Improving the Professional Competencies of Architect Students

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Abstract. In university education today, students must demonstrate motivation and show a willingness to take on a more proactive role in the acquisition of the competencies needed to successfully handle professional challenges if they are to gain a well-rounded educational experience, especially given the significant importance now being placed on learner autonomy in the professional world.

During their training, Technical Architecture students must assimilate and apply competencies relevant to the subject Graphic Expression. To assist them with this task, the authors have developed an experience that uses ICT-based Learning Objects (LOs) specifically designed and developed for use as teaching aids in a university degree subject delivering training to this type of professional in this subject area.

Results indicate that intrinsic motivation increases significantly amongst students following the use of the aforementioned LOs. This is fundamental in the development of deeper learning as it ensures the comprehension, retention and transfer of content being learnt, and, as such, facilitates the acquisition of competencies in the subject area of Architectural Graphic Expression.

Keywords: Competencies · Motivation · Graphic expression
Technical architecture

1 Introduction

The Degree in Building Engineering is a university qualification that entitles the holder of the degree to pursue a career as a Technical Architect, which is a highly valued profession within the construction sector. The course as a whole is designed to endow students with a series of general and specific competencies, however the subject area of Graphic Design, in particular, occupies a prominent role in the training of these competencies.

Falling under the area of 'graphic competencies', the following is a list of abilities that are considered basic competencies for professionals in this field: an ability to apply spatial representation systems, produce architectural drawings & blueprints, accurately reflect proportion, and apply graphic representation techniques and conventions using correct terminology and construction processes.

Traditionally, the process through which these competencies have been bequeathed to students has involved getting them to perform practical exercises run as part of

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lectures. However, when it comes to reaching set objectives this methodology has not always proven effective. In large part, this ineffectiveness has been due to it not generating much motivation in students.

ICT tools have been used in the teaching-learning process as an alternative means through which to facilitate the acquisition of such competencies. Arguments in favour of this approach claim that the use of ICTs increases student motivation and predisposes them to deeper learning [1].

From a psychological perspective, most experts define motivation that is linked to the teaching-learning process as the set of processes involved in the activation, direction and persistence of the behaviour [2].

Motivation is the process through which an individual sets an objective, uses appropriate resources, and continues with a particular behaviour in order to achieve a goal. Within education, this should be perceived as an individual's willingness to learn and to continue doing so independently [3]. It has proven to be a cornerstone in learning given that motivated students will engage more and concentrate better in academic tasks. They will put in great efforts to find solutions to problems, and will present alternative solutions to a problem in the hunt to resolve it [4].

Motivation involves decisive and sustained activity [5] and it is currently a key factor in the academic performance of university students and the success of higher education [6, 7] in general. As we train professionals in their chosen field it is important that we lay down foundations that guarantee them the greatest chances for success. This is something that requires teaching staff to work actively towards increasing motivation amongst their students [8].

Pintrich and De Groot [9] state that research has revealed a positive link between an individual's motivation and engagement in the learning process when: he or she trusts his or her own abilities; takes ownership of the learning objectives; possesses high expectations for their self-efficacy; and values the learning activities.

One noteworthy instrument for measuring motivation is the *Motivated Strategies for Learning Questionnaire* (MSLQ) by Pintrich et al. [10]. This is because it has repeatedly demonstrated its efficiency and good internal consistency when used in a number of different investigations studying motivation. The motivation section consists of 31 items divided into 6 areas covering the following motivational aspects or factors:

Intrinsic Motivation: students' motivation is driven by the activity itself. Enjoyment and interest in the activity lead a student to make greater efforts, focus his or her attention, and take pleasure in the task until the learning objective is completed. This is a reward in itself and no other external reward is necessary. The task is an end all to itself, with motivation stemming from internal reasons (Intrinsic Goal Orientation).

Extrinsic Motivation: students' motivation is driven by external incentives. These are not connected to the task of completing the activity, but rather the reward obtained upon its completion; in other words, the qualification obtained. The activity of completing the task is only performed as a means to an end and the reward itself becomes the final goal (Extrinsic Goal Orientation).

Tasks Value: students are asked their opinion about how interesting, useful, or important they felt activities to be. This reflection encourages a change in attitude towards their own learning.

Control of Learning Beliefs: students are asked the degree to which they feel they have control over their own learning, which provides them with the insight that outcomes and successes are dependent on their own efforts, and not external factors.

Self-efficacy Beliefs for Learning and Performance: beliefs students express about the extent to which they are capable of organizing and completing the actions that are necessary in order to achieve the learning objectives. Trust in their ability to perform tasks.

