

## **Collaborative work in a virtual environment in project-based learning: a case study in a Brazilian Undergraduate Design Program**

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**ABSTRACT:** In Brazilian undergraduate design programs, subjects based on PBL are common, and in it, students often select digital media for team organization and task execution. The present study sought to investigate the digital media used by design students for project execution as well as their strategies for the construction of collaborative documents. Their satisfaction concerning the subjects was also investigated. A case study was conducted using as a phenomenon student's projects carried out in the Design Practice subjects of the Degree program in Design at the Santa Catarina State University – UDESC, in Brazil. The results show that the use of a specific media may decrease during different phases of the same project, also, they use a combination of different strategies for the collaborative construction of documents. Also, students were satisfied with the discipline but dissatisfied with aspects related to the pedagogical dynamics of the PBL subjects.

**Keywords:** Project Practice, Design, Learning, Virtual, Project-Based Learning.

## 1. INTRODUCTION

in Brazil, undergraduate Degree program in Design frequently involves subjects where the students are involved in the creation of projects that require students to find answers to design issues through the actual application of knowledge and skills they have acquired in other subjects in the design course curriculum. As a result, learning happens actively and ranges from the creation of current and relevant projects which explores and aim to solve local problems through design practice.

Therefore, subjects with the aforementioned characteristics are enrolled in project-based learning (PBL), which is defined as " Students work on a project over an extended period of time – from a week up to a semester – that engages them in solving a real-world problem or answering a complex question. They demonstrate their knowledge and skills by creating a public product or presentation for a real audience. " by the Buck Institute of Education (2021). The PBL is presented to the student in the form of a project, which, according to Markha, Larmer, and Ravitz (2008), can be carried out in a team or alone, and last for a short or long period of time (eg. one semester), and can involve only a specific topic or be of an interdisciplinary nature. Projects may, as well, involve the community outside the limits of the educational institution.

An effective PBL application necessitates a student's active participation as the effectiveness of the learning process depends on the student's degree of engagement in the method (Markha; Larmer; Ravitz, 2008). For that, the PBL must encourage critical thinking, problem-solving, collaborative work, and self-management (LARMER; MERGENDOLLER; BOSS 2015), offering the student authentic design problems - that is, based on real (or simulated real) problems - and related to the student's personal and/or professional interests. It is the responsibility of the teacher to make clear to the students the phases, procedures, and goals of the design process, acting as an advisor who encourages critical thinking and provides project feedback. LARMER; MERGENDOLLER; BOSS (2015), complements this idea, describing that the degree of student autonomy and decision-making authority is essential for PBL to be successful.

it's possible to perceive in the Brazilian undergraduate design programs, academic subjects of practical nature are based on the methods by design theorists such as Löbach (2001), Baxter (2011), and Munari (2002) that place the design professional at the center of a creative process that aims solutions finding and problem-solving, combined with PBL. Therefore, in the academic subjects based on those methods + PBL, the student completes a project - evaluated and guided by the teacher - from beginning to end, whether or not in a team, that is consistent with the discipline's objectives, supported by design phases suggested in design methods. These academic subjects of this nature will be referred to as "project practice" in the present paper.

The project practice subject is often carried out with the students divided into teams and therefore tends to have a considerable amount of extra-class tasks that are frequently carried out in a virtual environment where the exchange of information between team members occurs remotely. Due to the aspects mentioned regarding the PBL, its necessary for the development of the present paper to comprehend the specifics of collaborative work in the context of education and, other than that, the context of education in a virtual setting. The next topic will provide theoretical support for this aspect.

### 1.3. COLLABORATIVE WORK IN A VIRTUAL ENVIRONMENT: THE EDUCATIONAL SCOPE

First, there is a need to establish the definition of teamwork in virtual environments. To this end, the work of Powell; Picolli; Ives, (2004) will be used as a reference, which defines virtual teams as "geographically,

organizationally and/or time dispersed workers brought together by information and telecommunication technologies to accomplish one or more organizational tasks". The authors cite that virtual teams tend typically remain organized for short periods of time, although this is not a strict factor of the definition.

