A Project-based Creative Product Design Course using Learning Management System

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Keywords: Creative Product Design, Project-based Approach, Learning Management System, Pedagogical Issues.

Abstract: This study presents an effective mode for creative product design learning through practical tasks generation by learner groups in a face-to-face course. This mode integrates project-based learning, and learning management techniques and tools. We include a quasi-experimental study in which the results of four academic years are analyzed. In this study we analyze phases such as exam grades, exam dropout rates, exam passing rates, and class attendance. Meanwhile, we also investigate the use of LMS, distinguishing between informational use and communicational use. The predictive model further involves: utility, user interface, subjective criterion, personal innovativeness in the domain of information technology and internal ICT support at school aspect. Learners that followed this active learning approach gained better results than those that followed a traditional strategy. In addition, the experience of the introduction of such a method in a student subgroup positively influenced the whole group. Finally, information use was found to be a precursor for communicational use, perceived user interface of the LMS is the strongest predictor in LMS acceptation. Internal ICT support has a direct effect on the information use of the LMS and on subjective criterion.

1 INTRODUCTION

Instructional methods traditionally used for computer-aided creative product design involve expositional lectures, and closed and hands-on laboratories. We will refer to this as "traditional mode" in the rest of the study. Nevertheless, some researches proposed that this mode seems to be problematic or even ineffective for the abstract and complex domain of creative product design (Howard et al., 2008; de Vere et al., 2010). One promising method in this field is based on the development of projects (Howard et al., 2008). Project-based learning (PBL) is a constructivist pedagogy that intends to bring about deep learning by allowing learners to use an inquiry based approach to engage with issues and questions that are rich, real and relevant to the topic being studied. It is designed to be used for complex issues that require learners to investigate in order to understand (Barron, 1998). Within this type of learning, learners are expected to use technology in meaningful ways to help them investigate or present their knowledge. Technology is infused throughout the project to reflect the emphasis on technological and academic content. PBL framework differs from inquiry-based activity in its emphasis on cooperation between team members. Cooperation refers to the practice of working in line with commonly agreed goals and possible methods, instead of working separately in competition. The several different approaches in project-based learning (ChanLin, 2008), which differ in project duration, number of team members, and in the way the learners cooperate. In summary, there are many benefits of PBL covered in the literature, For example, the possibility of increasing motivation, of connecting learning with reality, promoting problem-solving and teamwork, among others.

Project management is the application of knowledge, techniques, skills, and tools to meet project requirements (Project Management Institute, 2008). To integrate both perspectives of a project as an effective creative product design learning method, using PBL with aim of undertaking a software project that covers all the activities. The result of this integration should benefit from both PBL techniques and professional practices. Furthermore, we also organize, mange and controls the development of project tasks and their

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deliverables through the adoption of learning management systems (LMS) in a face-to-face course, in order to reduce the management time. The last objective is to investigate the results of two academic years using PBL approach and the technology acceptation of LMS.

2 COMPUTER'S ROLES: COURSE SOFTWARE AND LMS

Several of the project tasks need the use of three software programs for their development, computer-aided design system, a text editor, and a data store system. We present, in laboratories, their main functions, accessible from the graphical tool Management Studio. This makes it possible to deal with physical design in a subsequent task. Through the realization of these tasks, learners face several real-world features such as product specification, design constraints, data editing and storing, backups, etc. Furthermore, we adopted the institutional and commercial LMS tool Blackboard/WebCT Learning System® (Blackboard, 2012), other similar solutions, of course, could be also useful for our goals. This tool is applied as a support of a face-to-face course. This tool has been used to meet several primary requirements:

