Testing the Effects of Digital Gamified Creativity Training

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Abstract

This paper presents an experimental study that tests the effects of a new digital gamified creativity training program. Four techniques are used to assess the creativity level of a group of university students by taking measurements before and after the experiment. The instruments used are a domain-specific creativity test, a creative self-efficacy test, a belief in creativity training test and a domain-general creativity test. The study is performed among 100 undergraduate Communication students, divided into an experiment (N=51) and a control group (N=49). The experiment group participates in self-conducted training sessions and the control group is submitted to the same assessment procedure without participating in the training. Students in the experiment group performed online exercises for ten hours on a digital gamified creativity training program within a duration of four weeks. The results show that trainees in the experimental group increased their creative performance significantly in both domain-specific and domain-general creativity as well as their creative self-efficacy. No significant increase was found for their belief in creativity training. Furthermore, the implications of this study for digital gamified creativity training are discussed.

Keywords: Distance education and online learning**,** Games, Evaluation methodologies, Post-secondary education, 21st century abilities.

Introduction

Creativity is a key ingredient for business innovation (Sarooghi, Libaers, & Burkemper, 2015; Goodman & Dingli, 2017) and ranks in the top three most important skills of the future workforce (World Economic Forum, 2018). Training of creative skills is currently a hot topic in education. Fabricatore and López (2013) find that educational programs should rely on approaches and learning environments that foster creativity. Studies on classroom creativity training programs have consistently found evidence that trainees become significantly

more creative from their training (Rose & Lin, 1984; Scott, Leritz, & Mumford, 2004; Torrance, 1972). However, we know little about the effect of digital creativity training programs.

Future job tasks will most likely become even more digital and online, so it makes sense to start practising creativity in a digital environment. Dingli et al. (2018) even suggest that digital creativity training can have positive effects on both competence development, motivation and transfer of learning. To our knowledge, no previous studies have focused on digital gamified creativity training. This study aims to examine digital gamified creativity training by studying the effects of an existing training program called Academy for Creativity.[1]

Academy for Creativity is one of the first digital gamified creativity training programs designed for higher education. In August 2019, the program reached 100,000 users. It is a free plug-and-play web-based training system for deliberate practising of originality, fluency, flexibility, elaboration of ideas, visualising future scenarios (imagination) and persuasion (Brøndum, Hänninen, Núñez, Byrge, Tang, Dingly et al., 2019). The training program uses badges, progress trackers, difficulty levels, instant feedback on performance, experience points and an avatar in order to ensure a gamified experience during the training. It consists of 11 research-based training games, an assessment method as well as profiles for both teachers and students. The game narrative uses a storyline of the avatar working in a company where creative solutions are required and after each set of games, the system provides instant feedback on the players' performance. The games have three levels of difficulty and users can adjust the training duration as they wish, but constant exercise is required to advance from easy to medium and high level performance of each game. The game platform includes flexible teachers' options and permits the planning of diverse training sessions for each student group (from 15 minutes to 50 hours), selecting starting and deadline dates and providing a link to be sent to the student group. The system also provides automatic data on the student participation, and to evaluate students. This assessment is based on the relation between students actual training time and the time (or workload) set by the teacher, student gets a fail/pass. The platform enables teachers to track the number of ideas produced by students, level of idea descriptiveness, detail index, ideas generated per hour as well as the training time spent on each of the variables.

The following four examples illustrate the games' dynamics and some of the game access interfaces are shown in figures 1-4.

Game 1: *Trend Spotter*. Participants of this creativity game are simulating that they work at the product design department of a company and are asked to create original, totally new product ideas combining completely unrelated

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[1] www.academyforcreativity.com

products. The games focus on enhancing fluency and originality.

Game 2: *Sounds Like An Idea*. In this came, gamers play the role of office workers that hear a weird noise all of a sudden. They are asked to assist in discovering what has caused the noise linking the noise to one of the three objects they will be showed on the screen and explaining how it could produce such a disturbing noise. The noise game mainly trains gamers' imagination and originality.

