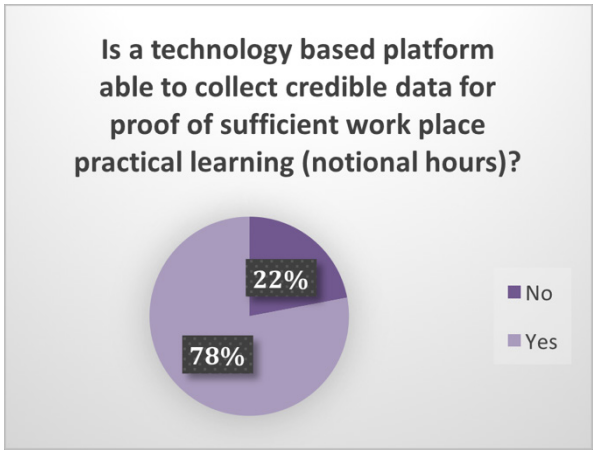


Figure 6.

Figure 6 indicates that only 78% of participants believe that credible data can be provided to demonstrate the workplace practical learning component. A larger 22% felt that this could not be seen as credible data. Comments provided were on how to trust the source of the data and validate that the person had interacted continuously to demonstrate the work integrated learning component. This is noted through comments like, “Depends largely on trusted source” (participant 50) and “As long as the source is credible” (participant 9). This implies that there needs to be a specific means in which to validate this source.

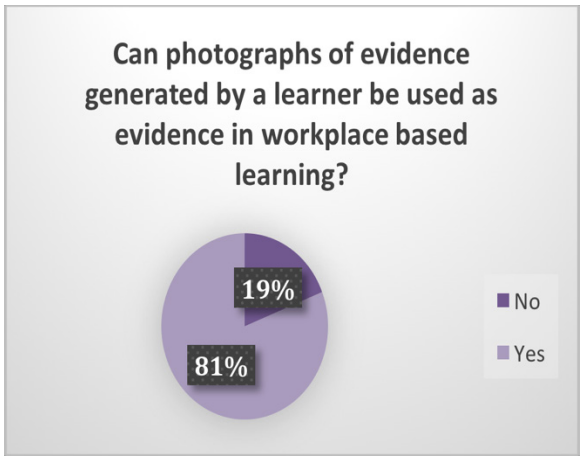


Figure 7.

In figure 7, it is clearly illustrated that 81% of participants agreed that photographic evidence generated in a workplace can be used for evidence and 19% do not. This implies that there is some trust linked to photographic evidence. The type of evidence like a photograph in comparison to a video (which requires more electronic storage space, and is the most authentic) is still seen as credible.

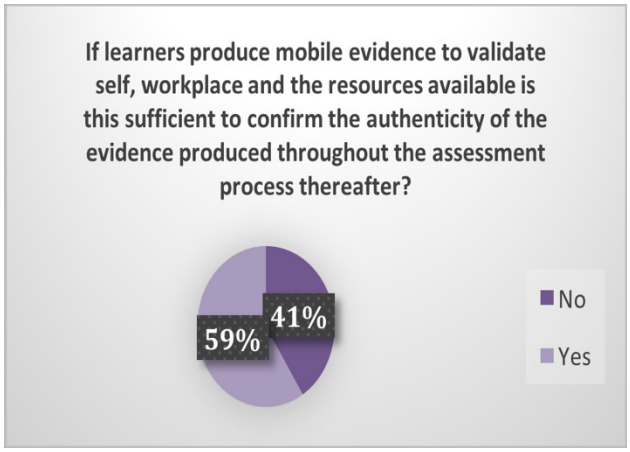


Figure 8.

The greatest challenge noted lies in evidence that validates self, the workplace and resources available from a sufficiency perspective. From figure 8 it can be seen that 59% of participants believe mobile evidence is able to provide sufficient and credible evidence, therefore 41% believe it would not. Evidence has to be evaluated by assessors, however, when this evidence is partial, it becomes problematic. Additionally, evidence which cannot be validated and evidence without context are also problematic.

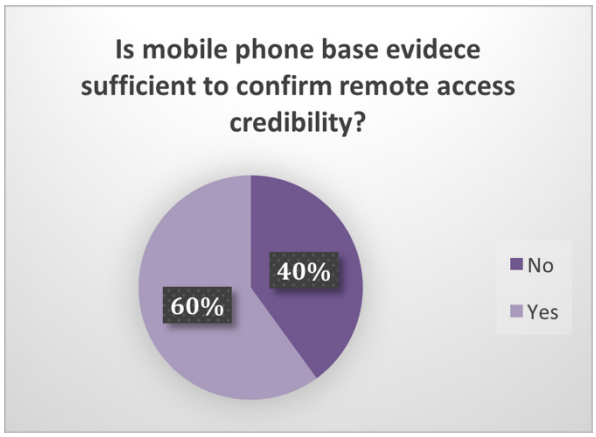


Figure 9.

The second challenge noted is the confirmation of credibility of remote access. Figure 9 indicates 60% of the participants indicated that mobile phone based evidence is sufficient to confirm remote access credibility, while 40% indicated the opposite. This implies that remote evidence has to be validated in order for its credibility to be considered.

*C. Perceptions of quality of platform (e-learning and m-learning)*

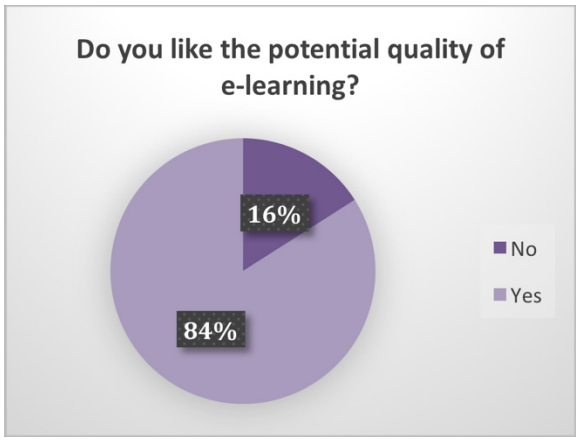


Figure 10.

In figure 10, it can be seen that perceptions of the platform are noted as being 84% who like the potential of e-learning or computer based learning. This is in contrast to the perceptions of m-learning in which only 76% like the potential quality.

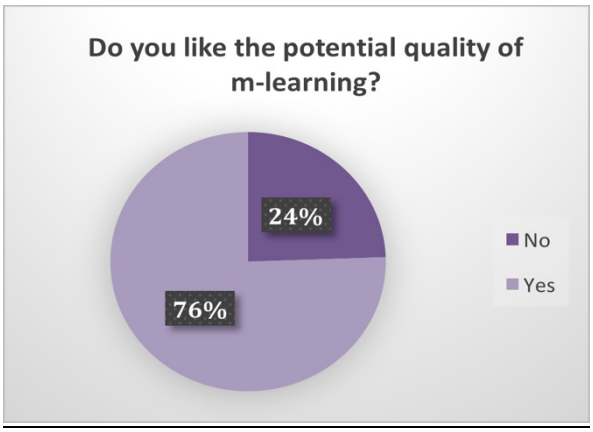


Figure 11.

Finally, in figure 11 it is noted that 24% of participants did not like the potential quality of m-learning versus the 16% did not like the potential quality of e-learning. This indicates the challenges that are noted in terms of the link of quality to the platform and how this needs to be further explored.

## V. Recommendations

One of the critical requirements is an outline of what m-learning evidence should be in part. The following are identified as to how the process of authentication can validate it:

•Encourage government funded projects to initiate m-learning models and implementation in the general, further and higher education areas of learning.

•Encourage engagement with cell phone companies to provide funding towards m-learning models and implementation in the general, further and higher education areas of learning.

•Ongoing research in the area of the quality of m-learning in both the delivery of learning as well as the assessment process.

## VI. Conclusion

Although this is an initial research project, it will be ongoing in order to evaluate the perceptions of e/m-learning. The research indicates that the challenge is not the platform but perceptions about the platform.

m-learning provides the opportunity for learning and collection of naturally occurring evidence to take place in the workplace even in remote areas within countries like South Africa.

e-learning has a large, untapped potential in education in how it is designed and implemented. Additionally, the service delivery of education can increase the potential for having education become more inclusive and diverse (Damoense, 2003). The inclusion thereof will allow for a more efficient platform through which competent and skilled persons can be trained. The involvement of WIL and e-learning combines the traditional understanding of education, but incorporates a broader sector of knowledge that will enable a larger portion of individuals to participate within the workplace, as well as become more competitive. This paper identified that a larger portion of the sample population support the involvement of e-learning into education, and that there is a support for e-learning and m-learning. There is, however, a small portion of participants who questioned the credibility of data collection through the use of technology based platforms, which can add to the disadvantages of WIL e-learning. Despite this, there appears to be firm support from literature and the participants within this study to affirm that e-learning has a future in education, especially within the South African context.