Test Anxiety: the worry felt by students prior to performing a task or sitting an exam, which may disrupt performance.

According to Naranjo [3] the overriding aim of the field of education is to ensure students are motivated to learn, and to instil motivation that is strong enough so that an individual is keen to learn and continues to do so, independently, for their own enjoyment or growth, be it academic or personal.

As such, the main driving force behind motivation, the university lecturer, should play an active role in providing students with a variety of resources and strategies that contribute towards increasing intrinsic motivation. These should serve to create the right sort of atmosphere in the classroom, thus leading to greater participation and sizeable interest in the subject.

In pursuing this line of thought, the authors of this paper have submitted their own contribution to innovation in university education by studying the application of ICT-based Learning Objects in the field architectural graphic expression. A series of 10 Learning Objects have been specifically designed and developed for this subject for use as additional teaching resources in university education. The objective is to test whether they improve student motivation, and consequently, to also identify whether they have a positive impact on the learning process and the acquisition of competencies. This study was designed to be run in the context of the Universidad de La Laguna, in the subject 'Architectural Graphic Expression Applied to Building Design', which forms part of the Degree in Building Engineering, a university qualification that entitles the holder of the degree to pursue a professional career as a Technical Architect.

2 Learning Objects

Learning Objects (LOs), also referred to as Reusable Learning Objects (RLOs), are digital modular learning resources designed to break information down into bite size pieces (made possible by ICTs wide range of capabilities). LOs are stand-alone structures that contain interactive materials for pedagogic purposes [11, 12]. They can be used and reused by students as many times as they desire and to the point at which learning is performed flexibly and independently. This makes the learning process more dynamic and provides students with a significant amount of autonomy as learners.

David Wiley, cited by Oliva Machado et al. [13], defines LOs as "any digital resource that can be used to support learning". Their raison d'être is to: reduce production and distribution timings and costs; make it possible to exchange and reuse educational resources used in the teaching-learning process; and facilitate support via the use of new technologies.

The characteristics that LOs must comply with in order to be defined as such also offer quality assurances relating to their construction. Said criteria dicate that they must: be in digital format; for pedagogic purposes; contain interactive content; be indivisible and stand-alone, or in other words, independent of other LOs; and reusable in different educational contexts beyond their intended use [12].

A set of standards and/or specifications have been developed and implemented for the construction of LOs that support the creation of good quality LOs. All LOs must have well-structured educational content and standards for creating metadata [14]. With regards to this structure, it must be clear in order to facilitate the process of sharing, reusing, importing or exporting them [15]. The SCORM model (Sharable Content Object Reference Model) developed by ADL (Advanced Distributed Learning) is of worthy mention as it is the most widely used model when it comes to LO creation [14]. The most commonly used standard for the creation of metadata is Dublin Core, which has widespread acceptance precisely due to its widespread use.

Exe-Learning is one of the most suitable applications for creating learning content [16] as it allows the user to create entire websites and insert interactive content as well as different types of activities and questions for evaluation purposes. It also uses the SCORM model as standard to create LO containing structured educational content. Exelearning allows users to export LOs created in SCORM format so that they can subsequently be imported into E-learning platforms for use in virtual classrooms, e.g. Moodle. Additionally, it has adopted Dublin Core for creating metadata.

According to the European Higher Education Area, learning must change from being a one-off activity to a lifelong activity that is pursued throughout our professional careers. What this means in reality is that instruments must be in place to facilitate this task; the most adequate tools for this task are Learning Objects, especially those within the field of Architectural Graphic Expression as they have an extended lifecycle, which reduces maintenance and update requirements and thus guarantees their reusability [11].

With these considerations in mind, the authors propose creating a series of Learning Objects that serve as teaching aids in the subject 'Graphic Expression' using the application *Exe-Learning*. This application has been chosen for its powerful features, unique characteristics, and its compatibility with both SCORM and Dublin Core.

3 Study

For this research, and in order to run this experience, a total of ten Learning Objects were designed for use in the subject area of Architectural Graphic Expression.

The design of each of the LO is based on a set of established objectives. Said objectives were clearly defined in detail with the aim of arousing the curiosity of students and encouraging motivation from the get go; by doing so, students can appreciate the importance and utility of the content, abilities and skills they are supposed to acquire whilst using the LOs to study.

The structural planning of an LO begins with an initial outline of the content that will be dealt with. This is then organized into sections and subsections so as to establish a hierarchy based on the importance of content. Once completed, these sections are

then placed into a particular chronological order. Next, the scheduling and design of appropriate activities is set - within the limitations of possibility for this type of resource - in order to fulfil the established objectives.

