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A Design Science Approach For Developing And Evaluating A Competence Acquisition Mobile App

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A DESIGN SCIENCE APPROACH FOR DEVELOPING AND EVALUATING A COMPETENCE ACQUISITION MOBILE APP

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Abstract

The continuous development and acquisition of competences by a firm's employee are fundamental instruments for achieving sustainable competitive advantage. In this scenario, digital technologies play a relevant role in providing a ubiquitous platform to foster and facilitate this learning process. This paper describes the design, development and evaluation process of a competence acquisition mobile app. The evaluation of the app was carried out through an experimentation involving middle managers as well as project managers form an IT consulting firm. The results indicate that the use of the mobile app effectively improved users' learning process outcomes as well as the ability to deploy the new competence – demonstrating that an ubiquitous learning environment can be paramount for the development of competence acquisition tools.

Keywords: organizational learning, competence acquisition, ubiquitous ecosystem, design science research.

1 Introduction

Organizational learning is an area of increasing concern for businesses seeking to achieve sustainable competitive advantage (Za *et al.*, 2014). In this context, digital technologies play a relevant role in transforming resources into core capabilities – having the potential to become an "active component of the firm's competitive advantages" (Yoo *et al.*, 2010).

These digital tools and their governance models can be used as a platform for fostering diverse learning processes through different learning strategies such as open and flexible learning (autonomous), distributed learning (dependent), and learning communities (collaborative) (North-Samardzic *et al.*, 2014; Za and Braccini, 2012). This can be particularly helpful within business settings as human resources can develop individual competences and skills that could translate into competitive advantages for their organizations (Boyatzis, 1982a).

Managers can attain continuous improvements of organizational performance by encouraging the development and strengthening of organizational competences (Boyatzis, 1982b; Prahalad *et al.*, 1990) As a matter of fact, a source of competitive advantage lies in the ability of top management to consolidate technologies and productive capacity into core competences that allow each business to quickly adapt to continuously changing scenarios as well as to capture potential market opportunities (Prahalad *et al.*, 1990).

There is no convergent definition of the term "competence" in the literature (Delamare-Le Deist and Winterton, 2005). It often referred as a combination of different factors such as knowledge, skills, and/or individual characteristics. Delamare-Le Deist and Winterton (2005) propose a holistic competence model composed by three fundamental dimensions: cognitive (knowledge and understanding), functional (skills) and social (behavior and attitude). While the distinction of the three fundamental dimensions could be analytically identified, in practice the competence of an individual is the result of the combination of the three fundamental dimensions. In addition, competencies may be learned through training and development (McClelland, 1998), aiming to improve the performance of specific tasks. The extent to which the training is effective may be measured on the basis of pre-established criteria (Boyatzis, 1982b).

Digital technologies can be a powerful tool for training and development of human resources (Andreu and Ciborra, 1996). The rapid pace of mainstream adoption of new forms of ubiquitous computing devices such as smartphones, tablets and 'phablets' is enabling an ubiquitous learning environment that can be paramount for the development of competence acquisition tools (Chu and Lo, 2011; Lyytinen *et al.*, 2004). As users are able to accomplish a multitude of tasks and interact fluidly in a ubiquitous ecosystem, they become empowered of their own individual learning process (Carillo *et al.*, 2014).

It is not surprising that the largest app category within Google Play (the world's largest marketplace for mobile apps[1]) is "Education". It equates to approximately 10% of Google Play apps, offering more than 135,000 apps focused on a variety of instructional goals[2]. However 18% of the apps in this category as classified as "unlikely to be useful" and only 4% reach the 50,000 downloads mark. Apps dedicated to learning a language are the most common type of app among the top 100 "all-time popular apps" in the Education category. This is followed by apps focused on acquiring technical skills (e.g. drawing, playing a musical instrument, passing the driving license exam), brain training, child development and accessing distance learning environments such as Backboard[3].

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[1] http://uk.businessinsider.com/google-play-vs-apple-app-store-2015-2?r=US&IR=T
[2] http://www.appbrain.com/stats/android-market-app-categories
[3] http://www.appbrain.com/apps/popular/education/

Following a Design Science (DS) research methodology, this paper attempts to describe the design, development and evaluation process of a competence acquisition mobile app. The structure of the paper is as follows: after this introduction section 2 describes the DSRM methodology. This is followed by a discussion on core theories related to skill acquisition, the problem to solve and the design of the artifact. Afterwards the instantiation of the app for acquiring a specific competence was done, followed by the evaluation process description. Final considerations and brief information on the next steps of the research will conclude the paper.