Furthermore, Teamwork in a virtual (or remote) environment has particularities that affect the relationships and work dynamics between its members, mainly, since the execution of tasks and communication are mediated by technology. One example of this, is the fact that the choice of appropriate virtual technology for the execution of a task will affect the clarity of the produced information and the time for the execution of this task. This, in turn, affects how the processes are managed and the job satisfaction is perceived by team members (Gilson et al., 2015)

Also, a virtual environment working can improve team performance in interdependent tasks, in addition to improving the individual's level of commitment to the team and reducing idle moments during a task. In contrast, high virtual workloads can reduce the feeling of productivity in a team. (Gilson et al., 2015).

When teamwork happens in the educational scope, it is known that the dynamics of collaborative work, also play a significant part in the socialization of individuals in learning situations. In recent decades, the advance in the use of computer technologies in the learning process has meant that collaborative work has not been restricted only to the physical environment of the classroom, but has also extended to the virtual environment. In the virtual setting, student collaboration is supported by virtual media platforms such as Google Docs and, Google Drive as well as communication media such as WhatsApp. Therefore, as well as teamwork in the professional field, teamwork in the educational field is also impacted by the particularities of the virtual environment.

In addition to that, Aritz, Walker, and Cardon (2018) noted that, in educational projects, the lack of understanding of team management and team coordination has a detrimental impact on the degree of organization among teams. However, studies such as those by Sundgren; Jaldemark (2020) and Onrubia, Javier; Engel (2009) observed that students -consciously or not – will establish strategies for collaborative work in a virtual environment, although, team coordination, task separation, and selecting the appropriate online tools to perform the task are still frequently challenging aspects of student collaborative projects.

Educational projects often have - as one of the deliverables - text documents written/developed by the team. In this regard, the authors Talib and Cheung (2017) observed in their revision - based on the examination of 68 papers - that the creation of collaborative texts enhances students' ability to engage in critical thinking as well as their motivation. This can happen based on the process of working with their classmates, students can improve their own written work. The same authors noted that team collaboration can be aided by media that permit text-sharing and message exchange amongst team members. Moreover, the virtual environment facilitates the search for information to compose such collaboration. However, the quality of learning depends on the student's ability to think critically concerning the quality and veracity of the information/knowledge he/her has obtained.

In this context, the present paper aims to investigate the strategies used for the construction of collaborative text documents by the students enrolled in undergraduate Design Programs and attending PBL-focused subjects in Brazil. Also, it aims to investigate the aspects of media usage in the process of collaboration in a virtual environment in PBL-focused academic subjects. Additionally, this paper is interested in knowing the students' satisfaction with their learning process and their knowledge acquisition in PBL-focused academic subjects. The study presented in this paper was carried out in the format of a case

study using as a phenomenon the disciplines of Project Practice of the Bachelor's Degree program in Industrial Design and the Bachelor's Degree program in Graphic Design at the University of the State of Santa Catarina - UDESC.

In sections 3 and 4 below, the Project Practice in Design subject of the undergraduate Bachelor's Degree program in Industrial Design and the Bachelor's Degree program in Graphic Design at UDESC will be presented, followed by studies with similar problems and objectives of the present paper.

## 1.2. PROJECT PRACTICE SUBJECT AT UDESC

The Project Practice in Design subject in the undergraduate Bachelor's Degree program in Industrial Design and Bachelor's Degree program in Graphic Design at the Santa Catarina State University has the goal to instigate students to execute projects within the scope of industrial and graphic, supported by the design process. The subject is offered in 6 semesters in both programs, and therefore, throughout their graduation, a student enrolled in the Bachelor's program will execute at least 6 design projects.

The subjects (1–6 in both programs) are based on PBL, and in them, in both programs, the disciplines follow the same structural pattern in which students must achieve and present the results obtained from three stages of a generic design process, which are as follows: 1. Informational Phase: a gathering of information data about the design problem. 2. Conceptual Phase: development of alternatives of solutions to the design problem. 3. Final project Submission: Dossier and prototype of the final project solution.