(1) Task management: this tool collect the deliverables, automatically registers the submission date and time, and allows for delivering several versions for the same task. Once delivered, it is possible to send the feedback to the group and also to assess the task. We use this tool as an organized repository. Both learners and instructors have access to the repository that can be checked in case of conflict.
(2) Group management: This tool allows us to update the group composition and automatically create a kind email distribution list useful for communication with the groups. It also to assign the groups to panels. Learners identify themselves when starting a session and the LMS uses this identify for all its tools. We also use the evaluation module to collect the individual report of the time spent on each task.
(3) Communication: there are several communication modules provided: announcement, calendar, email and panel modules. With the announcements the learners read instructor news at the beginning of a session. The calendar displays all the interesting events related to the project, as task deadlines. These events are easily created as part of the task definition. E-mail allows personal communication, for instance between a learner and the instructors. The panels permit the participation of authorized learners and instructors. To meet several purposes, three types of panels are used in this tool: (i) a public inter-groups panel for all group members. It should be used for general questions and to explain possible mistakes or problems. (ii) a private intra-groups panel is built for each group. It should be used for communication purposes among group members. (iii) a private intra-project panel is defined for each project domain. The panel is anonymous and constitutes the only communication channel between both groups. We look for a similar mechanism to moderated distribution lists. In this way, the instructor could superintend the contents of each message before publishing it in order to avoid inappropriate contribution.
(4) Description of learning method: Presented here are the general rules, the acquired agreements, the assessment method, the enumeration of the different tasks, including the estimated tasks deadlines and workload and the course schedule (involving lectures and labs).

At the beginning of the first project task, the participants have access to the first task description through the task module. The rest of the tasks are gradually incorporated through this module. Whenever a new task is available, the module highlights this to the students with a graphical representation on the main page. Each task includes a detailed description of what should be delivered before its deadline. Tasks can also be sent for a while after the time limit. Instructors and students can consult all the past tasks and easily access their deliverables during the whole project. Furthermore, group management workload was reduced as a result of LMS. We have shown its usefulness for interchanging instructions, asking and replying to questions, providing feedback, receiving and storing work results, and so on. The module requires a brief reconfiguration for each course: assigning task deadlines, defining the groups, adding new groups to the panels and tasks, etc. However, most of the work is reused from previous courses: method description, generation of panel, task presentations and definitions, and so forth.

3 RESEARCH HYPOTHESES

3.1 Project-based Method

The following hypotheses make conjectures on student results. These results include aspects such as dropout rates, exam passing, and class attendance. Better results mean more valuable learning outcomes for the students. The several hypotheses that we wish to examine are:

H1a: Students that follow the project-based method will obtain better results than their counterparts with a traditional method.

H1b: The project-based method will influence the whole student group: the results of the entire group when some students follow the new method will be better than the results of the group when everybody follows a traditional method.

H1c: The project-based method will influence the students that only follow a traditional method: these students will improve their results compared with groups of students where all their members follow a traditional method.

3.2 The Informational LMSuse

Malikowski, Thompson and Theis (2007) distinguish several layers of adoption with respect to CMS features: Layer 1, consisting of the most commonly used CMS features such as transmitting course content; Layer 2, comprising features with moderate adoption such as evaluating learners, courses and instructors; and Layer 3, including the least adopted features like creating class discussions and computer-based instruction. Features of layer 1 can be seen as features focusing on what Hamuy and Galaz (2010) refer to as the informational phase, while layer 2 and 3 correspond with the communicational phase (Hamuy and Galaz, 2010). Malikowski et al. (2007) concluded that CMS features for evaluating students or creating discussions are adopted much less often than transmitting content, so the flowchart suggests categories containing these features are adopted after instructors have transmitted content in a CMS. All these observations and arguments have in common that a basic usage phase of specific technologies, is required to foster the adoption of more advanced type of technology use. Hence, within the context of the study about LMS usage, we expect information use of the LMS to be a precursor of communicational use.

H2: Informational use will be a precursor of communicational use.

3.3 Perception of LMS

The perception of utility is defined as the degree to which a person believes that using a particular system will enhance job performance (Ware, 2004). In most TAM-studies, perception of utility has been the strongest predictor for behavioral intention. Therefore, King and He (2006) conclude their meta-analysis with the statement: “if one could measure only one independent variable, perception of utility would clearly be the one to choose”. But even if users think their performance will benefit from technology usage, they do not necessarily actively engage with the technology. Ware (2004) explains this as follows: “they may, at the same time, believe that the system is too hard to use and that the performance benefits of usage are outweighed by the effort of using the application” (p. 320). In this respect, the variable, perception of user interface, plays a role. It refers to an individual’s believe that using a system or technology is free of effort. Meanwhile, the variable, subjective criterion, refers to the social influence of important others (Ma et al., 2005). Though Ware (2004) did not include social influence as a direct determinant of behavioral intention, Venkatesh and Davis (2000) reconsidered this variable in the TAM2 model, especially in settings where a particular technology usage is mandatory. Van Raaij and Schepers (2008) refer in this context to LMS environments when they have to be used in order to complete the course. This reconfirms the position of subjective criterion in the present study. There are several hypotheses included in our model.