2 The DSRM process

The main goal of the Design Science research approach is the creation of successful IT artefacts (Peffers *et al.*, 2008). The design science research methodology (DSRM) proposed by Peffers et al. (2008) is a holistic design science process that is robustly anchored on prior IS literature (Gregor and Jones, 2007; Hevner *et al.*, 2004; J.G. Walls *et al.*, 1992; Joseph G. Walls *et al.*, 2004). The DSRM is composed by the following six steps:

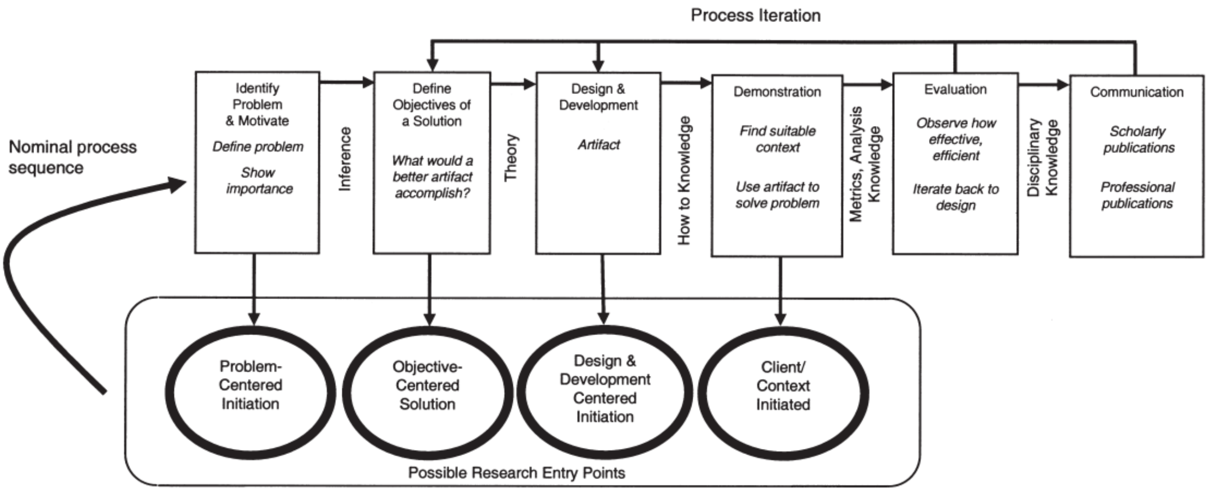

Figure 1. DSRM process model (Peffers *et al.*, 2008).

1. *problem identification and motivation* – including knowledge of the state of the problem and the importance of its solution;
2. *definition of the objectives for a solution* – from the problem definition and knowledge it is necessary to infer the objectives of a solution and what is possible and feasible. Usually, it is needed to take into account the knowledge of the state of problems and current solutions;
3. *design and development* – the creation of the artifact, such as technical or social innovation (Hevner *et al.*, 2004; van Aken, 2004), or more in general "new properties of technical, social, and/or informational resources" (Järvinen, 2007). This step includes the definition of the artifact functionality and architecture, and its creation;
4. *demonstration* – in this step it is demonstrated the capability of the artifact to solve one or more instances of the problem (e.g. through experimentation, simulation, case study, proof, or other appropriate activity);
5. *evaluation* – the goal of this step is to observe and measure how well the artifact supports a solution to the problem, comparing the objectives of a solution to actual observed results. The evaluation could take many forms, quantitative and qualitative (e.g. a comparison of the artifact's functionality with the solution objectives from step 2, objective performance measures, satisfaction surveys, client feedback, or simulations). At the end it is possible to decide whether to

iterate back to step 3 (design and development) attempting to improve the effectiveness of the artifact or to leave further improvement to subsequent projects.

6. *communication* – at the end, it is suggested to communicate the carried out process and the obtained results to researchers and other relevant audiences.