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# Absorptive Capacities and Innovation in Graduated Companies from a Business Incubator in the North of Mexico

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***Abstract*—The aim of this research is to identify the relationship between absorptive capacities and the generation of innovation, as well as their level of influence in companies graduated from an incubator in the north of Mexico. Through a quantitative research, correlational with a non-experimental design, a sample of 100 companies was obtained. The hypotheses of the study were partially approved, finding that the entrepreneurs were able to acquire, assimilate and transform the process of absorptive capacity, generating incremental innovation which is an intangible asset with high value for organizations.**

***Index Terms*—absorptive capacities, innovation, business incubator**

## I. Introduction

Today, knowledge has been considered as an intangible asset, capable of generating a competitive advantage [1-2]. Its importance lies in its level of use and employment for companies [3], and it depends on a series of immaterial variables, where it is possible to highlight the absorptive capacity and innovation as a set of valuable resources for organizations [4]. The first references related to absorptive capacity describe this variable as an economic ability to absorb and use external information [5]. Later, Cohen and Levinthal [4] define it as a process of knowledge accumulation, which allows the development of different business skills, including product improvement and principles that favor the innovation.

It should be noted that, due to constant economic and social changes, the development of companies is not only based on internal knowledge. It is for this reason that it is essential to establish strategies to redesign or complement organizations through assimilable and transformed external knowledge [6].

On the other hand, in recent years, entrepreneurship has been an important part of the society development [7], which is based on the creation of something new, different and with added value [8]. This phenomenon has also been linked to the economic growth of microenterprise [9], which is very important, because according to the latest report of the National Institute of Statistics and Geography (INEGI) [10] in Mexico, 97.6% of all enterprises are classified as micro-enterprises. Therefore, this sector represents a high proportion of economic development and employment generation of the nation [11].

However, although Mexico is considered one of the most enterprising countries in the world [12], only 53.2% of the Mexican population considers entrepreneurship as an economic development option for their life plan [13]. In addition, there is a low capacity to acquire new knowledge and to put it into practice within companies, because, according to data obtained from the National Survey on Productivity and Competitiveness of Micro, Small and Medium Enterprises (ENAPROCE), low levels of knowledge application were found within these Mexican companies during 2015 [14].

Absorptive capacities and innovation in microenterprises in the north of Mexico are very significant because they allow the development of competences of high value in this region. To develop these variables, it has emerged the business incubator of the Technological Institute of Sonora (Instituto Tecnológico de Sonora, ITSON), which has tried to support micro-enterprises in the region through the advice and incorporation of knowledge.

The incubator, which is known by the acronym IDEA (imagines, develops, undertakes and achieves), has established offices in the different cities in the north of Mexico, such as Obregon City, Guaymas, Empalme and Navojoa, where students, professors, professionals, entrepreneurs and businessmen of the region participate [15].

This is a space that provides services in the northern region of Mexico, promoting the economic and social development of the communities, with the mission of being an incubator that seeks to satisfy the needs of the community, through training services, consulting and business networks. Its main objective is to support the structuring of new self-sustainable companies, promoting an entrepreneurial and innovative culture in students, academics, universities and society [15].

Moreover, it is important to note that this incubator has obtained important recognitions. For example, the National Institute of Entrepreneurs in Mexico (INADEM), has recognized from 2013 to 2017 the business incubator of the Technological Institute of Sonora as a certified incubator through a rigorous national selection process. This process has the objective to develop and boost the economy of the north of Mexico through the advice to entrepreneurs in the opening and improvement of their companies.

In addition, since 2013 the incubator has participated in the National Program for Financing Micro Entrepreneurs from the Ministry of Economy (PRONAFIM), providing a training program to micro entrepreneurs in the northern region of Mexico. Through this series of trainings, the business incubator tries to generate improvements and development in the micro-entrepreneurs of the region with the training in the areas of management, financial, accounting, sales and innovation [15].

Since 2013, more than 300 entrepreneurs located in the north of Mexico have been part of the training program of this incubator. However, there is no study that has been carried out to know the absorptive capabilities in graduate enterprises of a business incubator, nor how this knowledge has associated with innovation in this kind of organizations. From these premises, the following research question arises: How are absorptive capacities associated with innovation in graduated companies from a business incubator in the north of Mexico?

In addition to the above, the increase of knowledge can influence the generation of innovation and, in turn, innovation can generate competitive organizations [16]. Then, it is possible to observe that the absorptive capacities within the formation of entrepreneurs can influence the capacity to innovate. Therefore, a second research question is established: How do absorptive capacities influence on innovation in graduated enterprises from a business incubator in the north of Mexico?

To answer the research questions, the following hypotheses are proposed:

*$H_1$: Absorptive capacities are positively associated with innovation in graduated enterprises from a business incubator in the north of Mexico.*

*$H_2$: Absorptive capacities influence by a significant and positive way on innovation in graduated enterprises from a business incubator in the north of Mexico.*

The relevance of this study is due to the fact that there is currently no research that measures the impact of training within this incubator program. In this way, the findings will make it possible to identify the impact on the acquisition, assimilation, transformation and exploitation of external knowledge on the innovation of the trained companies. Most of the incubation work focuses on the analysis of the level of entrepreneurship and the reasons for undertaking. However, there is a gap on the relationship between absorption capacity and innovation in emerging companies that have been in an incubation program, especially within the Mexican context.

## II. Literature Review

### A. Absorptive capacities

According to Zahra and George [6], absorptive capacities are a set of routines and strategic processes that allow organizations to acquire, assimilate, transform and exploit knowledge with the intention of creating value and competitive advantages. These authors propose the existence of four absorptive capacities: acquisition of knowledge, assimilation of knowledge, transformation of knowledge and exploitation of knowledge. It is important to note that these are a continuous process.

### B. Acquisition

The acquisition of knowledge is the first step in the absorptive capacities process. This stage is described as the ability of the company to identify, evaluate, select and acquire useful external knowledge for the activities in the organization [6].

### C. Assimilation

As a second step in the absorptive capacity process is the assimilation, which has been understood by different authors as the ability to analyze, process, interpret and understand the external knowledge [6, 17]. The relevance of this phase lies in the human capital that the organization has, that is why an individual with a higher degree of specialization and experience can present a mayor degree of assimilation knowledge [18].

### D. Transformation

In the third step of the process, is the transformation. It is defined as the ability to adapt the new knowledge to the reality and needs of the organization, through the aggregation or elimination of existing knowledge to combine with the new one, and thus, to obtain novel and radically different forms of knowledge [6].

### E. Exploitation

Exploitation is the last stage of the process of absorptive capacity, which is defined as the use of the acquired knowledge and its implementation in the activities of the organization that allows redesigning the existing and encouraging the creation of new things [4, 6].

### F. Innovation

Schumpeter [19] was one of the first authors to define a concept related to innovation. For this author, the innovation is based on the development of inventions, new methods of production, as well as the introduction of different products or services in the economic and social spheres, in order to provide alternative solutions to problems. It should be noted that this variable can be categorized according to its radical or incremental character.

### G. Radical Innovation

Radical innovation is a product whose use, elements, property, processes, materials or integration differ significantly from the previous one. This cannot imply a complete eradication of the previous product allowing changes in products, characterized by a great degree of investigation and specialization [20].

### H. Incremental Innovation

Incremental innovation is a minor change in products and / or processes seeking to strengthen and improve existing capabilities. Therefore, it is a product with which it is counted, which has been improved or increased [21].

### I. Relationship between absorptive capacities and innovation

It is important that companies recognize the value of the knowledge source, as well as the relevance of the exploitation of external information, so that new knowledge allows the generation of innovation [1]. Thus, the absorptive capacity is identified as a means for the generation of innovation, which reflects a close relationship between both variables [22].

## III. METHODOLOGY

### A. Research approach and design

The present research is quantitative type with a cross-sectional and transverse scope, because it tries to associate the study variables, through the use of a non-experimental research design [23-24].

### B. Study sample

The study population of this study was 370 incubated companies by the ITSON Business Incubator, that were advised in the development, structure and improvement of their company through the incubation process, which consists of training in different areas, such as: management, financial, marketing, innovation and accounting. This process comprises a period of time between 3 and 12 months, carried out from 2014 to 2016, in Obregón City, Navojoa, Guaymas and Empalme in Sonora, Mexico, state located in the north of Mexico. That is why the population in this study are micro entrepreneurs of the region and its surroundings.

A representative sample was used subjectively [25]. Thus, in the present study 100 instruments were applied to the micro enterprises. Table I shows the characteristic of the companies surveyed.