Students (one student or a team of students) independently select the design problem to be investigated and to be developed into a project. Therefore, they are entrusted to gather pertinent data for the resolution of project phases as well as make the project decisions themselves. The projects are guided and evaluated by the teachers.

## 2. SIMILAR STUDIES

### 2.1 Strategies for collaborative writing and phases of knowledge construction in CS CL environments. (Onrubia; Engel, 2009)

The study by Onrubia; Engel (2009) analyzed the construction of collaborative texts by higher education students performed in environments of computer-supported collaborative learning. The authors identified that higher education students may adopt a range of 5 strategies in the process of building collaborative texts, which are, as described by the authors:

(1) Parallel construction — 'cut and paste': Each member of the group contributes with a different part of the complete task and the final document is constructed through the juxtaposition of these different parts without the contribution of other co-authors;

(2) Parallel construction — 'puzzle': Each group member contributes with an initial document with the task fully or partially completed, and the final document is constructed by juxtaposing small parts extracted from the initial contributions of other co-authors;

(3) Sequential summative construction: One member of the group presents a document that constitutes an initial, partial, or complete proposal for the resolution of the task, and the other participants successively add their contributions to this initial document, without modifying what was previously written, therefore, systematically accepting what is added by other co-authors;

(4) Sequential integrating construction: A group member presents a document that constitutes an initial, partial or complete task proposal, and the other group members successively contribute to this initial document, proposing justified modifications or discussing whether or not they agree with what has been written previously;

(5) Integrating construction: The writing of the document is based on synchronous discussion through chat, with repeated revisions, where all group members react to comments, changes and additions made by other participants.

The authors, observed that groups of students usually focus on one or two main strategies for the construction of the document. Also, each of the strategies influences group organization and control that each member has over the group's work.

The authors also identified patterns in the collaborative knowledge construction phases. The first phase is the initiation phase - team members' ideas are made public and are not questioned by other team members; 2. Exploration phase - team members deepen and clarify their ideas and information and try to seek clarification and contributions on the ideas presented by other team members; 3. Negotiation Phase - an ongoing and explicit process of negotiation in which students critically and/or constructively analyze colleagues' ideas; 4. Co-construction phase - students reach a consensus on what should be presented as a final document.

## 2.2. Visualizing online collaborative writing strategies in the higher education group assignments. (Sundgren; Jaldemark, 2020)

Similar to the finding of Onrubia; Engel (2009), the authors Sundgren;Jaldemark, (2020) observed patterns of collaborative document construction in a virtual environment. The authors observed the collaboration process of 25 documents made on the Google Docs platform. As a result, 3 document construction patterns were noticed: 1. *Cramming (heaping or stacking)* - students divide tasks among themselves and do the tasks offline and then insert ready-made pieces of text into the online collaborative document; 2. *Expanding* - students include their text parts in the document, and each student complements or edits only their own part; 3. *Concentrating* - students include large amounts of text on the collaborative document - far from the due date - and as the project develops the amount of text in the document decreases as a result of the editing process. The authors observed that at least two of the patterns are used concurrently in the construction of a document.

## 2.3 Media use in virtual teams of varying levels of coordination. (Aritz; Walker; Cardon, 2018)

The authors conducted a study observing more than 75 student teams to understand media usage in virtual teamwork. The authors then cite the Media Richness Theory (MRT) or "The theory of media richness" which suggests that more complex tasks are better developed when done in richer communication media. The characteristics that make the media richer are the ability to deal with various information signals differently and simultaneously, the ability to provide quick feedback, the ability to establish a personal focus, and the ability to use natural language. The authors quote that the richest means of communication, in order, are: face-to-face communication, videoconferencing, telephone, chat, email, and printed material.

These authors suggest that as socially-focused media platforms evolve, more traditional means of collaboration, such as email and Dropbox, will be gradually replaced by other media that allow for more simultaneous exchanges of collaboration for task execution. As a result, they propose that media be measured using the Media Synchronicity Theory - MST rather than the MRT.