H3a: Perception of utility has positively affects informational use.

H3b: Perception of user interface has positively affects informational use.

H3c: Perceived user interface positively affects perceived utility.

H3d: Subjective criterion positively affects perception of utility.

3.4 Personal Innovativeness toward IT

Van Raaij and Schepers (2008) consider personal innovativeness as a form of openness to change. They agree with Schillewaert et al. (2005) that “being used to adapting to new systems and processes might indicate the utility and user interface more quickly to an innovative person than to a non-innovative person”. As reported by Schillewaert et al. (2005), it is not only possible to distinguish a direct relation between personal innovativeness and technology adoption, but also an indirect relation through perception of utility and user interface. They concluded that a person's predisposition toward technology plays an important role. In this respect, we expect that a learner with a higher level of technological innovativeness will more readily use an LMS, and this up to the communicational phase.

H4a: Personal innovativeness toward IT positively affects communicational use.

H4b: Personal innovativeness toward IT positively affects perception of utility.

H4c: Personal innovativeness toward IT positively affects perception of user interface.

3.5 Internal Support toward IT

Technical support is one of the most essential factors in the acceptance of educational technology (Wu, Hiltz & Bieber, 2010). Ngai et al. (2007) also stated a strong – indirect – effect of technical support on attitude, thus underscoring the importance of user support and training on the perceptions of users and ultimately their use of system. This is confirmed by the significant and strong association between user perceptions of school-based ICT support and actual classroom use of ICT in the study of Tondeur, van Keer et al. (2008). Thus, we can assume that internal ICT support will influence the perceptions of the learners and the use of the LMS.

H5a: Internal support toward ICT positively affects informational use.

H5b: Internal support toward ICT positively affects subjective criterion.

4 METHOD

4.1 Participant

This is a quasi-experimental study based on a face-to-face course on creative product design with one team of students per academic year. We will identify each academic year by its final year. For example, we will refer to the academic year 2010/2011 as 2011. The sample corresponds to four successive courses, from year 2008-2011, with 78, 85, 96, and 93 students attending the course, respectively. From year 2010 the project-based method was provided as an alternative and was optional to all the students. All the interested members were admitted. A total of 116 students followed this method (56 in 2010 and 60 in 2011) organized in 29 groups. All the groups had four members.

4.2 Research Design

For each academic year the two instructors were the same. Each lecturer was responsible for the same portions each year. The subject contents, books and written materials were also substantially the same. To investigate the previous hypotheses (H1a – H1c) we use the exam grades, which constitute the common assessment procedure for both learning methods. All the exams follow a common structure. They all are composed of the same set of exercise with very similar difficulty level among them. We also consider the number of students that did not take the exam and the student class attendance. Individual declarations of time spent have been taken into record in order to measure workload and to detect free-riders. The "contamination" between traditional and PBL subgroups is inevitable when we work with a single group. In addition, we considered their random division into experimental and control subgroups unethical. For these reasons we decide to propose the PBL experience as a voluntary option. Then, the possible bias included by the voluntary factor should be carefully taken into consideration. However, and taking into account the null variance in contents, exam and instructors, we still can compare the condition of the whole group before and after the introduction of the PBL experience. An alternative study would consider only voluntary learners and organize randomized groups with them. As has been mentioned, students either know the required computer tools from previous courses or can learn them in specific laboratories. The whole group uses the LMS for accessing materials. The project subgroup uses some additional tools in order to consult and deliver tasks, but there is no essential difference in both subgroups from a learning point of view.

Furthermore, a survey instrument was generated. It focused on the construct as represented in the proposed research model (as shown in Figure 1). Ten items assisted to determine the phase of informational use and communicational LMS use. Items about announcements, document publishing, receiving assignments, the agenda, and learner tracking module are linked to informational LMS use. Items about the use of the chat environment, the discussion forum, assessment module, and learning paths are connected to communicational LMS use. Participants were asked to indicate on a five-point Likert scale to what extent they did actively use the particular LMS tool or functionality. Based on several previous researches (Chau and Hu, 2001; Dong, 2009; Venkatesh et al, 2003), we adopted the four-item performance expectancy scale for perception of utility and the four-item effort expectancy scale for perception of user interface. For subjective criterion, the two-item scale based on Armitage and Christian (2003) is used. Personal innovativeness toward IT is assessed with the four-item scale from Rosen (2004). Internal ICT support is based on the four-item scale by Tondeur, Valcke, et al. (2008). All of these items are measured on a five-point Likert-scale, ranging from “very disagree” (one score) to “very agree” (five score).