TABLE I.
CHARACTERISTICS OF THE STUDIED COMPANIES (N=100)

| Characteristics | N | % |
|---|---|---|
| Company location | | |
| Obregón City | 67 | 57.3 |
| Navojoa | 22 | 18.8 |
| Guaymas | 10 | 8.5 |
| Empalme | 1 | .9 |
| Activity of the companies | | |
| Industry | 45 | 45.0 |
| Commercial | 26 | 26.0 |
| Services | 29 | 29.0 |
| Size of the companies | | |
| Micro | 100 | 100.0 |
| Participation program | 85 | 72.6 |
| PRONAFIM | 7 | 6.0 |
| INADEM | 8 | 6.8 |
| Traditional Incubation | | |

*Note*. Own elaboration

### C. Measurement instrument

A questionnaire composed of two segments was applied, with a total of 37 items. The first segment contains 17 items assessing absorptive capacities in four dimensions: acquisition, assimilation, transformation y exploitation, as suggested by Zahra and George' model [6]. While the second section comprises six items based on Subramanian and Youndt [26], where three items evaluate incremental innovation, and the other three, radical innovation. The questions are written as affirmation and are evaluated using the Likert-type scale with five points, ranging from 1 (strongly disagree) to 5 (strongly agree). For the reliability of the instrument, Cronbach's alpha analysis (α) was used. It was obtained favorable values for absorption capacities in the case of acquisition (α = 0.745) and transformation (α = 0.727); However, in the assimilation and exploitation, the obtained results were below 0.70. On the other hand, the reliability of the innovation was α = .84 for incremental innovation, while in the case of innovation radical, the obtained value was α = .675.

## IV. RESULTS

The obtained results empirically support the hypotheses raised previously in a partially way. It should be noted that the results coincide with the ideas proposed by Liao, Wu, Hu, and Tsuei [27], for whom the absorptive capacity is a key factor in the generation of value by developing innovation. Table II shows the correlation level of the variables. As can be observed in the correlation results of the variables, acquisition and transformation –dimensions corresponding to absorptive capacities– present a higher degree of relation with significant values; contrary to what happened with the dimensions of assimilation and exploitation, which show a positive but less significant link. On the other hand, the dimension of radical innovation is not related to the other dimensions; in contrast to incremental innovation, which has a positive and significant connection with all dimensions. In this way, it is observed that the entrepreneurs acquired and partially transformed the knowledge provided by the incubator, in order to generate added value in your product / service. This has allowed them to achieve incremental innovation.

TABLE II.
CORRELATION OF VARIABLES (N = 100)

| Factor | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Acquisition | - | | | | | |
| Assimilation | .448** | - | | | | |
| Transformation | .359** | .242* | - | | | |
| Exploitation | .192 | .202* | .512** | - | | |
| Radical innovation | .108 | .129 | .054 | .062 | - | |
| Incremental innovation | .410** | .332** | .426** | .293** | .136 | - |

*Note*. Own Elaboration
** $p < .01$; * $p < .05$ (two-tailed).

In the regression analysis –considering the incremental innovation as a dependent variable– it is observed that acquisition and transformation influence positively and significantly on this dimension, although with an explanation degree of 28%. Contrary to the above, regression analysis –considering the radical innovation as a dependent variable– indicates a low value in relation to each of the dimensions of the absorptive capacity, presenting in some of them, negative values. Added to this, this partially proved $H_2$, since it was found a certain level of influence of the independent variable on the innovation of the studied companies (See tables III-IV).

TABLE III.
REGRESSION ANALYSIS CONSIDERING THE "INCREMENTAL INNOVATION" AS A DEPENDENT VARIABLE

| Factor | B | SE | B | T | *p* |
|---|---|---|---|---|---|
| Acquisition | .352 | .153 | .233 | 2.295 | .024 |
| Assimilation | .276 | .184 | .147 | 1.497 | .138 |
| Transformation | .378 | .152 | .264 | 2.479 | .015 |
| Exploitation | .111 | .136 | .083 | .817 | .416 |

*Note*. Own Elaboration. $R^2 = 28$.

TABLE IV.
REGRESSION ANALYSIS CONSIDERING TO "RADICAL I INNOVATION" AS A DEPENDENT VARIABLE

| Factor | B | SE | B | T | *p* |
|---|---|---|---|---|---|
| Acquisition | .097 | .187 | .062 | 0.518 | .605 |
| Assimilation | .190 | .225 | .097 | 0.846 | .400 |
| Transformation | -.015 | .186 | -.010 | -0.082 | .935 |
| Exploitation | .050 | .166 | .036 | .302 | .763 |

*Note*. Own Elaboration. $R^2 = 21$.

The results show that the analyzed companies in the present study meet the process´ objectives of the absorptive capacity. Although they transform it, they do not fully exploit the new knowledge. Therefore, this is directly related to the ideas of Van den, Van and Volberda [3], as well as Todorova and Durisin [17], who explain that exists a combination between existing knowledge and the new one in this phase. Consequently, it produces partial or radical changes that can generate a type of innovation, influencing the development of improvements in the organization.

According to the obtained results, the 100 micro-enterprises analyzed present partial changes and improvements in their products / services, but they do not achieve a total transformation. Then, as Damanpour [28], Tidd, Bessant and Pavitt [29] explain, a company can perceive a new product, generating innovation in its activities; however, to others it can only be the modification of a process. Therefore, the level of innovation can be influenced by factors such as the degree of experience, infrastructure, technology, size and specialty of the subjects.

## V. Conclusions

During the last 8 years, the incubator worked with more than 400 entrepreneurs in the north of Mexico, where it has been possible to see how absorption capacities have favored innovation. An example of this is the training received by a woman who owns a restaurant founded 20 years ago, which improved its performance and increased its sales in the last three years of activity, by integrating technology, segmenting market and creating new ice cream products. In addition, it is possible to highlight a young entrepreneur, who, at 20 years of age together with the incubator, improved his business model and currently has three companies.

It is concluded that, despite not meeting a significant degree in all phases of the absorptive capacity, it is identified that the entrepreneurs preferentially develop the acquisition and transformation of knowledge, achieving an added value or partial change in their product / service. Moreover, it is considered as an incremental innovation, which was one of the dimensions with a greater degree of significance in the correlation, favoring the validity of the model.

It should be noted, that the low degree of significance observed in the obtained results from the analysis on the dimension of radical innovation, it is explained by Tidd, Bessant y Pavitt [29]. It describes that different factors may influence the degree of innovation presented in companies, such as: a smaller infrastructure, lack of years in the specialization, and other factors that can generate an environment where innovation is present.

Therefore, the absorptive capacity is not a determinant within the innovation processes of micro-enterprises; although, the use of external knowledge allows the development in low or high degree of improvements in the organization. The results of the present study are relevant to know the behavior of organizations and the use of external knowledge in order to convert it into an intangible asset of high performance; in addition to being a cluster of information for the process improvement in the model of training and monitoring of the service provided by the business incubator.

For future studies, it could be important to consider the next recommendations: increase the sample size to register a higher degree of validity in the model, and carry out a longitudinal study that allows to know the influence of the variables. In addition, considering that absorptive capacity is not an isolated factor, so it is recommended to associate this variable with others, such as: organizational structure, company size, experience in turnover and installed capacity, to improve the phenomenon explanation. Therefore, it is expected that through the present research findings, it needs to be considered the importance of absorptive capacity and innovation as relevant issues and thus prompting a number of mayor studies in the case of the intangible value in organizations.

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# The Design and Development of a Mobile Phone Application for STEM based on a Novel Engineering Approach

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***Abstract*—STEM education provides students with interdisciplinary knowledge to improve problem-solving ability and practical ability. The purpose of this study is to explore whether students could achieve the goal of STEM education by mobile learning. This study developed a mobile application which was named *Borrowing Your Enemy's Arrows* to support mobile learning about science, technology, engineering, and math (STEM). According to the textbooks for Grades 5-7, the teaching content of the APP was designed to help students consolidate knowledge and to help teachers save much time in preparing classes. The central narrative, like cartoon or the dialogue of cartoon is used for APP to link the subject knowledge. Therefore, learners can construct a real-life situation by APP. To inspire learners' interest in STEM courses, the APP used games to test how well students did in learning. A shipbuilding task with the narrative background was set to improve learners' skills and interest in engineering learning. The educator could make the assessment of learners based on all their work in the process of learning, including the design sketches, final products, the message from students and the grade of game. For the purpose of improving the APP, teachers and students were interviewed to investigate user feedback in this study.**

***Index Terms*—STEM education, mobile learning, novel engineering**

## I. INTRODUCTION

By integrating STEM education in science, technology, engineering, and mathematics, students can see the connection of knowledge between dispersed disciplines. By designing good STEM thematic activities, it is possible to increase students' interests and achievements in related disciplines [1]. However, since STEM education is multidisciplinary, it often takes a lot of time to develop a STEM course. This will prolong the student's study time, and will not achieve the goal of reducing the burden on students. What is worse, it will cause both students and teachers to feel impatient [2]. In the process of improving the STEM curriculum, some scholars have successfully used mobile devices as teaching tools to guide students in autonomous exploration through mobile phones or tablet computers.

In previous studies, many scholars have developed APPs suitable for STEM learning to assist students in learning. Some Italian scholars have developed an application based on artificial intelligence. In the VLE (virtual learning environment), several students form a group and learn through role-play in the style of 3D images. Students in this learning environment will be more interested in participating in the course [3]. In the Science Center, with the help of the staff of the venue, the researchers selected the teaching content and reorganized students into multiple themes. The learners took mobile devices to learn. Not only can they get timely feedback, but they can also learn the science center's fusion of STEM. Knowledge and attention are also more concentrated [4]. Digital game-based learning methods have been proved to be useful in improving students' enthusiasm and promoting learning in a technologically enhanced environment [5].