At this stage the content for each of the LOs must be carefully selected to ensure that all necessary information is covered for a specific piece of knowledge, whilst also ensuring that there is no overlap with other LOs. Simultaneously, it is important to analyse how to include digital content (made possible thanks to the digital format) whilst always keeping sight of the instructional and pedagogical purpose behind the LO. And, finally, in keeping with the defining characteristics of LOs described by Martínez Naharro et al. [12], Latorre [17], and Peñalosa and Landa [18], amongst other authors, it is important to ensure that the content can easily be reused.

In this phase of the LO design process, images are selected that can serve to illustrate the content in question. These are of vital importance given that the subject matter of each of these revolves around learning questions related to Graphic Expression and their application as a teaching aid for said materials. In the majority of cases, drawings will be selected instead of the typical photographs that form part of LOs belonging to other subjects.

Furthermore, in order to help users become familiar with how to use the LOs, special emphasis is placed on ensuring that each one has a similar structure. As such, all LOs have a home page containing a general presentation that provides a welcome message and informs the user about content. This is followed by a description of the objectives that will be covered during use, and an outline of the content. This outline always begins with the more general content and works down to the more specific content, all of which contains abundant illustrations to assist in their assimilation.

Finally, a series of activities are designed in order to complete each LO, including: gap fill exercises, multiple-choice questions, True/False dichotomous questions, tests, or SCORM questionnaires. Students complete these activities at their own convenience and they can chose to adapt them to their own individual pace of working. The activities can be taken as many times as wanted or needed depending on real-time feedback about the number of correct answers or incorrect answers in each attempt. As this feedback is instantaneously provided by the system, students can identify when the have mastered content and are placed in a position in which they can decide whether to progress onwards or not, which encourages self-directed learning.

Once all these strategic approaches have been taken into account, the LO are then built. The app Exe-learning is used as an authoring tool to facilitate this process.

In this study two student sample groups are used. The first group is to study motivation prior to the implementation and use of LO that have been designed as a teaching aid in the field of Graphic Expression. It consists of 83 students, 39 of whom are women (47%) and 44 of whom are men (53%). The average age of these individuals is 23.57 years old with a typical deviation of 4.11. The second group is to study motivation following the implementation and use of LO. It consists of 54 students, 27 of whom are women (50%) and 27 of whom are men (50%). The average age of these individuals is 23.84 years old with a typical deviation of 4.44.

Before commencing with the study, the sample sizes were checked to ensure they were capable of producing statistically viable and consistent results. Calculations were made to establish the number of participants needed to be able to estimate a given

parameter with the desired degree of certainty, or to detect differences between study groups [19].

The next stage involved administering the questionnaire that had been selected to measure student motivation in this subject: the Motivation section of the *Motivated Strategies for Learning Questionnaire* (MSLQ) by Pintrich et al. [10]. The questionnaire was completed by students at the start of the academic courses 2014–15 and 2015–16, prior to using the Learning Objects designed for this study. The aim was to identify their initial motivation when taking subjects within Graphic Expression.

Subsequently, the ten LOs designed and built especially for this study were put into use. To do so, they were exported from the design application *Exe-Learning* in SCORM format – a standard that attempts to meet demands relating to accessibility, adaptability, durability, interoperability, and reusability – thus making it possible to insert them into the Learning Management System (LMS) in question, just like any other resource. In this case, their designated destination was the virtual classroom for the subject 'Architectural Graphic Expression Applied to Building Design', as the goal of the study is to test their potential academic benefits on students taking this subject.

Each LO is then made visible in parallel with the theoretical class in which the same content is covered. LO are revealed gradually in order to prevent students from feeling overwhelmed by too much content at once, and to create a certain amount of anticipation with each new incorporation. This encourages greater student participation in theoretical classes, which is conducive to better understanding and greater assimilation of the subject matter being covered. These classes are underpinned by teaching practices (working in small groups) that allow the teacher to assess each student's progress and the quality of their learning. They are also aided by the fact that students feel rest assured knowing the following: firstly, that said materials are readily available for use in self-directed learning, secondly, that they can be adapted to their own individual pace of learning; thirdly, that they can be viewed as and when necessary, for as long as necessary, and in any order they desire; and finally, that the activities can be repeated as many times as necessary until the content it totally mastered. Given that instant feedback is provided by the LOs following the correction of each completed activity, a student is able to assess for him or herself whether he or she is ready to continue on to the next set of proposed content.