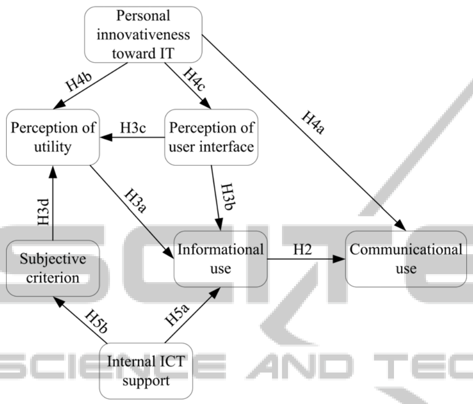

Figure 1: Proposed research model.

5 RESULTS AND DISCUSSION

5.1 Effects in Both Learning Methods

Table 1 compiles the data obtained comparing traditional and PBL methods in courses 2010 and 2011. Also means comparison tests or Person’s chi-square tests are included. The exam results correspond to the grade (from 0 to 10) obtained in the final exam of the course. The dropout rates were measured by the absence of mark in this exam. This exam was passed obtaining at least five points. Attendance of lectures and labs was not compelled. We controlled, however, the attendance of practical classes (15 in 2010 and 17 in 2011). Learners were informed that this control was only for statistical purpose. We find that attendance has a direct correlation with success in the exam (r = 0.402, p < 0.05). As shown in Table 2, the data allow us to identify a better attitude towards the course in the PBL group. We observe that participants of the project group obtained better exam grades, passed the exam, and attended more classes than their fellows of the traditional group in a significant way. The findings seem to support the hypothesis H1a.

Table 1: Results in PBL and traditional approach in 2010 and 2011.

	PBL group	Traditional group	Statistical test
Sample N (%)	116 (61)	73 (39)	
Grade Mean (SD)	6.47 (1.82)	5.06 (1.78)	t = - 4.579[a]
Dropout rates %	7.3	21.85	χ^2 = 12.726, df = 1 [a]
Pass exam %	77.5	28.6	χ^2 = 35.143, df = 2 [a]
Attendance Mean (SD)	9.65 (3.85)	4.87 (3.92)	Z = -4.862[a]

[a] p < 0.001

The PBL experience was a bit different when we analyze each of the last two courses. The mean grade (SD) obtained in course 2010 by all members was 5.45 (2.10) whereas in 2011 it was 4.62 (1.82) (t = -2.734, p < 0.05). In 2010 the mean grade (SD) for the project-based group was 7.05 (1.46) and in the traditional method group it was 5.02 (1.74) (t = -4.892, p < 0.001). Nevertheless, in 2011 those data were 5.18 (1.62) and 4.48 (1.80), respectively (t = -1.902, p = 0.076). Although both courses showed better grades in PBL than in the traditional approach, in course 2010 only a trend to a statistical significant difference is observed. This means that the hypothesis H1a could be only partially supported. A long-term study may possibly illustrate if this current tendency is a permanent factor. Table 3 includes exam results and dropout rates gained from the whole group from 2008 to 2009 (traditional learning method) and from 2010 to 2011 (traditional and PBL). The class attendance has not been involved because it was not measured the first two years. From the introduction of the project-based method the results of the whole group have increased. Table 2 reveals better percentages of members that passed and took the exam than in previous courses. We can also appreciate certain improvement in exam grades, although not in a significant way. All these results seem to sustain the hypothesis H1b. If analyze each of the last two courses we obtain that is 2010, 35.1% of the members did not attend the exam and 39.8% passed it. These data were 33.8% and 26.3% in 2011, respectively. However, only the dropout rate maintains during the two last courses. There is not a clear tendency in exam grades. This means that the hypothesis H1b would be only partially supported.

Table 2: The results before and after PBL introduction.