In order for learners to maintain a sustained focus on STEM courses, stories and novels are often used as one of the forms to guide curriculum progression. The novel engineering integrates engineering education and literacy in school-based curriculum in a new way. When students read materials (such as stories, novels, etc.) in a literature class, the characters in the novel or story will encounter some problems. Based on the situation of the story, the students can use their own knowledge and skills to complete the engineering design in collaboration with the team and the support from the teacher to help the story characters solve the problems [6]. Wilson-Lopez and Gregory [7] pointed out that literacy instruction can be used to think deeply about engineering problems at various stages of the design process. Literacy and engineering are complementary and mutually reinforcing. The way the students design activities when they practice engineering can help them become more experienced readers or writers. Students apply reading comprehension strategies to engineering projects to help them become thoughtful engineers. Through the problems encountered by the characters in the novel, digging out the STEM elements among them makes it possible for the learner and the protagonist to overcome the difficulties and make the course more interesting and more persuasive. Therefore, the purpose of this study is to design and develop a mobile phone application which is called *Borrowing Your Enemy's Arrows* for STEM based on a Novel Engineering Approach.

*Borrowing Your Enemy's Arrows* was implemented with seventh grade students from a junior high school of Jiaxing, China in March 8, 2018. This research study describes the design of *Borrowing Your Enemy's Arrows* and the results of recording-based interviews of six students and four teachers who had at least five years in their respective fields. We analyze these interviews to address the following three research questions:

RQ1: Is the design of *Borrowing Your Enemy's Arrows* reasonable?

RQ2: Is *Borrowing Your Enemy's Arrows* popular with seventh-grader students?

RQ3: How to improve *Borrowing Your Enemy's Arrows*?

## II. Design of Mobile Learning Game Apps

The serious educational games can promote scientific practice and flow experience [8] so the teaching content of *Borrowing Your Enemy's Arrows* was based on the sixth- and seventh-grade teaching materials which is published by Shanghai Education Publishing House in order to foster STEM knowledge and skill (see Table 1). The novel project could help students who were afraid of science and engineering disciplines to overcome psychological barriers in order to improve students' interest in learning and participation, and help students who were not interested in Chinese learning to improve their literacy by solving engineering problems [6]. In the game of educational APPs, it was necessary to design clear knowledge instruction and practice to make the game more effective [9], and the test of knowledge was more helpful to students' mastery of knowledge than practical application [10]. In educational games, clear goals, immediate feedback, and appropriate difficulty were precondition of flow [11].

TABLE I.

| Subject | Knowledge | Contents |
|---|---|---|
| Science | Gaseous, liquid and solid<br>The effect of force<br>Friction<br>Buoyancy | The formation of fog<br>Deformation of the arch<br>Rolling log<br>Floating boat<br>Wind-blown boat |
| History | Action and reaction<br>The history of the ship<br>The history of the Three Kingdoms<br>Time | Ancient ship and modern ship |
| Chinese | Peculiar language of character | Ancient time and modern time |
| Engineering | The structure of the ship | Shipbuilding |

### A. Description of the Game APP

*Borrowing Your Enemy's Arrows* is a serious mobile educational game played with Android mobile devices out of the junior high school. It was designed with Photoshop and developed with APP inventors. The design of interface and character were original.

The content of game APP is divided into five modules: Guide (guide to how to use); Cartoon (knowledge, story background); Think tank (list of knowledge); Shipbuilding (hands-on); Athletics (test). The players gained knowledge through cartoons, and then they built ships and played games. When they encountered difficulty, they could enter Cartoon to relearn or enter the Think Tank to summarize important knowledge (see Figure 1).

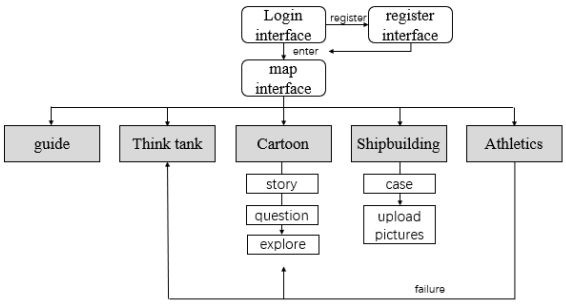


Figure 1. The Structure of Borrowing Your Enemy's Arrows

### B. Cartoon

*Borrowing Your Enemy's Arrows* used a central narrative to link every module together. The core narrative was a story of the Romance of the Three Kingdoms by Luo Guanzhong. This is an episode from the Three Kingdoms. Zhou Yu ordered Zhuge Liang to manufacture 100,000 arrows within ten days, a mission almost impossible, with the hidden purpose of punishing Zhuge Liang in case Zhuge Liang can not fulfill the task in time. Zhuge Liang rode a boat to the enemy's camp for making them believe surprise attack to shoot arrows. Zhuge Liang collected arrows by the scarecrows. The story is presented by comic so the students will be more interested and the relevant questions are set to promote students' thinking (see Figure 2).

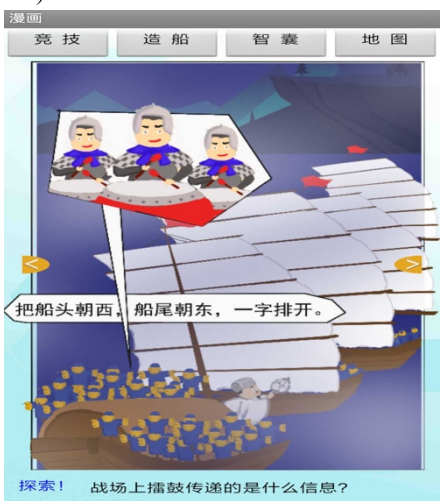


Figure 2. Screenshot of a Cartoon

### C. Shipbuilding

In the story of Cartoon, Zhuge Liang needed 20 ships, and thus *Borrowing Your Enemy's Arrows* demanded players to build ships. The task design of the game should follow the small step principle and accord with the requirements of the "zone of proximal development" [12], The virtual character will guide the students through the small tasks step by step. (see Figure 3). And the players were asked to upload a sketch of the design, a picture of artifacts, and their note taking sheets that were scanned into the devices during the production process in order to evaluate students from different dimensionality.

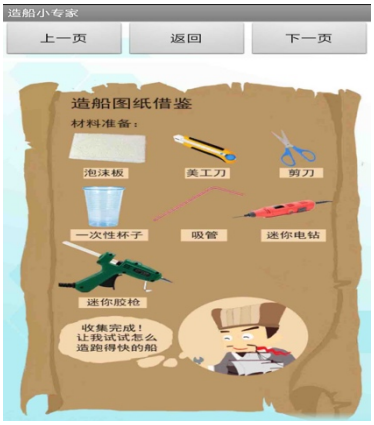


Figure 2. Screenshot of a Shipbuilding that Receives Hints during Gameplay

## III. ATHLETICS

The background of the Athletics was the story in Cartoon, and the players played games by role-playing for promoting the engagement. The goal of the game is to borrow 100,000 arrows from Cao Cao. Every time when the player is out of cards, the Athletics would display the number of arrows which the player had borrowed to make the player define the progress of the task (see Figure 4). When the player is at fault, the mobile phone vibrates to provide negative feedback and when the player wins the game, the mobile phone would sound a note of congratulation for the player, more specifically the sound of a firework display, to provide positive feedback.


Figure 4. Screenshot of Athletics

## IV. METHODS

### A. Setting and Participants

A sample of six seventh-grade students and four teachers was obtained from a junior high school in Jiaxing, China. The school had not a course about STEM or engineering. The six students included three male and three female students and every gender included high, middle and low grades. The four teachers who were at least five years in their respective fields included a computer teacher, a history teacher, a Chinese teacher, and a science teacher.

### B. Study Design and Data Collection

This study employed qualitative research method. Date sources included: interviews, field observations, screen recording and the scores of the Athletics.

### C. Interviews

Students and teachers were assigned to play *Borrowing Your Enemy's Arrows* for half an hour. Immediately after it was completed, students and teachers participated in the interviews. The interview protocol of the students (see Table 2) included questions about TAM, flow experience, the overall design of the software and the attitude towards the software. Whereas the questions about flow experience were removed from the interview protocol of the teachers. All the interviews were audio recorded and later transcribed by the researcher.

TABLE II. THE INTERVIEW PROTOCOL OF THE STUDENTS

| | Dimensionality | Questions |
|---|---|---|
| TAM [13] | Perceived usefulness | When you use this APP, have you encountered any problems? |
| | Perceived ease of use | By using this APP, do you think it is useful for your study? What knowledge have you learned? |
| Flow experience [14] | No fear of failure | What do you do when you fail? |
| | Time distortion | Do you think time passes quickly than you realize in the process of using the APP? Do you want to play with it again? |
| | Loss of self consciousness | Field Observations |
| | Focused attention | |
| The overall design of the software. | Module design | What do you think of the modules in the software: Comics, Athletics, Shipbuilding, Think Tanks? Which are you most interested in? Which do you think needs to be improved? Please elaborate your suggestion. |
| | Art Design | What do you think of the art of software, or do you think it looks good in the software? Where do you think the artists need to change? |
| | Interaction | Do you think you can get clear and immediate feedback when you use the software? Do you find the interaction in software interesting? |
| | Teaching content | Do you think the knowledge involved in the software is difficult? |
| Attitude [15] | Degree of affection | Do you like this software? |

### D. Field Observations

Two researchers conducted field observations during gameplay by following players. The researchers recorded observations about students' attention and expression to show the flow experience of the students especially in terms of focused attention and loss of self-consciousness.