Game 3: *Poster Perfect*. This game improves the trainees' capacity of elaboration, persuasion and flexibility. The game situates the players in the setting of an advertising team working on a campaign poster which needs to be completed. Here the avatar is required to be open-minded as well as elaborative and finish the draft picture the team started, elaborating it into a proper campaign poster. Also, the avatar needs to include a slogan and justify the campaign objectives.

Game 4: *Race For The Raise*. Here the game is about getting a pay raise by competing with work colleagues in a simulated office surrounding, spotting the most creative ideas among several suggestions. The avatar needs to put herself/himself in the shoes of both the public and the creativity experts and spot the most creative ideas. This game trains imagination and originality.

Figures 1-4. Screenshots of the game access designs.

An automatic assessment is available for students, providing feedback on their progression. They receive experience points for completing each round in the

game. These points relate to the key creative skills trained in each game (fluency, flexibility, imagination, creative self-efficacy, and elaboration & persuasion).

After each gaming session, trainees can see their scorings in the different games and also, see their global performance in terms of the six creative qualities addressed by the games. The skills circle shows the proportion corresponding to the training efforts of each quality and alters according to the scores obtained in each individual game.

Figure 5: Screenshot of the skills overview that users can access after each gaming session.

Once the students have completed a minimum of 10 hours training, they can request a certificate of achievement, which is given to everyone regardless of experience points or levels of difficulty achieved, rewarding this way the learning effort.

Study Design and Ethics

This study used the following tests: a domain-specific creativity test; a creative self-efficacy test; a belief in creativity training test; and a domain-general creativity test.

The trainees consisted of one hundred third-year advertising and public relations (PR) undergraduates from the Faculty of Communication Science, Complutense University of Madrid. All students who joined the study received student credits for their participation. All participants were of Spanish nationality. The trainees were randomly divided into an experimental group (N=51) and a control group (N=49).

The intervention for the experimental group consisted of the following procedures:

1. Trainees received a brief face-to-face lecture-style introduction to the study, as well as a rationale for creativity training and digital gamified creativity training.

2. Trainees were instructed and observed during all pre-tests. These were performed in the following order: 1) domain-general creativity test; 2) domain-specific creativity test; 3) creative self-efficacy test; and, 4) belief in creativity training test.
3. Trainees attended a workshop-style introduction to the digital gamified creativity training program. During the workshop, all trainees created an account and performed a minimum of one hour of training.
4. Trainees were instructed to perform approximately half an hour of actual training per day, reaching a total of ten hours of training during the following four weeks (twenty workdays). Trainees could follow their actual training time on the screen through the software. The actual training time calculated only the active time training, not the time navigating through the software. Trainees received a reminder every day (via WhatsApp and e-mail) during the twenty workdays.
5. Trainees were instructed and observed during all post-tests. These were performed in the following order: 1) domain-general creativity test; 2) domain-specific creativity test; 3) creative self-efficacy test; and, 4) belief in creativity training test. All trainees performed their post-tests in the week following the end of the four-week training period.

The control group participated only in procedure 1, 2 and 5.

The research complies with all current research regulations, specifically those related with (non-medical) research done with human subjects, privacy and data protection rules. Verbal informed consent was obtained from the participants and it was made clear to the participants that they could withdraw from the study at any moment. No personal data was stored, transferred or processed with the only exception of the email addresses, which were used to identify the participants all through the 3 phases of the study. This data was only used by the research and data analysis team and kept in safe encrypted servers. Afterwards, this data was erased and only the anonymised (codified) information was kept for record and traceability. A committee formed by members from a previous international research in creativity approved the research design and would respond in case any ethical issues related with the study would appear.

Domain-specific Creativity

In this study, we focus on the transfer effect of the creative skills acquired through a specific training program, a so-called domain-specific creativity test. Byrge and Hansen (2013) used reflection reports to gain insights into how training affected trainees in general life. Birdi, Leach, and Magadley (2012) studied how training affected the creative skills directly related to their work (e.g., idea generation at work, idea implementation at work and job performance). Glover (1980) instructed psychology student-trainees to write assignments related to educational psychology. Glover (1980) used two rating scales to score the level of creativity in assignments handed in before creativity

training and assignments handed in after creativity training. Similar designs have been used by other researchers to study the transfer effect from creativity training to the domain of the trainees (e.g., Cropley & Cropley, 2000).