	Group (2008– 2009)	Group (2010– 2011)	Statistical test
Sample N (%)	163 (46)	189 (54)	
Grade Mean (SD)	4.76 (2.36)	4.96 (2.12)	t = - 1.368
Dropout rates %	48.9	31.2	$\chi^2 = 14.648$, df = 1 [a]
Pass exam %	23.6	32.7	$\chi^2 = 8.256$, df = 2 [b]

[a] $p < 0.001$, [b] $p < 0.01$

To analyze the influence in traditional students of classmates following PBL, the first column of Table 1 and the first column of Table 2 should be considered. While there were no differences in the grade nor in the percentage of members who passed the exam, the dropout rate decreased ($\chi^2 = 4.925$, df = 1, $p < 0.05$). The project-based method influenced the traditional group, at least in the aspect of attending the exam (Keogh-Brown et al., 2007). Meanwhile, mean grades obtained by the traditional group before and after the introduction of the project-based method are essentially the same. From the last two ideas, more people participating with similar universal results, we can infer a positive overall success improvement in traditional learning students. Therefore, these results seem to support the hypothesis H1c. However, the mean mark remained flat throughout the four courses and decreases the last year although not in a significant way. This indicates that the hypothesis H1c could be only partially sustained.

Participants revealed to have spend a mean (SD) of 35 (11.6) hours of individual work developing the project, almost double the estimation (18 h). This reflects a negative aspect of PBL, a workload increase for both learners and instructors (Martínez & Duffing, 2007; Van den Bergh, et al., 2006). However, there are two interpretations of the estimated time. The PBL project viewpoint uses the task as a way to learn (constructing internal structures by discussing and understanding concepts, and so on). The software perspective assumes that an engineer will apply knowledge previously acquired to solve problems. The time scheduled corresponds to the second interpretation, whereas the time declared could include aspects related to the first aspect. These individual time declarations have not helped to identify the free-riders presence (Van den Bergh, et al., 2006). The coincidence in the spent time in all group members is probably due to the teamwork scheme. Obviously, all group members used to meet to fulfill their tasks collectively. Therefore, we have no idea of the level of contribution of each particular member from this data. Instructor workload has increased compared to the traditional method, although we did not systematically measure this item. The LMS has been revealed to be a very useful tool that significantly mitigates the work related to document, schedule, and communication management. In addition, students need quick feedback, especially in the first steps. The group tutorship and task feedback and assessment also increase the instructor workload. We have also identified other benefits of PBL that were not measured, including reflective thinking (more critical contributions, noticeable interest towards the subject topics, improved quality of questions, etc.), development of work skills (developing a full creative product design, fulfilling a set of rules and deadlines, and so on), and social skills (collaborating with the rest of the group members, unbroken teams, and so forth.).

5.2 Psychometric Quality of the Research Instrument

To examine the psychometric quality of the instrument section focusing on the identification of types of an LMS usage, a two-step validation procedure was adopted. The sample (N = 116) was divided into two sub-sample to evaluate the construct validity. We have used SPSS version 18 to conduct an exploratory factor analysis on the data of the first sub-sample (n = 56), using Maximum Likelihood estimation with oblique rotation. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.87, exceeding the suggested threshold for factor analysis of 0.6 (Manly, 2004). The Bartlett's test of sphericity was – as required – significant at 0.001 level. The number of factors was determined by a parallel analysis (O'Conner, 2000) and an examination of the scree-plot. On the basis of a first EFA, a two-factor solution was found, but two items (student tracking module and the agenda) were deleted due to communality values exceeding the threshold. A second EFA was performed on the 8 remaining items. A two-factor was performed on the nine remaining items. A two-factor solution emerged, accounting for 61.2% of the common variance among the items, with eigenvalues of 4.06 and 1.38. As illustrated in Table 3 and marked in italic and bold, two substantially different constructs can be distinguished and are in line with the findings of Hamuy and Galaz (2010). Releasing announcements, publishing document, uploading exercise and receiving student works can be considered as indicators of an informational phase in LMS usage. Learning path, chat, forum, assessment modules and social support can be marked as indicators of the communicational phase in LMS usage.

Table 3: Exploratory factor analysis of the dependent variables.