### *E. Screen Recording and the Score of the Athletics*

When the students were using *Borrowing Your Enemy's Arrows*, the screen recording software recorded the students' operation. And one researcher kept the score of the Athletics by watching screen recording.

## V. RESULTS

### *A. The Score of the Athletics*

Table 3 presented the score of the Athletics in the screen recording. After going through the cartoon and the Think Tank for the first time, the students did not complete the task, but most of them were able to complete the task at last. This indicated that the difficulty of the Athletics is appropriate. And the study found that when students failed their first try in the game some of them would go to Cartoon to review or go to Think Tank to learn or both for a second time. Different choices were available to individuals (The full marks is 11).

TABLE III. THE SCORE OF THE ATHLETICS

| Student | Gender | Age | Ranking of the School/(N=500) | First Score | Last Score |
|---|---|---|---|---|---|
| S1 | Female | 13 | 1/500 | 8 | 11 |
| S2 | Female | 14 | 232/500 | 8 | 10 |
| S3 | Female | 13 | 411/500 | 4 | 8 |
| S4 | Male | 13 | 250/500 | 6 | 11 |
| S5 | Male | 14 | 39/500 | 8 | 11 |
| S6 | Male | 14 | 451/500 | 7 | 10 |
| mean | | 13.5 | 230.6/500 | 6.8 | 10.2 |

### *B. Interviews*

#### *1) Technology Acceptance*

Students could use the APP easily even without teacher's guidance. They thought that there was no problem with APP usage. Only one girl had a problem with the button, and she thought the problem was with the phone. However, teachers had demanded better APP usage, especially the computer teacher. Below, the computer teacher describes the problems using the APP:

*I can play it by myself, but some buttons are too small to recognize at first. Of course, the Icon of the Guide is also so small that I think it is just a picture. So I think you can put it in the middle of the map. And sometimes the button is malfunctions.*

(interview, computer teacher, seven years' teaching experience)

In this APP, students and teachers agreed that it could promote students' learning. And they were all aware that this is an interdisciplinary education software, but most people could only recognize science, history, and language.

#### *2) Flow Experience*

Most students could have flow experience. They didn't fear failure and thought time passed quickly. They wanted to play it again. On the other hand, five students focused on the APP and one student was distracted when the researchers were taking pictures and walking.

#### *3) The Overall Design of the Software*

For the most impressive module, different people had different answers. Students preferred Shipbuilding and Athletics. Teachers' choices were much more dispersed since all four modules were mentioned. For the artistic designing, the requests of the girls were generally more than boys. Girls thought the image of the characters could become more exquisite. The computer teacher put forward her own ideas for the interaction of the Cartoon:

*Cartoon is more attractive, but the interaction of the Cartoon is too easy. You can increase the frequency of interaction. For instance, when you touch on the characters, words and sounds then appear.*

(interview, computer teacher, 7 years' experience) For the teaching content, researchers asked the students about the difficulty and asked the teachers about its reasonableness. Students thought the difficulty of knowledge was appropriate, because the teaching content had the knowledge they had learned and the knowledge quite unknown to them. The teacher thought the content was accurate.

#### *4) Attitude*

The students' attitudes were positive. They thought the APP was very interesting, and they would like to recommend it to their friends. However, on the one hand, the teacher thought that this was a useful tool for the students. On the other hand, the teacher thought that the phone could disturb the students' study and other problems. Chinese teacher's description of the problems of APP is as below:

*You should consider which teacher can teach this curriculum. Now none can teach it in our school. And the app just has a story, so the curriculum is just one. It's too little.*

(interview, Chinese teacher, 20 years' experience)

## VI. DISCUSSION

This paper described a mobile phone application for STEM based on a novel engineering approach to foster STEM knowledge and skills. In this study, researchers introduced the design of *Borrowing Your Enemy's Arrows* and implemented a simple user evaluation in order to find out whether the mobile phone application design was reasonable, weather the teaching content was accurate, and how to improve it.

As a whole, the teaching content of *Borrowing Your Enemy's Arrows* is accurate and conforms to the content of the textbook. The design of *Borrowing Your Enemy's Arrows* is reasonable and has the following advantages. First, *Borrowing Your Enemy's Arrows* based on a novel engineering approach created a problem-based learning environment to promote students' learning. Second, the method of evaluation was diverse, both competitive and practical. Third, students could personalize their learning based on different knowledge types.

Of course, there were some deficiencies in *Borrowing Your Enemy's Arrows* that needed to be improved. First, add story content, design a series of curriculums to support systematic teaching. Second, increase the forms of interaction and increase the chance of human-computer interaction. Third, improve the design of both the character and the interface to increase visual aesthetics.

## VII. STUDY LIMITATIONS

In this study, a STEM educational software on the basis of novel engineering was developed. After interviewing students and teachers, the results showed that the software could stimulate students' interest and help them learn

STEM contents better. However, there were still some limitations. In the study, we only had six samples. Due to the limited time of investigation, the subjects failed to complete the engineering module and further investigation on subsequent memory wasn't able to be carried out.

In addition to the fact that STEM type apps could help improve students' learning motivation, they also had a positive effect on guiding students to complete STEM content. However, researchers still needed to develop learning materials to go with the APP (e.g., textbooks, courses, video, toolkit) to support students in learning STEM contents.

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# Play and Learn 3D (PAL3D®)

# A Collaborative Way of Learning Project Management with Minecraft®

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***Abstract*— Play and Learn 3D is an effective way for people to learn about Project Management (PM) and develop managerial skills with a team under "extreme" circumstances. Users of this program can plan a project in teams, calculate budget and time requirements, introduce this data in our app and play Minecraft® on our server. The app and server are connected so the student will always know the impact of their performance and will introduce corrective measures if required, with consensus from the team. Teachers can analyze their learning patterns and infer behavioral models. (Disclaimer: Minecraft® is a trademark of Mojang Synergies AB. and has not participated either in the conceptualization or in the development of this course methodology or in the course itself).**

***Index Terms*—Project Management, play and learn, collaborative learning, PAL 3D**

## I. Introduction: Origin and Evolution of the Idea

### A. *First Steps*

We discovered Minecraft® accidentally, inevitably, through our children. After playing with our children and dying too many times we realized that we must plan our next interaction with the game in order to survive. As I own a project management training company and am a trainer myself, I was inspired! I have a project each time I enter Minecraft® but, was there a chance to use it in our trainings? In June 2015 we shared our thoughts on LinkedIn and generated a healthy debate which showed us that teaching Project Management with a game like Minecraft® was, at least, appealing and useful.

We chose Minecraft® mainly because it is a 'sandbox' game, which means that each player crafts their own future manipulating the specific terrain and habitat provided in the game. But what really attracted us was that apart form a single player option, Minecraft® could be played with multiple players.

Further investigation helped us discover that this game also let us work on specific knowledge areas of a project: there are numerous situations when you have to handle risk and properly manage it, for example, when you have to deal with hostile creatures which can injure or damage you; time management is also an important skill in the game since during the day you have to organize acquiring weapons or a shelter in order to survive the night; scope management or even quality management could also be variables included in the game.

### B. *Initial Concerns and Constraints*

#### 1) *Our Game Had to be Collaborative*

Being collaborative in Project Management means that apart from theoretical content we can work on skills like: handling stress, leadership, team roles, and stakeholder management. This was not a game to play but to play collaboratively.

At a certain point in the course, students gather both offline and online. This helps them put into practice much more than what they expect, becoming real members of a project and reproducing the micro cosmos of a project with member roles, decision making processes, rules, and different leadership styles.

#### 2) *Students' Interactions with the Game had to be Traceable*

The course had to show the students the impact of their decisions, and we had to be able to measure their interactions with the game. Without measuring the progress of each student Minecraft® was just a "game" and we wanted it to be a Project Management experience.

Defining the variables to be measured implied a sound knowledge of the game and of the infinite chances of interaction. Once programmers and methodologists understood the logic behind the game, we could produce a "construction map" and define which variables we wanted to be measured. In order to trace these variables, we first tried with Minecraft® Realms but finally decided to use Sponge which lets the system "know" which actions are being taken by each student.

In order to make all calculations according to the information provided by Sponge we developed an app where all stats of the game appear individually and by teams.

#### 3) *Online / Blended Based*

Certificacionpm®, my thirteen-year-old company is focused on online training and we have developed a campus for teaching Project Management, Risk Management, Scrum, PMP, and CAPM. We are strong in technology and can infer certain learning patterns. We could not miss all this expertise.