In this study, the domain-specific creativity test was an advertisement task designed by two domain-specific experts (two of the authors). It consisted of one pre-test task and one post-test task, adjusted to the domain and culture of the trainees: advertising in Spain. The tasks were performed individually.

The pre-test task instructions were:

1. "Turrón"[2] is a well-known Christmas candy in the Spanish market. Please give as many creative ideas as you can to motivate people to consume it in other seasons. You have ten minutes to do this task."

The post-test task instructions were:

2. "Tinto de verano"[3] is a typical Spanish drink for the summer season. Please give as many creative ideas as you can to motivate people to consume it in other seasons. You have ten minutes to do this task."

The domain-specific creativity test was scored using a modified version of the consensual assessment technique (Amabile, 1982). Two domain experts scored each response for originality and usefulness using their own judgment criteria. They scored each response from 1-5 points, where 5 points were given to highly novel/useful responses and 1 point was given to responses with little or no novelty/usefulness.

Creative Self-efficacy and Belief in Creativity Training

Merton (1948) studied the interpersonal manifestation of the self-fulfilling prophecy phenomenon, according to which positive expectations about performance and capabilities produce better performance. This construct can be transferred to the field of self-perception of our creative capacities, where positive expectations play a crucial role. Creative self-efficacy relates to self-belief in your ability to produce creative outcomes (Tierney & Farmer, 2002). Bandura (1997) found that strong self-efficacy was a necessary condition for creative productivity. Whereas self-esteem and confidence are broad generalised feelings, creative self-efficacy can be understood as a judgement made on capacity in a narrower arena (Bandura, 1997), such as creative production. Furthermore, because it is creativity-specific, it also differs from general self-efficacy, related to capabilities across domains (Chen, Gully, & Eden, 2001). In this study the self-efficacy test was a three-question questionnaire adapted from Tierney and Farmer (2002).

The degree to which the trainee believes that their creativity could be advanced

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[2] A southern European nougat confectionery.
[3] A cold, wine-based drink similar to sangria.

through creativity training may affect their motivation and future investments in creativity training. From a continuous educational point of view, this is highly relevant since future investments in creativity training are needed for students to achieve higher levels of creative skills. It is particularly interesting for digital out-of-class educational training materials that require high levels of self-motivation to have high effects. In this study, the belief in creativity training test was designed as a two-question questionnaire that was administered together with the creative self-efficacy questionnaire.

These combined tests consisted of pre-test and post-test questionnaires. The questionnaire was performed individually. They were then asked to answer to what degree they agreed or disagreed to the questions using a Likert 7-point scale, with one representing 'strongly disagree' and seven representing 'strongly agree.'

The pre- and post-questionnaire included the following questions related to creative self-efficacy:

- Originality: I feel that I am good at generating novel ideas.
- Creative problem solving: I have confidence in my ability to solve problems creatively.
- Elaboration: I have a knack for further developing the ideas of others.

The pre- and post-questionnaire included the following questions related to belief in creativity training:

- Nurture: I believe my creativity will advance through the deliberate practice of creativity.
- Digital nurture: I believe my creativity will advance through the deliberate practice of creativity designed as online games.

The trainees were instructed to spend about five minutes answering the questionnaire.

Domain-general Creativity

The Torrance Test for Creative Thinking is one of the most widely used creativity tests (Davis, 1997), one of the most referenced creativity tests (Lissitz & Willhoft, 1985) and it has shown high validity in assessing creative performance. It was developed to identify creative potential (Torrance, 1974) by instructing subjects to produce responses to a series of creative tasks. An advanced scoring guide helps people to evaluate the responses for creativity. The Abbreviated Torrance Test for Adults (ATTA) is a shortened version of the highly time-consuming original Torrance Test. ATTA is suitable for studies with a large number of trainees.

In this study, the domain-general creativity test was designed as an adapted digital version of ATTA, provided by Dr Erik Guzik and VAST Learning System.[4] It consisted of four pre-test tasks and four post-test tasks. The tasks were performed individually, and the trainees were asked to log into their account using their student ID.