Even though the process described above is structured sequentially, it is important to observe that there is no expectation to always proceed in a consecutive order from step 1 through step 6, as shown in figure 1. For example a problem-centered approach should follow the nominal sequence, starting from step 1. An objective-centered solution, could start with step 2, triggered by a research need that can be addressed by developing an artifact, while a design- and development-centered approach would start with step 3.

In the following section we provide the description of our design problem and the DSRM process for developing a competence acquisition mobile app.

3 The development of a competence acquisition mobile app through the DSRM

Based on the DSRM process model, this paper follows a Problem-Centered approach. Firms can be viewed as a collection of "unique competences and capabilities" that influence their performance, evolution and strategic growth (Lei *et al.*, 1996). In order to achieve competitive advantage, firms need to strategize the management and development of their unique set of competences (Spender and Grant, 1996; Spender, 1993). In this process, digital technologies could become an "active component" of building or reshaping firms' core competencies (Andreu and Ciborra, 1996; Srivastava *et al.*, 2013).

The extinction of mobile phones and the proliferation of fluid multi-device platforms that have blurred the traditional boundaries between stationary and mobile information systems (Carillo *et al.*, 2014; Vodanovich *et al.*, 2010), enabling a new digital environment to facilitate organizational learning processes (Lyytinen *et al.*, 2004). With this context in mind, the following subsections sequentially describe the six steps of the DSRM process.

3.1 Step 1: Problem identification and motivation

There are several models in the literature focused on developing and measuring competence acquisition – e.g. Russel's (Russell, 1995) five stages for learning a new technology, Bloom's educational objectives (Bloom *et al.*, 1956; Krathwohl, 2002) and Nonaka's (Nonaka, 1994) modes of knowledge creation. In this paper we adopt Howell's (Howell, 1982) five-stage competence model (figure 2). This learning model is quite comprehensive and could cover a wide variety of competences valuable to a organizational setting – from behaviors related to IS security (Thomson *et al.*, 2006) to skills required for cross-cultural team working (Barnes *et al.*, 2000; Tung, 1993). The key assumption underlying the model is that people will respond to training when they are aware of its value and need (Thomson *et al.*, 2006). The five stage of competence are described below:

1. *Unconscious Incompetence*: At this stage employees are unaware of the existence of a specific competence. Unintentionally, they may possess an undesired behavior regarding a specific task. They do not necessarily perceive a deficiency in their skills set. As a result, there is a need to become conscious about the competence before starting the specific learning process.

2. *Conscious Incompetence*: employees are aware about the missing competence required to carry out a desirable behavior or to perform a specific task correctly. Often this state of awareness occurs when the individual lacks parity with other colleagues competence set.

3. *Conscious Competence:* employees need to make a mental effort (think through) in order to be able to perform a task competently. The desired behavior is still not spontaneous or "innate".

This phase is characterized as being "thoughtful-analytical", where each problem is considered and analyzed at a time.

4. *Unconscious Competence*: the task is performed correctly and spontaneously. The correct behavior is part of the employees' subconscious. In this case, employees could have some difficulty to really explain how the task need to be done since it has become mostly ingrained in their competence set.
5. *Unconscious Super Competence*: in this stage employees have practiced and internalized effective ways to accomplish tasks. They become extremely (or super) competent in accomplishing these tasks.

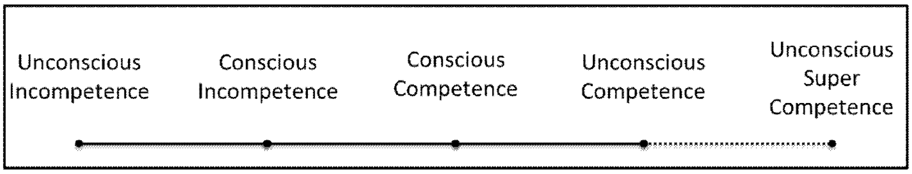

Figure 2. *The five-stage competence model* (Howell, 1982).

In this competence acquisition process, once the competence required for improving the level of task performance is identified, it is necessary to specify the duration of the required behavioral change (only once, span of time, or on-going), and the type of change that need to accomplish (whether a new behavior is introduced, a familiar behavior is maintained, increased, decreased, or ceased to occur (Boer *et al.*, 2013; Fogg, 2009a).