The MST suggests that there are five media capabilities: 1. Immediacy (also known as transmission speed) - the media's speed in conveying messages; 2. Parallelism - the number of simultaneous transmissions (sends) between team members that the media allows; 3. Symbol Sets - the ability of visual symbols that support the decoding of information; 4. Rehearsability - the ability of a sender to prepare and adjust a message to the way the message is intended to be; 5. Reprocessability - is the ability to access and reprocess messages again (Dennis et al., 2008; Maruping & Agarwal, 2004 apud Aritz; Walker; Cardon, 2018)).

The study identified that to execute collaborative work in a virtual environment, undergraduate students use the media: Google Docs (90.8% frequency), email (82.8%), Facebook (71.8%), video conference (51.5%), text messages (41.6%), phone calls (23.3%), conference calls (13.9%), instant messaging (11.1%), and Dropbox (6.1%). They concluded that the students opted for media with low immediacy, but with high Rehearsability and Reprocessability.

Finally, it was found that well-coordinated student teams were able to identify the need for more robust means of communication earlier in the process than less coordinated teams. In addition to the exchange of documented information, well-coordinated teams supplement task execution with video conferences and phone calls.

#### 2.4 Student evaluation of a virtual experience for project management learning: An empirical study for learning improvement (González-Marcos et al. 2016)

The study aimed to measure students' satisfaction and academic performance (grades) concerning their gains in learning, in the execution and management of PBL activities in a virtual environment. 122 students (undergraduate and masters) participated in the experimental test, divided into 2 groups to carry out the same project. The first group carried out the project in virtual environments, in different locations, and used a framework developed by the authors of the study. The second group was formed by students from the same university who worked locally.

To measure student satisfaction, the authors used an adaptation of the SERVQUAL model (used to measure the perception of quality in services) with specific items about project-based learning to be evaluated by students. The questionnaire items are grouped into 6 groups that, according to González-Marcos et al. (2016):

1. Access: Teachers pay attention to the individual needs of students and make it easy for their students to follow the teaching and learning process.
2. Tangibles: Availability and performance of physical facilities and technological resources.
3. Reliability: Ability and organization of the educational program to meet learning objectives.
4. Competence: Knowledge, experience, and skills required for teachers to ensure academic performance.
5. Responsiveness: Availability and flexibility of teachers to face problems and difficulties raised by students.
6. Relevance: Adequacy of duration and distribution of course time to facilitate the development students' learning in their normal or future performance.

From the analysis of their data, the authors observed the usage of the PBL methodology increased the students' perception of satisfaction. The analysis also suggests a correlation between the increase in satisfaction and the increase in students' performance (grades). Therefore, the authors suggest that motivation and satisfaction with academic activities can impact academic performance and the overall student's learning process.

### 3. METHODOLOGY

The case study presented in this paper aimed to identify in a group of undergraduate Bachelor's Degree program in Industrial Design and the Bachelor's Degree program in Graphic Design at UDESC, the strategies used by the students regarding the use of media in the collaboration process, made in virtual environments, for the execution of projects in the subject of Project Practice. As well as the students' satisfaction with the subject. Three aspects were observed:

1. Which media were used for the execution of each phase of the project in the subject (1. Informational project;
2. Conceptual Project; 3. Final project Submission) in both degree programs;
2. Which patterns for collaborative construction of documents in a virtual environment are used for final project documentation;
3. How satisfied are students with their PBL process, considering the virtual environments and the tutoring of the teachers.

The study was carried out in May and June 2021, and involved the participation of 16 students (sample n=16) in the undergraduate Bachelor's Degree program in Industrial Design and Bachelor's Degree program in Graphic Design at UDESC. Of these, 10 students are Industrial Design students and 6 are Graphic Design students. To be able to participate as a respondent all participants must have already participated in at least one semester of Design Practice subject.

To collect the students' responses, each participant was sent a link to a form made in Google Forms, containing the following sections:

- *Section 1* - What media and/or software do students usually use - for each subject phase to carry out their projects and for team communication in prior Design Practices;
- *Section 2* - What strategies do students commonly use for the construction of collaborative documents in a virtual environment in Design Practice subjects;
- *Section 3* – Student's satisfaction in their learning process and the teacher's guidance during the execution of project phases in a virtual environment in Design Practice subjects.