Once the subject has been delivered, the students are once again asked to complete the motivation section of the *Motivated Strategies for Learning Questionnaire* (MSLQ) by Pintrich et al. [10] with the aim of identifying the influence of the LOs used as a learning aid in Graphic Expression on student motivation.

In order to perform the statistical processing of the data gathered from the study's participants, it was first necessary to the variables that need to be taken into account and assign each and every one with a code or abbreviated name; these are detailed in Table 1 below. The terms *before* and *after* that appear after each variable refers to the timeframe in which the measurements were recorded in relation to the use of the LOs designed and built for this study.

Using results from the first practical tasks undertaken before using the LOs, sample sizes are checked to ensure they are large enough to run the experimental trials and representative of the population. An analysis of the participants' marks is performed to check whether they are similar to the total population. To do so, a student T-test for

Table 1. Identification of variables in the Motivation section of the MSLQ

Identification	Motivational factors
MOI A	INTRINSIC GOAL ORIENTATION BEFORE
MOI D	INTRINSIC GOAL ORIENTATION AFTER
MOE A	EXTRINSIC GOAL ORIENTATION BEFORE
MOE D	EXTRINSIC GOAL ORIENTATION AFTER
VT A	TASK VALUE BEFORE
VT D	TASK VALUE AFTER
CCA A	CONTROL OF LEARNING BELIEFS BEFORE
CCA D	CONTROL OF LEARNING BELIEFS AFTER
CA A	SELF-EFFICACY BELIEFS BEFORE
CA D	SELF-EFFICACY BELIEFS AFTER
AP A	TEST ANXIETY BEFORE
AP D	TEST ANXIETY AFTER

Source: Prepared by authors based on MSLQ data

independent samples is performed and the results compared against the total population and also the sample to confirm via the resulting p-value that the sample size is representative of the population.

The statistical results that describe the answers provided by students suggest a strong disposition towards learning at the start of the first term. Using measurements gathered through a Likert-like scale (1–7), high average values are obtained.

It is important to note that the descriptive statistics are the result of answers provided by students to the MSQL that is designed so that a respondent self-reports about the perception he or she has of himself or herself. It should not be forgotten that these represent the perceptions of a small number of students (based on it being a pilot study), as such it is understood to be an approximation that can provide interesting elements that invite further reflection on several points: the conditions or characteristics presented by students; what motivates them to undertake tasks or provide the feedback given; and how to analyse or rethink teaching practices.

We must then check whether the use of the LOs designed and built for the subject 'Architectural Graphic Expression Applied to Building Design' has any effect on the motivation of students participating in the study.

Once the motivation questionnaires have been administered at the start and end of the course the values for each of the motivation variables are obtained. These values must follow normal distribution to ensure that the data can be used when performing statistical calculations. As the sample contains more than 50 participants, to demonstrate this the Kolmogorov-Smirnov test is applied.

All Motivation variables, both *before* and *after* taking the subject are above p-value 0.05, as such they all follow a normal distribution and it is possible to use the results of the study to perform calculations and statistical analysis.

With the aim of identifying whether there are differences in the group's motivation upon completing a subject using the LOs, a comparison is made between each of the *before* and *after* motivational variables.

A statistical analysis is performed using a student T-test on paired samples (from the available 52 paired data sets for students) (Table 2).

Table 2. Statistics for related samples of motivation variables obtained *before* and *after* LO use

		Average	N	SD	Std error
Par 1	MOI_A	4.7019	52	1.07790	.14948
	MOI_D	4.9663	52	.98646	.13680
Par 2	MOE_A	4.5962	52	1.38457	.19201
	MOE_D	4.5337	52	1.40293	.19455
Par 3	VT_A	5.7187	52	.99706	.13827
	VT_D	5.6827	52	1.04887	.14545
Par 4	CCA_A	5.1490	52	.89149	.12363
	CCA_D	5.2356	52	.93726	.12998
Par 5	CA_A	4.8292	52	.83911	.11636
	CA_D	4.8558	52	.88819	.12317
Par 6	AP_A	4.2000	52	1.22714	.17017
	AP_D	4.4654	52	1.24537	.17270

Source: Prepared by authors based on MSLQ data

These results indicate that there is significant difference only in MOI. As such, it is possible to state that the goals that cause students to gain better quality deeper learning, and to use better strategies, are significantly different before and after using the LO designed for this study; thus, as indicated by the comparison of averages, this is classed as an improvement (Table 3).