Persuasion is known to be an effective method to imply a voluntary change of behavior in individuals (Berdichevsky, Daniel & Neuschwander, 1999). It differs from coercion or deception since persuasion does not force a change of behavior or stipulate the use of misinformation. In this situation, media technologies (from billboards to television as well as the internet) play a relevant role in "facilitating the delivery of persuasive messages to purchase, donate, vote, concede, or act" (IJsselsteijn *et al.*, 2006). "Persuasive technologies" are interactive computing systems designed to influence people's attitudes and behaviors towards a specific target (Fogg, 2002). Furthermore, the continuous temporospatial availability as well as profound user affinity with these systems could also represent one of its core advantages and translate into greater persuasive power (Fogg, 2002). The process of persuading individuals to perform a target behavior requires the simultaneous presence of three factors: motivation, ability, and triggers (Fogg, 2009b). Figure 3 presents Fogg's conceptual framework that illustrates the relationships among these three factors.

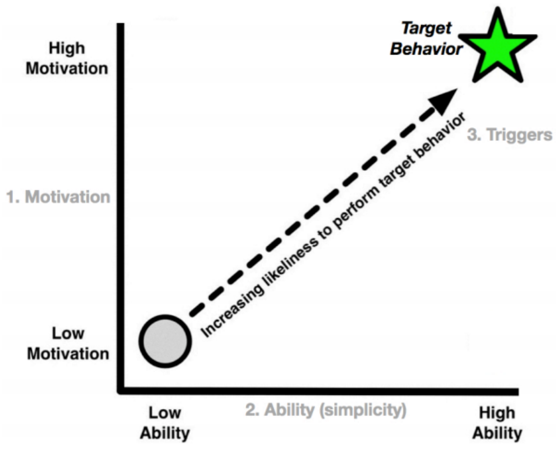

Figure 3. *The three main factors for persuading people to perform a specific behavior* (Fogg, 2009b)

The green star represents the target behavior to be performed, and its position suggests that high motivation (reason to carry out the target behavior) and high ability (often related to "simplicity" for accomplishing a specific task) are necessary to make it possible. Finally, the third factor is emphasized by the dotted arrow pointing to the target behavior (green star). Triggers are the third fundamental factor: "without an appropriate trigger, behavior will not occur even if motivation and ability are high". A trigger can have different forms, such as an alarm or a notification. The main objective is to draw the individual's attention to perform a specific task.

As illustrated above, the interactive and persuasive mature of mobile technologies bring new challenges and opportunities for managers to encourage the development and strengthening of organizational competences.

3.2 Step 2: Definition of the objectives for a solution

The objective for a solution is to develop a method-based mobile app for supporting acquisition (learning process) of a specific competence – exploiting the ubiquity nature of modern digital technologies.

This mobile app needs to provide tools for individuals to leverage a specific competences from "unconscious incompetent" to "unconscious competent" (Howell, 1982). During this learning process the three factors suggested by Fogg (Fogg, 2009b) must be present simultaneously.

3.3 Step 3: Design and development

The artifact (app) could be perceived as an instrument for delivering a sequential training method (STM). This method is based on a series of small specific exercises regarding an atomic competence (Baldoni *et al.*, 2011). Atomic competences (also known as micro competences) can be understood as the smallest element of a competence (Pedraza-Jimenez *et al.*, 2004; Valverde-Albacete *et al.*, 2003). These exercises are used for training individuals during a pre-defined period of time (e.g. 3 or 4 weeks) by performing one small set of exercises every day. There is a correspondence between the number of exercises completed successfully and the level of "consciousness" of the specific competence. Users develop the competence following a step by step structure - starting from initially becoming aware of their current incompetence, then acquiring and applying it consciously, to finally executing this competence autonomously (figure 4).

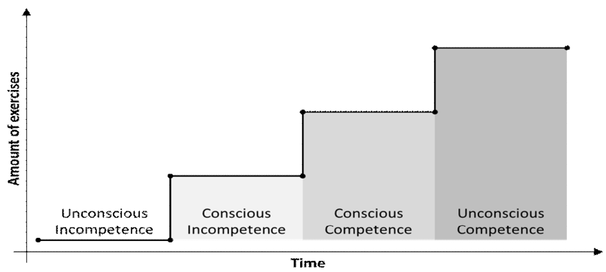

Figure 4. The sequential training method for acquiring an atomic competence

The main principles on which this STM is based could be summarized in the following sequence of steps:

a) Identifying the competence to acquire, verifying if it is an atomic competence (Baldoni *et al.*, 2011) or if it is composed by a set of micro competences. If so, each micro competence will require a dedicated training process.