	Factor	
	Informational use	**Communicational use**
Releasing announcements	***0.952***	-0.0051
Publishing document	***0.725***	-0.022
Uploading exercises	***0.575***	0.176
Receiving student works	***0.480***	0.235
Learning path	-0.075	***0.802***
Chat	-0.122	***0.720***
Forum	0.185	***0.628***
Assessment modules	0.136	***0.572***
Social support	0.085	***0.526***

Next, AMOS (an add-on module for SPSS) was used to perform a confirmatory factor analysis (CFA) on the data of the second sub-sample (n = 60) and building on the two-factor structure resulting from EFA. The following indices were calculated, taking into account criteria for the evaluation of goodness-of-fit indices (Byrne, 2009): Chi-square/degrees of freedom is less than 3 (2.32), the root mean square error of approximation is higher than 0.05, but lower than 0.08, reflecting a reasonable fit. The comparative fit index (0.96), the normed fit index (0.94), and the Tucker-Lewis index (0.96) reflect good fit values since they are close to 0.95. To conclude, on the base of the EFA and CFA, we can report that the instrument to determine LMS use reflects good construct validity. Construct validity was evaluated for the other variable measured with the instrument. Exploratory factor analysis (n = 56) using Maximum Likelihood estimation with oblique rotation was performed. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy is 0.87, exceeding the suggested threshold for factor analysis of 0.6 (Manly, 2004). The Bartlett's test of sphericity was – as required – significant at 0.001 level. The number of resulting factors is in line with specific variables that were intended to be measured. All values are close to 0.85, exceeding the threshold value (Marcoulides & Raykov, 2011). Besides, correlations between all variables are listed. A correlation matrix approach was used; most values are low among the different constructs. All mentioned values suggest adequate validity of measurements.

5.3 Analysis of Research Model

As described earlier, the hypothetical relationships between the variables were tested on the base of structural equation modeling, using AMOS. The following fit indices were obtained. Chi-square/degree of freedom is slightly higher than 3 (3.05), the root mean square error of approximation is close to 0.05, suggesting a good fit. The comparative fit index (0.96), the normed fit index (0.92), and the Tucker-Lewis index (0.89) have value close to 0.9 or approach the benchmark of 0.95. All common goodness-of-fit indexes exceeded or approached their respective common acceptance levels, suggesting that the research model exhibited an acceptable fit with the data. Properties of the causal paths, including standardized path coefficients and p-values are shown in Figure 2.

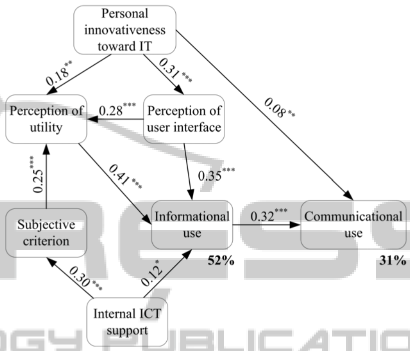

Figure 2: The result of research model testing.

As to the assumption that informational use can be considered as a precursor for communicational use (H2), this hypothesis was sustained (β = 0.32, p < 0.001). The traditional TAM elements appeared in four hypotheses. Perception of utility has a positive significant effect on informational use (H3a, β = 0.41, p < 0.001). Perception of user interface in a significant and positive way informational use (H3b, β = 0.35, p < 0.001) and perception of utility (H3c, β = 0.28, p < 0.001). Subjective criterion is found to be a significant factor in determining perception of utility (H3d, β = 0.25, p < 0.001). In line with other TAM studies, all hypotheses constituting the TAM-framework (H3a, H3b, H3c and H3d) are confirmed. The findings indicate that personal innovativeness toward IT has a direct positive effect on perception of utility (H4b, β = 0.18, p < 0.01) and on perception of user interface (H4c, β = 0.31, p < 0.001). The effect on communicational use is significant but rather weak (H4a, β = 0.08, p < 0.01). Hypotheses H5a and H5b postulated the impact of internal ICT support on informational use and subjective criterion. The analysis results show that internal ICT support has a positive significant effect on informational use (H5a, β = 0.12, p < 0.05) and a significant effect on subjective criterion (H5b, β = 0.30, p < 0.001). The whole model is able to explain 52% of the variance in formational use and 31% of the variance in communicational use.