Students were asked to answer the questions in the Google Forms sections based solely on their experiences with Design Practice subjects in which they had previously participated and completed. In other words, the answers are related to their projects developed in the semesters preceding the data collection for this study.

The media cited in Section 1 of the form were classified according to Aritz; Walker; Cardon (2018) who, in turn, were based on the MST theory to identify the ability of the media to assist in group tasks. The classification can be seen in Table 1 below:



Table 1 - Comparison of Selected Media and Their Capabilities in Virtual Teamwork

	Immediacy	Parallelism	Symbol variety	Rehearsability	Reprocessability
<i>File sharing</i>					
Google Docs	Medium	Medium	Few	High	High
Dropbox	Low	Low	Few to some	High	Medium
Email	Low to medium	High	Few to some	High	Medium
Social networking (Facebook) <sup>a</sup>	Medium to high	Medium	Medium	Medium	Medium to high
<i>Web conferencing</i> Skype					
	High	Medium	Some to many	Low	Low to medium
Google Hangouts	High	Medium	Some to many	Low	Low to medium
<i>Messaging</i> Texting					
			Few to some	Medium	Medium
	Medium to high	Low to medium			
Instant messaging	Medium to high	Low to medium	Few to some	Medium	Medium
<i>Calls</i>					
Phone calls	High	Low	Some to many	Low	Low
Conference calls	High	Medium	Few to some	Low	Low to medium

Fonte: Aritz; Walker; Cardon (2018).

*Section 2* of the form was based on the patterns of collaborative document construction as described by Onrubia; Engel (2009), and *Section 3* of the form was based questionnaire presented by González-Marcos et al. (2016), which had its items adapted and was presented to students in our translation to Portuguese. In the questionnaire students rated the items from 1 to 5, with 1 being "completely disagree" and 5 being "completely agree" with each item. The data collected and their analysis will be presented in Sections: 6. Results and 7. Discussions, that follow.

#### 4. RESULTS

*Section 6* describes the results of the analysis of the data gathered according to the method described in *section 5*. The results presented in this paper are based on the responses of 16 students. The average age was 22 years old, with the youngest participant being 19 years old and the oldest being 43 years old, with the latter being treated as discrepant data for the average age definition. Due to the number of respondents (n=16), the data presented in the results were analyzed without distinguishing between both programs of the Bachelor's degree in Design at UDESC cited in the methodology of the present paper.

##### 4.1 Results of *Section 1* of the form

This section, it was aimed to discover which media students use to assist in the completion of the design project as well as the used media to communicate with teammates at each phase of the Design Practice subjects. In the results of *Section 1*, we found that the media most used by students during any of the 3 phases of the project were: WhatsApp used by 100% of students, Google Drive (87.75%), Pinterest (75%), E-mail (62.5%), and Google Meeting (56.3%). Tables 1, 2, 3, 4, and 5 display the results of

the Section 1 responses, that is, the media that students mentioned for each phase of the Design Practice subjects, as well as the frequency (%) that each media was mentioned as being used.

Table 1 - Media commonly used by students in Design Practice disciplines to share files, and frequency of responses.

	Informational Phase		Conceptual Phase		Final project Submission	
	Media Used	Frequency of responses (%)	Media Used	Frequency of responses (%)	Media Used	Frequency of responses (%)
<i>File sharing</i>	Google Drive	87,5%	WhatsApp	87,5%	WhatsApp	68,8%
	Drive	81,3%	Google Drive	87,5%	Google Drive	87,5%
	WhatsApp	62,5%	E-mail	62,5%	E-mail	56,3%
	E-mail	31,3%	Pinterest	37,5%	Canva	31,3%
	Canva	18,8%	Canva	31,3%	Pinterest	25%
	Pinterest	12,5%	Miro	6,3%	Notion	6,3%
	Miro	6,3%	Behance	6,3%	Miro	6,3%
	Discord	6,3%	Dribbble	6,3%		
	Skype	6,3%	Notion	6,3%		
	Notion	6,3%				
	Facebook					
	Messenger					

source: authors

As shown in Table 1, the most commonly used media during the project were Google Drive, WhatsApp, and e-mail. The Canva and Pinterest media were found to be more popular during the Conceptual Phase and Final Submission of the Project phase when compared to the Informational Phase. Furthermore, the variety of media used by students to share content decreases throughout the project.