The pre-test task instructions were:

1. "What is blue? Enter your ideas one at a time, trying to generate as many different ideas as possible in two minutes."
2. "How many different and unique uses can you think of for a tin can? You have two minutes to complete this task."
3. "Complete the provided drawing to create a picture or pictures (you can create whatever you would like). Try to be as creative as possible with your drawings. You are not being scored for artistic ability. Add titles to your drawings using the text button. You have five minutes to complete this task." (see Figure 6).
4. "Use the repeating figures to create a picture or pictures. You can create whatever you would like. Try to be as creative as possible with your drawing. You are not being scored for artistic ability. Add titles to your picture[s] using the text button. You have five minutes to complete this task." (see Figure 7).
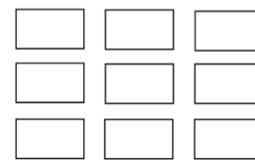

Figure 6. Drawings for pre-test task three.

Figure 7. Repeated figures for pre-test task four.

The post-test tasks instructions were:

1. "What is red? Enter your ideas one at a time, trying to generate as many different ideas as possible in two minutes."
2. "How many different and unique uses can you think of for a paper clip? You have two minutes to complete this task."
3. "Complete the provided drawing to create a picture or pictures (you can create whatever you would like). Try to be as creative as possible with your drawing. You are not being scored for artistic ability. Add titles to your drawing[s] using the text button. You have five minutes to complete this task." (see Figure 8).
4. "Use the repeating figures to create a picture or pictures. You can create whatever you would like. Try to be as creative as possible with your

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[4] https://www.vastlearningsystems.com/

drawing. You are not being scored for artistic ability. Add titles to your picture[s] using the text button. You have five minutes to complete this task." (see Figure 9).
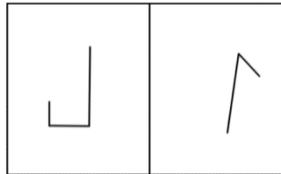

Figure 8. Drawings for post-test task three.   Figure 9. Repeated figures for post-test task four.

Two professional graders scored each response for originality, fluency, flexibility and elaboration.

Results

A Cronbach Alpha analysis was conducted to test for inter-rater reliability. It revealed a weak inter-rater reliability in post-task 4 of the domain-general creativity test. As a consequence, this task was not further analysed.

Paired T-tests were conducted to test for significant differences between pre- and post-scores/responses for both the control group (N=49) and the experimental group (N=51).

The control group exhibited no significant increase in task 2 and task 3 for the domain-general creativity test and no significant increase in the domain specific creativity test nor in the creative self-efficacy test. There was a significant increase for the control group in task 1 for the domain-general creativity test. As a consequence, this task was not further analysed.

For the experiment group, the domain-specific creativity test showed a significant effect from the online training both for originality and usefulness.

Also, the creative self-efficacy test showed a significant effect from the training for the experimental group. Students that did the online training expressed augmented confidence in their capacity to generate novel ideas, to solve problems creatively and to further develop the ideas of others.

The experiment group showed no significant increase in the test for belief in creativity training.

For the experiment group, a significant increase was found in the domain-general creativity test from the training for total creativity score in task 3. There was no significant increase for task 2 in the same test, finding different uses for a common object.

Variable	M	SD	T	P	Cohen's d	95%CI	
PRE creative self-efficacy	5.10	.677	-2.127	.039	0.306	-.378	-.011
POST creative self-efficacy	5.29	.723					
PRE domain specific, originality	1.90	.918	-3.349	.002	0.478	-.751	-.188
POST domain specific, originality	2.37	.755					
PRE domain specific, usefulness	1.82	.782	-2.451	.018	0.349	-.483	-.048
POST domain specific, usefulness	2.08	.640					
PRE domain-general, task 3	9.56	.605	-2.552	.014	0.341	-5.754	-.692
POST domain-general, task 3	12.79	.651					

Table 1. Paired sample T-test for experimental group

Conclusion and Discussion

Overall, the results demonstrate some positive effects as a result of the use of the digital gamified creativity training. The trainees advanced both their creative skills related to their domain (advertising), their general creative skills as well as their creative self-efficacy. This supports the notion that creative abilities can be positively improved through creativity training (Rose & Lin, 1984, Scott et al., 2004; Torrance, 1972) and gives new insights into how it can also be improved through digital gamified creativity training. As expected, the results show that the control group did not generally perform significantly more creatively in the post-test. This is in line with previous studies showing that the creativity of trainees in control groups have no significant change (Cliatt, Shaw, & Sherwood, 1980; Karakelle, 2009; Memmert, 2007).