b) Defining the three intervals of time (phases) in which the individual a) becomes aware about his/her incompetence, b) acquires the competence and c) applies it in an autonomous way (phase 3). According to Fogg (2002; 2009b) the aim is to foster a short daily exercise. It is also suggested that one-week intervals would be an appropriated duration of each phase. In addition, the progress on each phase must be empirically verified during the demonstration step of the design process.

c) Building a set of specific exercises (such as multiple choice and true/false questions, matching quiz, etc.) for each of the three phases. These exercises need to be really simple and clear, with an objective understanding, avoiding any form of subjectiveness or interpretation.

d) In order to attain an unconscious competence level, the individual need to be capable of applying the new skill autonomously. This means that she/he will perform a desirable behavior even though there are "distractions" (e.g. the presence of a count down during an exercise, a random flashing alert or physical vibration of the device).

In order to ensure that the process of persuading individuals to perform a target behavior is robust, the training system must also possess three fundamental characteristics: ability (or Simplicity), motivation and triggers (Fogg, 2009b). Ability could be attained by developing very simple, clear and objective exercises that doesn't allow any form of subjectiveness or interpretation by the users. Motivation could achieved by exploiting the hedonic and gamification nature of mobile apps (Landers, 2015; Shchiglik *et al.*, n.d.). Triggers could be incorporated in the mobile app by implementing a notification system. This system could be used to remind the user to perform the exercise on a daily basis as well as to notify if there is an invitation for a challenge or to award achievement.

Based on the abovementioned principles, the app was designed to challenge the user on a daily basis with a set of ten tiny exercises (called "*micro-quest*"). The set of exercises in each micro-quest is randomly selected and there is not duplication during the entire training process. Every time the user completes a micro-quest (MQ) s/he receives a feedback and a score. The micro-quest is considered passed if the 80% of the answers are correct. During the day the user can redo the micro-quest until s/he passes it (exercises are not repeated if a micro-quest is retaken). The user has also the option to not perform a micro-quest. Hence, the micro-quest can have three states: passed, failed or expired (if the user doesn't perform the daily micro-quest at all). In each STM phase the user needs to pass at least five out of the seven micro-quests available during the week. If a user passes less than five micro-quests s/he will be required to restart the specific phase. At the end of each successful phase, the user receives an award: bronze, silver and gold medal respectively in the first, second and third phase. The duration of the entire training process is set for three weeks by default (one week per each STM phase). A test is provided at the beginning as well as at the end of this process in order to measure the effectiveness and efficiency of the training method (figure 5).

The app also allows a user to challenge other users on an additional micro-quest. It can also group the people involved in the training process in two teams and the score of each team is calculated on the basis of the scores of each member.

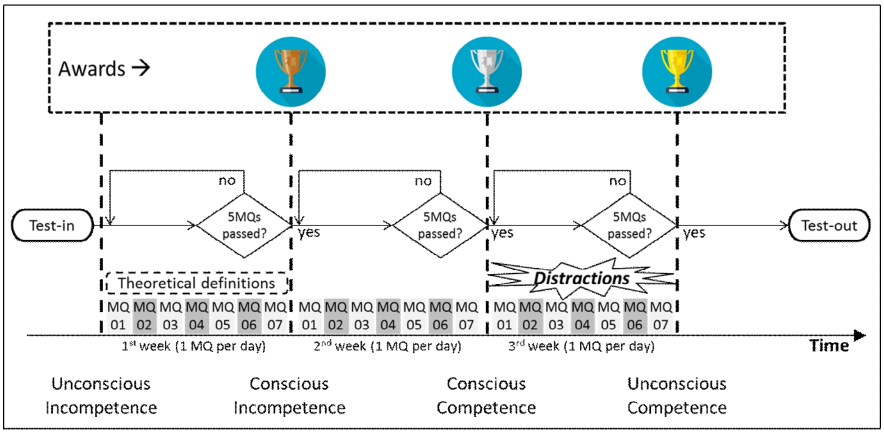

Figure 5. The implementation of the sequential training method (STM)

3.4 Step 4: Demonstration

As suggested by Peffers et al. (2008), the demonstration stage has the purpose to solve one or more instances of the identified problem. Therefore, the first step necessary for creating the set of specific exercises for the STM was to identify the competence to be acquired by the users.