As a result, our first course was 100% online. It was meant for people from all over the world working in coordination and at some moments simultaneously. After some test groups we realized that this was a strong methodology which recreated a real-world working scenario where team members had to face communication issues, technology limitations, and cultural and timing gaps. The use of online project follow-up boards like Trello and Asana was suggested by some members of these remote teams. This experience helped to transcend the game.

As some teams preferred to physically gather at some point in the process, we shaped the online methodology and made it a blended one. It let us introduce physical cards and gadgets which resulted in an ideal project planning process. The best of both approaches combined resulted in a perfect match.

### C. *Road Map*

**June 2015 - March 2016. Research work.** After initial ideas, we started reading about the use of Minecraft® for educational purposes. All the literature we read was about Minecraft® for children, and nothing specifically focused on adults. In fact, the Minecraft® pedagogical approaches to teaching were not something new, but the methodology we had in mind was new: it had to do with an engaging experience for adults who could learn collaboratively about Project Management and assess the learning impact.

In order to test our idea, to see if it generated curiosity and if a market for the project existed, we started sharing our thoughts on this course and gathering online feedback, as well as feedback from clients and colleagues.

**March 2016. Prototype.** Basic prototype was developed: software, native application, course server and course content.

**June 2016. Beta testing May.** We tested the idea at the Northwest Startup Day (Galicia) with an overwhelming reaction from attendants to become testers of the product. We also tested the product with a team of eight people with different backgrounds, ages, and experiences. We came to the conclusion that the student's main concern when attending a gamified course is to learn over playing. This drove us to strengthen the theoretical part of the course and increase its level of difficulty. Testing was crucial.

**July 2016. Minimum Viable Product (MVP).** We launched the course at the University of Zamora in its Masters in Project Management. We found a group of enthusiastic students and experts in Management, who could put into practice what they had learned. The collaborative part and the stress on soft skills was a good complementary activity for the Masters. The competitive part of the game proved very motivating for the teams. We decided to include a gift for winners as part of the process.

**June 2017. Final product V.1.** Testing with the corporate sector. We presented the product to Heads of the Human Resources Department of eight Corporations. They learned, played and provided us with great feedback in order to tailor the courses to their departments.

**July 2018. Final product V.2.** 2nd training at the University of Zamora in its Masters in Project Management. We had introduced some lessons learned from previous sessions and students saw the real application of the game.

**October 2018. Final product V.3.** The training and corporate sector are demanding this type of training. Each new training lets us grow the product. We are eager to see what the future brings.

## II. Facts

### A. *Product Audience*

We are focused on training adults specifically in the discipline of Project Management. Our target age is between twenty-five and forty-five years old. This condition made it possible that this may be the students first contact not only with Project Management but also with the game. The game is a tool in this course and the student has to see it as such. We worked on all materials in order to avoid frustrating situations. Students are used to basic Project Management concepts and also to basic Minecraft® commands sequentially, step by step.

By adults we mean both students and professionals who want to learn about Project Management and managerial skills: stress, team building, decisions making, etc.

Apart from the course participants, we also saw that this course could be a great asset for Human Resources Departments who want to analyze leadership styles, or work on specific aspects of their profession: conflict resolution, ethics, roles, etc. This information could prove helpful in developing professional paths.

### B. *Product Goals*

Basic goals of this course are related to professional goals of participants and also those of HR departments.

For the professionals the course helps them become aware of their role in a team, their leadership style, aids in learning managerial and project management concepts, and how to develop a collaborative way of approaching a problem.

For training HR departments the course can provide tools that help analyze team performance and any soft skills related aspects. The course also helps in teaching collaboration and team building skills.

## III. Overview of the Product

This course runs in 3 scenarios:

### A. *First Scenario: Online Campus on Certificacionpm®*

By means of four mini-adventures the students would not only learn how to cope with Minecraft® but they would acquire a deep PM knowledge. This is an online self-study/practice moment.

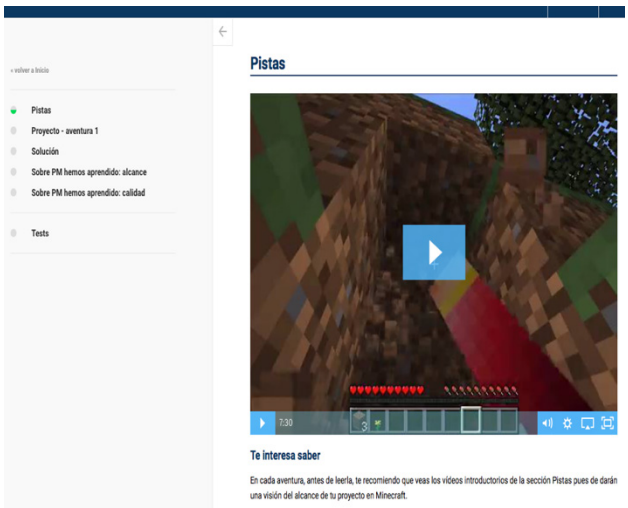


Figure 1. Snapshot Certificacionpm® campus

### B. *Second Scenario: In Class, Off Line, for Planning Purposes*

Each group receives instructions about what they have to build in Minecraft®. They receive a folder with visual resources and aids in order to build a hut, or small house. With this information they will conclude how much money the project will cost and how long it will take. They will upload the information to The Minehut Project App, developed by ourselves.

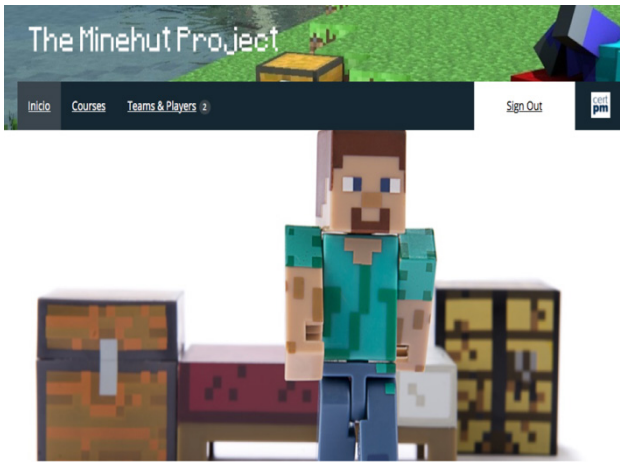


Figure 2. Snapshot. Certificacionpm®, Minehut Project App

### C. *Third Scenario: In Class, Online, Executing the Project in our Minecraft® Server*

All students enter our Minecraft® server, find their team members and start building according to their planning, and what is really worth all the pedagogical and technological development: as the Minehut application and the Minecraft® server are connected students can see in the Minehut application various graphs showing them how they are performing against what was planned. The Earned Value Analysis is so useful in PM control and will aid in controlling their performance and introduce corrective measures when needed.

## IV. Conclusions

With over 16.5 million Project Managers in the world and more than 75 million Minecraft® active users a month, the course had to welcome all profiles, from novice to experts, for both project managers and gamers. None of them had to feel frustrated because of the high level of the course, or discouraged because of a low learning ceiling. We are happy to say that the course welcomes all profiles, all of them will learn project management high level concepts, experience them, and have a good time.

The course becomes collaborative the moment the students have a common goal which implies not only socializing but sharing their knowledge and creating a common understanding of the project. The game helps in this path, providing a common ground to evolve as a group.

The final lessons are learned when students and facilitator share their experience, and is essential for all to be aware of their progress in the field of management and behavioral patterns.

## Acknowledgment

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# Experiential Learning at Scale with Computer-Based Roleplay Simulations

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***Abstract*— Experiential learning is an effective method for changing behavior and teaching new material at work. Unfortunately, experiential learning is difficult to deliver at scale as it requires hands-on participation and interactivity.**

**EmpowerTheUser (ETU)'s computer-based roleplay simulations enable experiential learning at scale. In a simulation, learners take on a role and have to react to various situations and make choices that have downstream consequences. ETU Simulations engage the learner in cycles of assessment and practice, with summative scoring in the assessment mode and real time coaching and feedback in the practice mode.**

**ETU partnered with one of the oldest custodian banks headquartered in New York to deliver a series of three simulations on risk management to nearly 6,000 managers on five continents. User feedback shows that learners are highly satisfied with the program. Performance improved from simulation I to simulation II, indicating transfer of learning. Underperforming learners were remediated using the assess/practice/assess learning loop, resulting in a 227% improvement in performance.**

**EmpowerTheUser Simulations provided fast, consistent training in risk management. Feedback was overwhelmingly favorable and decision tracking within the simulations demonstrated effective learning.**

***Index Terms*—eLearning, simulations, evaluation, risk, experiential learning**

## I. Introduction

Learning and development are essential to employee success. Experiential learning, i.e. learning by doing, promotes behavioral change and retention of training content [1], making it ideally suited to the workplace. Unfortunately, experiential learning has historically been difficult to deliver at scale, leading to the use of less-effective passive learning methods such as on training manuals, linear didactic web based training, or videos.