4 Analysis and Discussion

In light of the study carried out and the results obtained, the first observation to be made is that following the use of LOs as a learning aid, the majority of students found themselves to be intrinsically motivated despite not all their goals being intrinsically motivated. Intrinsic goals coexist with extrinsic goals, that is to say, students state that they approach the study of Architectural Graphic Expression with a positive attitude based on the fact that the material is of importance to them both academically and professionally. As such, their perception is marked by the idea of mastering content and developing abilities with the intention of improving their level of expertise.

To a lesser extent however, they also acknowledge they are motivated by external recognition factors when studying, such as obtaining good grades or winning awards. They also place significant importance on tasks that accompany the learning process, finding the content, activities and materials in their subjects useful, important and interesting

Furthermore, feedback shows a high rating is given to control beliefs and having a high degree of control over their own learning: objectives are clear, the resources

Table 3. Student T-test of related samples: Motivation variables before and after LO use

Related Differences									
		Average	SD	Std error	95% Conf. Intervals for difference		t	gl	Sig.
					Upper	Lower			
Par 1	MOI_A- MOI_D	−.264	.815	.113	−.49149	.03735	−2.338	51	.023
Par 2	MOE_A- MOE_D	.062	.864	.119	−.17816	.30316	.521	51	.604
Par 3	VT_A- VT_D	.035	.625	.086	−.13804	.20997	.415	51	.680
Par 4	CCA_A- CCA_D	−.086	.931	.129	−.34582	.17274	−.670	51	.506
Par 5	CA_A- CA_D	−.026	.698	.096	−.22104	.16796	−.274	51	.785
Par 6	AP_A- AP_D	−.265	1.223	.169	−.60608	.07531	−1.564	51	.124

Source: Prepared by authors based on MSLQ data

needed to achieve said objectives are used, difficulties that may be encountered are handled well, and responsibility is assumed both for learning and for the on-going effort and commitment involved. Students also rate their self-efficacy highly, believing that they are capable of understanding complex content within the subject as well as performing satisfactorily in tasks and exam, thus demonstrating a greater sense of expertise which in turn translates in greater demands, aspirations and dedication in the tasks that guide them through the learning process.

Although the initial results, being as positive as they are, might indicate there is little room for improvement, the study has revealed that students' intrinsic goal orientation is significantly improved following the use of LOs. This suggests that the use of LOs contributes towards improved learning and it also suggests that they improve the competencies that would support the development of intrinsic motivation, a quality that is needed for deep learning and which is also an important prerequisite for the self-directed and independent learning being promoted by the European Higher Education Area as part of students' new proactive role in the learning process.

5 Conclusion

The study that was performed has made it possible to determine that following the use of the series of Learning Objects that were designed and implemented as teaching aids in the subject of Architectural Graphic Design, significant improvement was produced in students' intrinsic goal orientation.

Thus, the use of LOs in Graphic Expression significantly improves students' intrinsic motivation, enabling them to successfully perform and master the tasks that lead to learning and to the use of more complex strategies, which in turn will also contribute to the development and refinement of the skills they possess and encourage their interest in self-study, without the need for any form of external incentive or reward.

The aforementioned is fundamental in terms of achieving deep learning, which guarantees the necessary understanding, retention and transfer of what is being learnt, and, as such, facilitates the acquisition of student competencies in the subject of Graphic Expression.

However, caution is advised when looking that the results and conclusions of this study as the authors' initial aim was to merely build a pilot study that would reveal a suitable approach for a larger scale experiment. There is no doubt that the results have delivered positive findings. The fact that this study has provided good results can, and should, serve as an invitation to further exploit the use of these types of pedagogical methodologies and initiatives as a means through which to comfortably handle the new teaching styles that are currently being imposed across Europe.

In is also worth noting that this study has been an incredibly positive experience and is highly recommended for university teaching given that it has provided students with a resource that serves as an aid to learning; the authors believe this is a crucial part of a teaching methodology that is student-focused, and in which great importance is being placed on self-directed study guided by a teacher who's role it is to accompany them throughout this process.

Lastly, it should be stated that this study, in focusing attention on the design and implementation of LOs in the field of Graphic Expression, and on the analysis of their impact on student motivation as a means through which to secure deep learning, that in turn acts as a more convenient way to familiarise oneself with how to obtain and develop competencies in subjects within the field of Graphic Expression, has demonstrated its contribution towards innovation. Based on the results presented, there is hope that this study will serve as inspiration to the academic community to continue building on the findings and strengthen the desired relationship between teaching and research. In terms of future courses of action, there exists the possibility of taking the experiences of first-year Graphic Expression students and expanding them to include all Engineering students in order to analyse the variances that arise from larger and more heterogeneous sample sizes.

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