An analysis of educational apps available on Google Play revealed that soft skills acquisition is an area that seems be underexplored. Indeed, a keyword search on Google Play (not only in the Education category) resulted in less than ten apps explicitly dedicated to the developing this type of skill. According to Robles (2012), soft skills are "intangible, nontechnical, personality-specific skills that determine one's strengths as a leader, facilitator, mediator, and negotiator" and are broadly applicable independently of one's profession. The author points out that the most important soft skills perceived by business executives are integrity and communication. As a result, it was decided to develop the app focusing on the skill of communicating an "improvement feedback" when an employee or colleague misbehaves.

An "improvement feedback" should be provided in four sequential steps (Aharon Tziner and Latham, 1989; Blanchard and Johnson, 1983; Pearce and Porter, 1986; Shute, 2008): (i) the description of undesirable behavior (that is the reason for providing the "improvement feedback"), (ii) its possible negative consequences (disadvantages), (iii) the description of the desirable behavior (the alternative), and (iv) its possible positive consequences (advantages). The feedback must be referred to the behavior and not to the person, and it must be free by the influence of personal opinion. It also should not be based on a comparison with what is done by other people and must be based on objective information or direct observation. Finally, the improvement feedback must be clear and shall not contain contradictions.

Approximately 500 simple exercises were developed for the app. Most of the exercises provide a description of a simple real situation in which a hypothetical manager needs to give a feedback to an employee or a colleague. Few exercises provide theoretical short definitions on the "improvement feedback" used for the first part of the training process (figure 5). The exercises were presented in the following formats:

- *read and repeat*: the text is visualized character by character (as if using a typewriter). Once the entire text is shown in the screen the "OK, I read it! /next" button appears. Usually this exercise is mostly adopted in the first phase since it provides some definition on the specific atomic competence
- *true or false*: provides a question to verify if a certain feedback is elaborated correctly
- *multiple choice*: a feedback example is provided and the user is asked to identify what specific characteristics or components are missing in the example
- *reorder*: this exercise provides the user with a few feedback sentences (components) and asks s/he to organize them in the right order
- *complete*: in this exercise an incomplete feedback is provided. The user is asked to select one or more sentences to correctly complete the feedback formulation.

In order to demonstrate the capability of the artifact to solve the instance of the problem, a test group of six people was involved. The use of the mobile app by the test group simulating an entire learning process for the specific "soft skill" gave the possibility to demonstrate the functionalities of this method and to refine some aspects about the usability of the app (e.g. default values settings), bugs on the app (user interface) as well as the server side (administration interface).

3.5 Step 5: Evaluation

An experiment based on a real-life scenario was developed to evaluate the overall effectiveness and efficiency of the app. Twenty employees (middle or project managers) of an IT consulting firm were invited to take part of the experiment. The participants were divided in two groups: a test group consisting of 12 members and control group with the 8 remaining participants.

Both groups started the learning path together in a introductory class. This class introduced the basic concepts on “how to provide improvement feedback”. During the lesson, several examples were provided based on common scenarios – strongly linking with the work activities that the group was involved. At the end of the class both groups performed the test for measuring their entrance level (test in).

During the following three weeks, both groups received by email multimedia material (e.g. slide or small video) with messages that reinforced specific concepts covered in class. These messages also encouraged them to apply those concepts in their work environment. In addition to the emails, the test group members had access to the mobile app.

At the end of this follow-up period, all employees involved in this experiment performed a test (test out) in order to assess if there was any improvement of their competence level. Both test-in and test-out are based on three open-ended cases. Each case provides the description of a hypothetical scenario where an employee produces an undesirable behavior. The user is challenged to provide an improvement feedback for each of three cases. The test assessed the users’ understanding of improvement feedback structure (completeness, order, focus on behavior and specificity) as well as assertiveness (based on direct experience and observation, not be based on a comparison with other people, not be subjective or contain contradictions). The test-in and test-out results are reported in the figure 6 for both groups.