In summary, the study contributes to the literature in a number of ways. Firstly, the use of

LMS by college students has been further explored and refined. Secondly, the study focused on the acceptance of the LMS by college students. Further, the operationalisation of an LMS use into informational use and communicational use appeared to be valid. The research model is able to explain 52% of the variance in informational use and 31% of the variance in communicational use. As hypothesized, informational use seems to be a precursor of communicational use. Meanwhile, we could successfully generate on perception of utility, user interface and subjective criterion as predictors from the original TAM-framework. Both perception of utility and perception of user interface were found to have a strong effect on informational use. This means that in order for a college student to use his LMS in informational way, the utility and user interface of the LMS will be both taken into consideration. However, since we found a significant effect of perception of user interface and subjective criterion on perception of utility, we can additionally postulate that the user interface of the LMS should be a critical initial variable, followed next by learners' perception of the system's performance.

Another finding is the direct effect from internal ICT support on informational use and on subjective criterion. This result implies that supporting learners at the school level will not directly influence personal use, but especially impact the opinion of important others. More important, as also indicated by Tondeur, van Keer, et al. (2008), the impact of internal ICT support suggests the school level variables are important to understand technology acceptation. The adoption of the variable internal ICT support makes the TAM model congruent with the real – school – world setting and conditions as requested by Sun and Zhang (2006) and Ong et al. (2004). Also important is the positive effect of personal innovativeness on perception of user interface. This reveals that innovative learners are more easily convinced about the user interface of the LMS. On the other hand, the impact of innovativeness on utility was low, meaning that being innovative does not automatically result in a positive belief about a system's performance. This is also confirmed by the impact of personal innovativeness toward IT on communicational use. Being innovative is clearly not enough to start using an LMS for communicational use. Based on the importance of the participant's perception of the user interface of their LMS and the availability of support, school manager or LMS coordinators can consider the following practical recommendations: (i) Introduction sessions can be considered and manuals provided. If applicable, a proper translation of the LMS to the native language of the learner and clarification on specific design characteristics should be foreseen. (ii) Some learners are not familiar with functionalities like the social support or the learning path module. Best practices, adaptive guides and easy access to support will definitely be valuable for the learner and might be that extra little thing to get them inspired.

6 CONCLUSIONS AND LIMITATIONS

The use of LMS with PBL approach has been suggested for creative product design learning as a more effective way for students to obtain the essential knowledge and skills. On the other hand the development of projects corresponds with the main activity of a graduate on Mechanical Engineering and Information Systems. This study presents an approach that integrates both perspectives of a project as a useful creative product design learning method that tries to overcome several problems of PBL applications. Our approach focuses on the development of projects where students, organized in groups, design and build real product. Certain scaffolding is offered to reduce both the project complexity and the uncertainly inherent in the beginning of the tasks, and also to motivate learners. Participants propose the project topics and the imposition of some constraints in the first task achieves the complexity balance control. The communication with end-users is emulated throughout role-playing between pairs of student groups. The computer is essential tool to put this method into practice, from the point of view both of the creative product design and task management. An LMS is a powerful solution in order to minimize the necessary effort to organize the information shown to the learners, group management, deliverable collection and communication with and among students. There are not many works about PBL effectiveness for creative product design learning. We have explored the results of two academic years using the proposed project-based learning approach. This quasi-experimental study shows that on the one hand, learners that follow this method obtain better results than members that follow a traditional learning method. And on the other hand, the introduction of such an approach in a student subgroup positively influences the whole group.

Furthermore, the purpose of this study was twofold: (i) developing a better understanding of college student acceptation of an LMS and (ii) investigating the way this group of students actually uses an LMS in their learning setting. Though the result, discussed above have clearly helped to attain our research aims, a number of limitations are to be considered. Firstly, instead of reported use of an LMS, we expect that using log files could lead to more accurate LMS related data. However this was not feasible practically in the current study, given the number of respondents and the difficulties in getting access to log files. Secondly, our study validates the categorization of LMS-interactions as defined by Hamuy and Galaz (2010). However, additional LMS functionalities, such student tracking module and the agenda had to be removed during the factor analysis process. Future research should continue to focus on the refining of LMS usage categories. Thirdly, we were able to explain 52% of the variance in informational use, but only 31% of the variance in communicational use. Further research should focus on identifying additional variables to explain the adoption and implementation of communicational use. The latter could be for instance linked to beliefs of instructors about the types of learning strategies that are linked to the adoption of these LMS functionalities.

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