Table 2 - Social networks commonly used by students in Practice subjects Project, and frequency of responses.

	Informational Phase		Conceptual Phase		Final project Submission	
	Media Used	Frequency of responses (%)	Media Used	Frequency of responses (%)	Media Used	Frequency of responses (%)
Social networking	WhatsApp	93,8%	WhatsApp	87,5%	WhatsApp	93,8%
	Pinterest	56,3%	Pinterest	75,5%	Instagram	31,3%
	Instagram	37,5%	Instagram	56,3%	Pinterest	6,3%
	Facebook	6,3%	Behance	12,5%	Facebook	6,3%
	Behance	12,5%	Facebook	6,3%	TikTok	6,3%
			TikTok	6,3%	Discord	6,3%
		Dribble	6,3%	Behance	6,3%	

Source: authors

As shown in Table 2, the most used social media platforms for carrying out the subject's phases were WhatsApp, Instagram, and Pinterest, with Pinterest being most popular in the Informational and Conceptual phases and suffering a significant drop in usage in the Final Submission phase. The same phenomenon happened with Instagram, but with less expressiveness.

Table 3 - Media commonly used by students in Design Practice disciplines to share instant messages, and frequency of responses.

	Informational Phase		Conceptual Phase		Final project Submission	
	Media Used	Frequency of responses (%)	Media Used	Frequency of responses (%)	Media Used	Frequency of responses (%)
Instant messaging	WhatsApp	100%	WhatsApp	100%	WhatsApp	100%
	Instagram	18,8%	Instagram	12,5%	Instagram	12,5%
	Google	6,3%	Google	6,3%	Discord	12,5%
	Docs	6,3%	Docs	6,3%	Google Meeting	6,3%
	Discord	6,3%	Discord	6,3%	Google Docs	6,3%
	Facebook		Facebook		Facebook	6,3%
	Messenger		Messenger		Messenger	

Source: authors

As seen in table 3, all students report sending instant messages during all project phases of the Project Practice subject, and for that, WhatsApp was used by 100% of students throughout the project, followed - with much less frequency - by Instagram.

Table 4 - Media commonly used by students in Design Practice disciplines to hold videoconferences, and frequency of responses.

	Informational Phase		Conceptual Phase		Final project Submission	
	Media Used	Frequency of responses (%)	Media Used	Media Used	Frequency of responses (%)	Media Used
Conference calls	Google Meeting Microsoft Teams WhatsApp Discord Zoom Skype Don't usually perform	56,3% 31,3% 25% 18,8% 6,3% 6,3% 25%	Google Meeting Microsoft Teams WhatsApp Google Hangouts Discord Skype Don't usually perform	56,3% 43,8% 18,8% 12,5% 12,5% 6,3% 18,8%	Google Meeting Microsoft Teams WhatsApp Google Hangouts Discord Skype Don't usually perform	56,3% 31,3% 25% 18,8% 12,5% 6,3% 25%

source: authors

Approximately 23% of students do not normally hold video conferences during the execution of the phases of the Project Practice subject, as shown in Table 4. But the majority of those who do, hold their conferences in Google Meeting, Microsoft Teams, or Whatsapp. Discord appeared to be another frequently used medium.

Table 5 - Media commonly used by students in Design Practice disciplines to make phone calls, and frequency of responses.