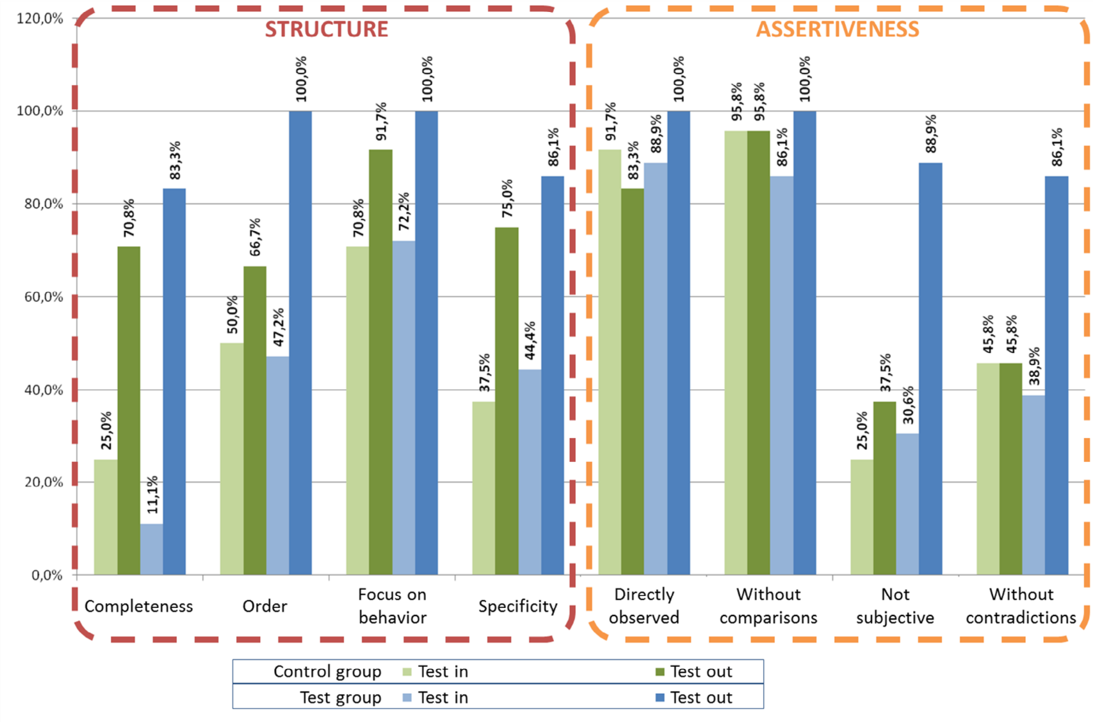

Figure 6. Test-IN and Test-OUT results comparison between control and test group

The efficacy of the two post-lesson training approaches (with and without the mobile app) was notable by an overall improvement in the scores of the test-in and test-out results. It was also noticeable that the level of improvement on the results of the group using the app was significant higher. Indeed the average improvement for the control group was 15,6% while for the test group was 40,6%. This divergence is quite salient in with regards to the categories measuring feedback assertiveness. In addition, members of the test group achieved a final score of 100% in four categories. On the other hand, the control group did not achieve a score 100% and in one criteria ("Directly observed") the actual test out score was lower than the test in.

4 Conclusion

Organizational learning and the continuous development and acquisition of competences by a firm's employee are fundamental instruments for achieving sustainable competitive advantage. In this scenario, digital technologies play a relevant role to foster this learning process.

This paper, following a Design Science approach, aimed to describe the design, development and evaluation process of a competence acquisition mobile app. In order to elicit the system's key components and characteristics, the literature on competence acquisition was used as a starting point and theoretical foundation. Based on this, a prototype of the competence acquisition mobile app was developed. This was followed by an evaluation of the app which was carried out through an experiment that tested the training system in a real-life scenario. This process counted with the participation of 20 employees in a partner organization during a three-week period.

The results indicate that the use of the mobile app effectively improved users' learning process outcomes as well as the ability to deploy the new competence. In addition, it was observed that the ubiquitous learning environment was able to empower users on their own individual learning process – making it a fertile ground for the development of competence acquisition tools.

Moreover, based on this experience, the design science research methodology proposed by Peffers et al. (2008) proved to be a robust approach in the creation of successful IT artefacts.

Additional qualitative data should be collected regarding the user's experience using the app. Moreover a second test-out is planned after six months from the conclusion of this experiment, for evaluating the efficacy over the time, as well as an interview to the top-manager leading the member of the two groups. The information collected will be useful to refine both the method and also the mobile app.

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