New technological developments have enabled experiential learning at scale through computer-based roleplay simulations, where learners take on a role and have to react to various situations and make choices with downstream consequences in the simulation. Simulations can be delivered to hundreds of thousands of employees simultaneously. Research has shown that simulations result in content retention and behavioral change because they are a) emotionally engaging, b) require active participation and decision making, and c) give learners control and responsibility for their learning [2].

## II. Experiential Learning with EmpowerTheUser Simulations


Figure 1. EmpowerTheUser Simulations at Scale

EmpowerTheUser (ETU) uses rapid collaborative authoring to enable companies to quickly develop situational simulations that incorporate personalized learning and behavioral analytics. ETU Simulations engage the learner in cycles of assessment and practice. In Assess Mode, learners complete the Simulation without assistance and receive their benchmarked scores at the end. In Practice Mode, learners receive real time coaching and feedback for each decision and can evaluate different decision-making strategies to arrive at optimal outcomes.

## III. Case

### A. Challenge

ETU was contacted by one of the world's oldest and largest global custodian banks (GCB), who offer a variety of investment management and investment services. The importance of understanding and managing Risk Culture (i.e. the system of values and behaviors present in an organization that shapes risk decisions of management and employees) is paramount to their continued success. As a global organization, training needs to be administered consistently and effectively to a broad range of locations around the world.

### B. Solution

In 2017 GCB successfully deployed a program of three ETU Simulations to a target global population of 5,728 managers in the United States, Europe and the Middle East, and Asia Pacific. The set of three 17-minute (approximate) simulations covered material equivalent to three 60-minute vILT (Virtual Instructor-Led Training) programs. This program delivered an approximate

savings of over $700,000 relative to the cost of typical vILT training.

All three simulations focused on the same risk-related skills, here referred to as skills A-G, but in three different roles. In Simulation I, the learner takes the role of a Relationship Manager meeting with a prospective client. Their job is to negotiate the contract and onboard the client. In Simulation II, the learner takes the role of an Operations Manager addressing a problem presented by a new client. Their job is to take ownership of the problem and make a plan for next steps to resolve it. In Simulation III, the learner takes the role of a team member doing a post-mortem on the problem incident described in Simulation II. Their job is to devise an appropriate institutional and procedural response to understand why the incident occurred and how similar incidents could be prevented in the future.

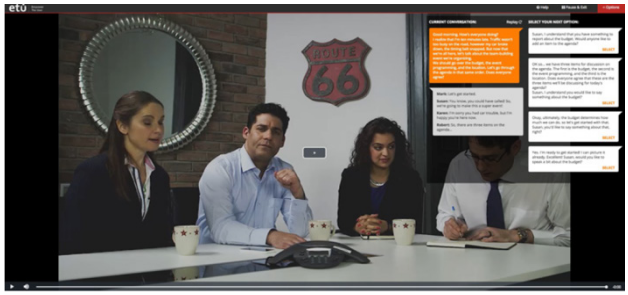

Figure 2. Screenshot of learner point-of-view in a simulation. The left topmost dialogue box contains the learner's statement from the previous decision-point, with the stakeholders' responses below. The right-side column of dialogue boxes contain the learner's menu of response options. Once an option is chosen, the simulation will progress with the stakeholder's reply, delivered both in text and as a video with professional actors.

In all three simulations, the learner has first-person point-of-view "conversations" with relevant stakeholders: Clients, fellow team-members, and members of other teams. Learners choose their questions, and respond to stakeholders' answers, by selecting one of a menu of possible actions or statements. The options represent optimal (the best choice), suboptimal, or critical (a serious error) decisions. Stakeholders' questions and comments are shown via pre-recorded videos that play in response to the learner's choices. The simulation changes as the situation progresses to reflect the learner's behaviour. Figure 2 shows an example of one decision-point in a simulation.

The script for the simulation, both the learner's choices and the various responses of the actors, was written in collaboration between GCB L&D and the ETU Simulation development team, and reviewed by relevant Subject Matter Experts at GCB. In addition, coaching videos provided additional support and scaffolding in the "Practice" mode.

It was expected that Simulation III would be the most difficult as it involves the broadest scope, while Simulations I and II would be of similar difficulty.

## IV. EFFECTIVENESS

### A. *User Satisfaction*

Learners reported high levels of satisfaction with the simulations, with 80% saying they agreed or strongly agreed with 9 multiple-choice questions asked by GCB, including "The way the program was delivered [...] was an effective way for me to learn the content."

### B. *Quantifying Learning*

Each ETU Simulation incorporates automated person-level tracking of all decisions. Decisions can be categorized by the specific risk-related skills they involve and scored by whether the decision is optimal, a suboptimal mistake, or a critical mistake. This tracking yields rich and granular data, as shown in Figures 2 and 3.

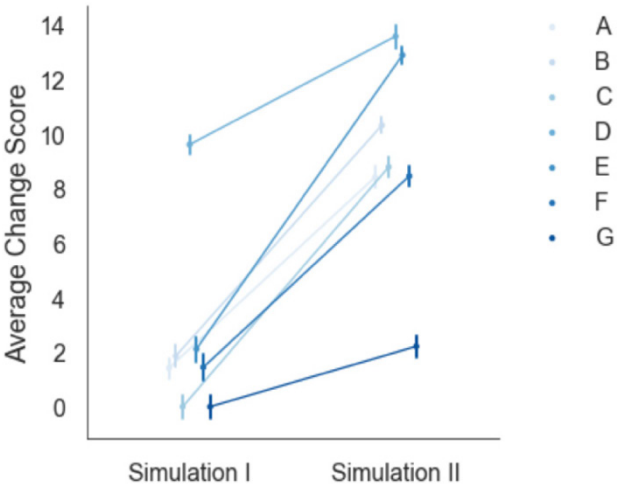


Figure 3. Change in performance from learners' first attempt at Simulation I (mean-centered so that the Simulation I average is 0) to their first attempt at Simulation II (with the mean for Simulation I subtracted out) for seven different skills. Vertical error-bars represent 95% confidence intervals for the average scores.

GCB established a minimum performance threshold and over 99% of learners passed on their first attempt. As shown in Figure 3, scores improved from Simulation I to Simulation II (all t-values > 9.4, $p < .0001$). The effect sizes of the improvement ranged from $d$=.13 to $d$=.60 with a mean of $d$=.40, suggesting that meaningful transfer of learning occurred from one context (Relationship Manager) to another context (Operations Manager). Scores for Simulation III dropped by an average of 4% from Simulation I, supporting the expectation that the risk manager context was the most challenging. These insights can be used to fine-tune further training.

### C. *Remediation through Practice*

Learners whose scores fall below the passing benchmark set by GCB in Task Mode are prompted to complete the simulation in Practice Mode and then to re-take the Task Mode. Forty of the 62 learners in the repeat group retook at least one simulation, and 39 of 40 scored above the passing threshold on the second try. As shown in Figure 4, on average performance improved by 227% on the second attempt. This is the equivalent of going from a score of 30 to a score of 98.1.

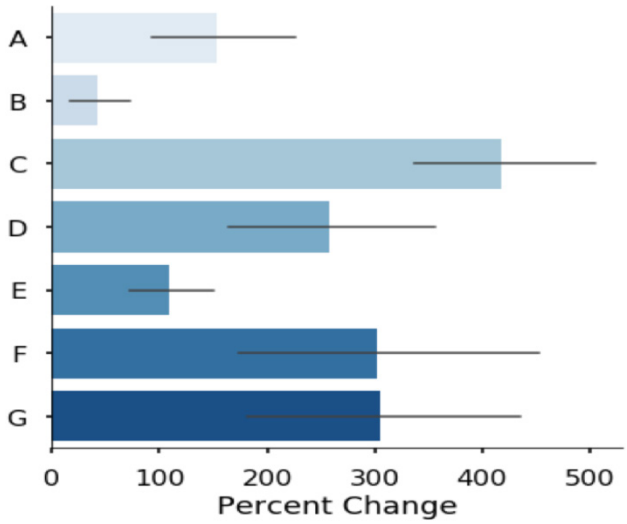


Figure 4. Change in performance between first and second attempts for learners who fell below the passing benchmark on their first attempt. Error bars represent 95% confidence intervals around the average percent change represented by the columns.

## V. Conclusions

The three-simulation course developed with ETU provided the equivalent of 180 minutes of vILT training through 51 minutes of experiential training in simulations. User feedback was favorable and detailed evaluation of learner performance provided evidence of content mastery. Under-performing learners were prompted to practice and re-assess, resulting in substantial improvements in performance. Statistics on performance across simulations identified opportunities for further training.