The results did not demonstrate any significant effect in belief in creativity training. This test was designed to examine whether the performance of the digital gamified creativity training would have an effect on the trainees' belief that creativity training leads to an advancement in personal creative skills. However, the results did not support the idea that digital gamified creativity training leads to a stronger belief that such training advances personal creative skills. It may be that the level of belief in creativity training is more affected by theoretical insights rather than practical experiences. Also, some students in this sample may relate the concept of creativity to design capacity, particularly because they have academic courses on such subjects. Or, it may be that the post-test should have been performed much later after the training ended in

order to allow the trainees time to experience how the training may have affected their everyday and domain related creative problem solving. It should also be noted that the initial pre-test scorings for this belief were relatively high, which means the students had positive expectations, though these were not significantly increased by the training experience.

The trainees were all studying advertising and PR. Scott et al. (2004) found that creativity training had a significant effect across various kinds of trainees and domains. Still, since advertisement students may have a strong "digital mindset," it would be interesting to further study digital gamified creativity training across other domains. Moreover, it would be interesting to include an international and intercultural perspective in future studies, in order to obtain a better understanding of whether there may be differences in how trainees are affected by digital gamified creativity training.

The creativity assessment used in this study includes a triangulation of methods. Still, it would be interesting to use even more methods in future studies in order to gain a deeper understanding of why we see these effects, in particular, why we see no effects in belief of creativity training. Long's (2014) review of 612 empirical studies on creativity showed that creativity research was mainly quantitative, using predominantly psychometrics and experimental methodologies with correlation techniques, and judges were frequently employed to assess creative outcomes. In terms of qualitative approaches, the case study was the most common technique used. As pointed out by Johnson, Onwuegbuzie, & Turner (2007), mixed-methods research forms a middle ground between the two methodologies, allowing both to be combined "…for the broad purposes of breadth and depths of understanding and corroboration" (p. 123).

It is unclear why there was no effect for task 2 in the domain-general creativity test for the experimental group and why there was a positive increase in task 1 for the control group. One explanation could be that advertising students found the task less challenging as it is about simply shooting ideas (fluency), whereas the other tasks score for originality, flexibility and elaboration. Furthermore, why did the raters disagree on the scoring of task 4 in the domain-general creativity test? Further studies on digital creativity tests need to be conducted to better understand this unusual outcome. With these limitations in mind, the authors still believe this study improves our understanding of an emerging and novel area related to creativity training: the area of digital gamified creativity training.

This study focuses on the product and self-perception elements of creativity. However, we are conscious of the importance of individual traits and related psychological aspects, and acknowledge that the contextual, social aspects of creativity are outside the scope of the present study. Since Guilford's (1950) early work examining creativity from the viewpoint of creative dispositions and his psychological trait theory, several scholars have mapped characteristics, attributes and traits that underlie creative performance (Treffinger, Young, Selby,

& Shepardson, 2002; Kaufman & Sternberg, 2010; Root-Bernstein & Root-Bernstein, 1999). Digital gamified creativity training offers a unique opportunity for self-facilitated long-term creativity training. Therefore, it also opens up interesting questions on how creativity training may affect such creative traits and dispositions. Further studies will be needed to understand this novel opportunity for creativity training research.

Guidelines for Applying Research to Practice

Digital gamified creativity training does have significant effects on creative performance. It can help develop those creative competencies that are becoming more important in education and industry. Practitioners in the field of education, management and human resources can now:

- Implement digital gamified creativity training into their curriculum and employee development programs.
- Be confident that the training will have a significant effect, thus it will be possible to evaluate the training by completion rather than using scores.
- Advance the creative self-efficacy as well as the domain related creative production and the domain general creative production.

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