## Acknowledgment

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# Case Study: Voxy "English for Software Engineering"

# The Conception and Creation of an E-Learning English-Language Course Tailored to Learners' Real-World Needs

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***Abstract*—This case study provides an overview of Voxy's language-learning platform and the needs analysis conducted to determine the content required for its "English for Software Engineering" course, which received a 2018 International E-Learning Award in the Business Division. This study documents Voxy's methodology and theoretical underpinnings. Further, the report outlines the rationale behind using authentic, real-world content, how the company identified the English skills that software engineers require to do their jobs, and how a team of working software engineers provided both guidelines and raw materials to help develop the course content.**

***Index Terms*—software engineering, e-learning, second language acquisition (SLA), language learning solution**

## I. Introduction: Voxy's Methodology and the Need for the "English for Software Engineering" Course

### *A. About Voxy and the role of authentic content in language learning*

Voxy is a flexible language-learning solution that has been used successfully by over four million learners and hundreds of clients in more than 150 countries. The company has drawn on established best practices from the fields of Second Language Acquisition (SLA) and Technology-Mediated Instruction to identify three core ideas that form the basis of its theoretical underpinnings: 1) Language learning is acquiring a skill, not studying a content area, and it works best when it is personalized [1]; 2) A blended approach is the most efficient and effective method of instruction [2]; 3) Learners require access to authentic content, the opportunity to produce the language themselves, interactive practice, and ongoing feedback [3].

Voxy's approach is needs-based at both the level of the learner and the learner's sponsoring organization (i.e., workplace, school, university). The platform provides a flexible solution with a combination of autonomous, online instruction, regular assessment and testing, and synchronous classes offered both individually and in small groups. Every part of the course—from the content to the number of classes and the topics covered in the live instructional sessions—is flexible and adapted to each organization's curricular needs, as well as each learner's proficiency level, learning goals, and performance.

Using authentic, real-world content is the most effective and efficient way to give learners the input they need for second language acquisition [4]. At the outset of instruction, the platform determines what job tasks learners need to accomplish in English and tailors instruction accordingly, employing a combination of proprietary adaptive technology and human intervention. Using a wide-range of real-world materials, from business emails and video recordings of client meetings to recorded phone conversations, learners acquire the English they need to do their jobs. Voxy's patented content-processing engine allows the company to take authentic English materials and turn them into lessons that adapt to learners' needs in real-time, resulting in personalized instruction that leads to faster learning outcomes.

The Voxy platform currently has over 60,000 hours of authentic English content, which is supplemented daily by the company's curriculum team via the company's content-processing engine. All of the content comes from real-world sources, and includes media ranging from genuine news articles to videos of real people ordering food at a restaurant to recordings of actual business meetings, so that learners have the communicative and intercultural competencies they need to thrive in a global working environment.

### *B. The "English for Software Engineering" audience and course overview*

With over 21 million developers across the globe, software engineering is one of the world's fastest-growing professions. English has already become the most widely accepted language of international business, and is central to a career in software development because almost every programming language borrows both commands and syntax from English. There is a huge demand for software engineers to communicate in English in order to work in the U.S. or overseas for U.S. companies, making "English for Software Engineering" a requisite for Voxy's growing curriculum.

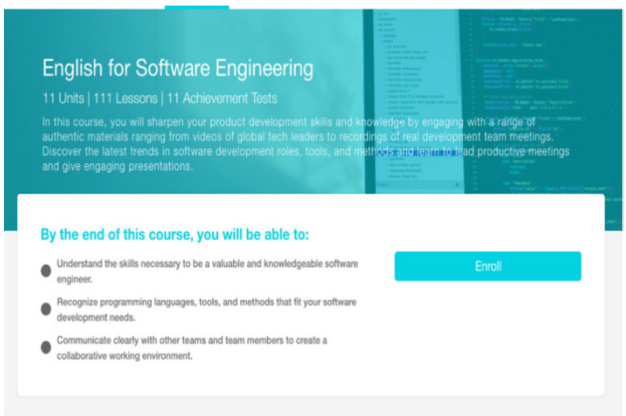


Figure 1. Voxy created its "English for Software Engineering" course in response to both learner feedback and the growing demand for software engineers worldwide

"English for Software Engineers" uses a web and mobile platform to provide highly contextualized English language instruction to current software engineers as well as engineers in training. Learners acquire the English they need to perform their job duties while simultaneously sharpening their product development skills and domain knowledge by engaging with a range of authentic materials, spanning from videos of global tech leaders like Apple, Google, and Microsoft, to recordings of real development team meetings to product documentation. They also discover the latest trends in software development roles, tools, and methods and learn to lead productive meetings and give engaging presentations.

## II. Conducting the Needs Analyses

### A. *Course Rationale*

Voxy courses and content are developed based on learners' real-world needs, which are identified through multiple channels. Based on students' responses to the initial platform needs-analysis form, the Voxy curriculum team determined that more than half of the platform's users were interested in technology. To drill down further, the company created a needs-analysis form for teachers of learners in private classes (conducted in virtual classrooms) to ascertain what specifically about technology would help their work and daily life. Voxy has thousands of entries from these learners, which reveal that beyond general business English, engineering is a primary focus area. (It's important to note that this is a not a course to train someone to become a software engineer; it's one for those who are already software engineers, or are training to become them, to learn the English necessary to be able to do their work.) This feedback, coupled with the exploding global demand for software engineers, compelled Voxy to create the course.

### B. *How Voxy determined the course content*

Voxy turned to its own in-house software engineering team, including employees in Sao Paulo, Brazil, and New York, NY, to determine what software engineers need to be able to do in English. Voxy's course developers observed and interviewed the engineers, checking in with weekly questions—for example, which programming languages to include—to ensure the course content was entirely applicable and up-to-date. The course developers considered some of the tasks required of global software engineers, such as giving presentations and attending meetings in English at global companies. Their ability to discuss jobs and responsibilities is also crucial: If they're trying to change jobs, they need to be able to talk about both what they do now and what they'd like to do in the future.

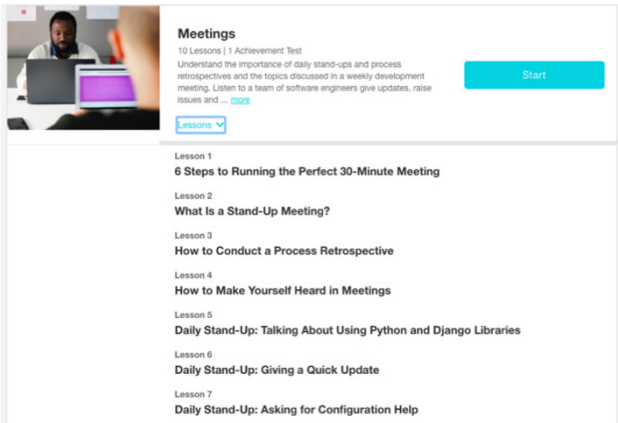


Figure 2. Unit 7 of Voxy's "English for Software Engineering" course teaches learners how to organize meetings and includes audio of authentic conversations

In keeping with its authentic-content ethos, Voxy also included hard-to-find, genuine audio and video from its software engineering team's meetings and presentations, as well as text-based conversations conducted by team members during their workdays via internal messaging tools like Slack. These rich language sources were recorded and edited to create the course materials, and are key differentiators between Voxy's course and others: Learners actually see how software engineers are using the language in real life.

## III. Next Steps

Voxy's "English for Software Engineers" course is the first of its kind to offer the real-world, needs-based content that these in-demand professionals use to do their jobs in English. Given that the course is relatively new, the company's next step is to test its effectiveness by measuring the English proficiency gains and speed of a group of engineers who are using the platform.

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**International E-Learning Awards, Business and Industry Division**
**2018 Winners**

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The International E-Learning Awards, presented by the International E-Learning Association (www.ielassoc.org), recognize the best uses of technology to improve learning and job performance within companies or through individual professional development. Our IELA Awards Committee looks for a number of attributes when reviewing submissions, including, among others, educational soundness and effectiveness, usability, and overall significance.

The 2018 award winners were announced at our Awards Ceremony in New York at the **ICELW Conference** on June 15, 2018, by the IELA President and International E-Learning Awards Chair, Dr. David Guralnick. We are pleased to congratulate all of the winners!

The award winners are as follows:

**Winner, E-Learning: *"Nicos Weg - Einfach Deutsch lernen,"* Deutsche Welle**, Germany. Representative: Barbara Syring-Marks.

**Winner, Mobile Learning*: "Transfusion Reaction Management Mobile Learning App,"* Children's Hospital Association – Pediatric Learning Solutions**, USA. Representative: Jennifer Shackleford.

**Winner, Blended Learning: *Play and Learn 3D (PAL3D®): "Collaborative way of learning Project Management with Minecraft,®"* Lanarvi Consultants (dba. certificacionpm®),** Spain. Representative: Claudia Alcelay.

**Runner-Up, E-Learning: *"BD Market Shaping Toolkit Online,"* Becton Dickinson,** USA**.** Representative: Jonathon Levy.

**Runner-Up, Mobile Learning: *"Learn German: Die Bienenretter,"* Deutsche Welle,** Germany. Representative: Barbara Syring-Marks.

**Runner-Up, Blended Learning*: "English for Software Engineering,"* Voxy**, USA. Representative: Katharine B. Nielson.

**Honorable Mention, E-Learning*: "Cool, Calm and Connected,"* Savv-e and Commonwealth Bank**, Australia. Representative: Alisa Crowe.

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**Honorable Mention, Blended Learning: *"goFLUENT Language Training Solutions,"* goFLUENT**, Philippines. Representative: Sophie Nakasako.

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