	Informational Phase		Conceptual Phase		Final project Submission	
	Media Used	Frequency of responses (%)	Media Used	Media Used	Frequency of responses (%)	Media Used

Phone Calls	WhatsApp	43,8%	WhatsApp	37%	WhatsApp	31,3%
	Google	18,8%	Discord	12,5%	Google	18,8%
	Hangout	18,8%	Microsoft	6,3%	Hangout	12,5%
	Discord	6,3%	Teams	6,3%	Discord	3,6%
	Skype	3,6%	Google	50%	Microsoft	56,3%
	Microsoft	56,3%	Hangout		Teams	
	Teams		Don't usually perform		Don't usually perform	
	Don't usually perform					

source: authors

In addition to video conferences, at least half of the students say they do not make phone calls during the execution of the discipline subject phases. However, Whatsapp, Hangout, and Discord were mentioned more frequently as being used for this purpose by students.

#### 4. 2 Results of Section 2 of the form

When asked about the strategies (as described in the methodology section), students use to build documentation for the different stages of the project, students reported they used the "Puzzle" (43.8%) and "Cut and Paste" (37.5%) more often, followed by "Integrating Construction" with 31.3% and finally the "Sequential summative construction" and "Sequential Integration Construction", both with a frequency of 25%.

the most mentioned strategy combination was the "Cut and Paste" combined with the "Puzzle" strategy. Also, 3 students answered they used a combination of 3 of these strategies, and 4 students said they used a combination of 2 strategies to assemble collaborative documents in a virtual environment.

#### 4.3 Results of Section 3 of the form

The results of section 3 can be seen in table 6.

Table 6 - Averages of students' degree of satisfaction with the Design Practice subjects.

Dimension	Item	Min.	Max.	Average
<b>Access</b>	1. I was able to coordinate the attendance at this course with my work responsibilities	2	5	<b>3,18</b>
	2. The course information provided an overview that allowed me to organize my personal agenda properly.	2	5	<b>3,62</b>
<b>Tangibles</b>	3. The physical environment of the classroom aids learning.	3	5	<b>4,62</b>
	4. The technological resources were operating throughout the learning process.	3	5	<b>4,43</b>

<b>Reliability</b>	5. What I learned from this course is aligned with the course learning objectives.	3	5	<b>4,12</b>
	6. The learning objectives relate consistently to course contents.	2	5	<b>4,12</b>
	7. The learning strategy has increased my subject knowledge.	2	5	<b>3,81</b>
	8. The learning strategy has improved my skills in the subject.	3	4	<b>3,87</b>
	9. The theory and practice have been adequately balanced.	1	5	<b>2,93</b>
<b>Competence</b>	10. The instructor is knowledgeable in his/her field	3	5	<b>4,25</b>
	11. The instructors' professional experience fosters a better understanding of the subject	3	5	<b>4,37</b>
	12 The instructor provides good materials for properly follow up of the teaching sessions.	1	5	<b>3,37</b>
<b>Responsiveness</b>	13. The instructor responds quickly and efficiently to students' questions.	1	5	<b>3,87</b>
	14. The instructor properly coordinates students' interventions.	2	4	<b>3,31</b>
<b>Relevance</b>	15. The duration of the course is appropriate to achieve the intended objectives	1	5	<b>2,87</b>
	16. I can improve my professional competences because of what I learned	4	5	<b>4,18</b>

Source: authors, from the adaptation by González-Marcos et al. (2016)

The data in Table 6 presents students' satisfaction with the subjects' structuring, as well as the student's own performance and the teacher's tutoring. Satisfaction was assessed by using the average value of the Likert scale of the student's level of agreement for each of the items in Table 6. Results showed that, in general, students are neutral but satisfied (average of dimension items of 3.4) with the subjects' "Access" dimension. Also, students are satisfied with the "Tangibles" dimension (average of 4.52), satisfied but neutral with the "Reliability" dimension (average of 3.77), satisfied but neutral with the "Competence" dimension (average of 3.99), satisfied but neutral with the "Responsiveness" dimension (average of 3.59), and neutral but satisfied with the dimension "Relevance" (average of 3.52).

## 5. DISCUSSIONS

The media that students report as used the most for the collaborative and virtual execution of projects in Design Practice subjects are WhatsApp, used by 100% of students, Google Drive: 87.75%, Pinterest: 75%, and E-mail: 62.5% and Google Meeting: 56.3%. Google Drive and WhatsApp were the main file-sharing media cited, which may indicate that the "immediacy" and "parallelism" of Whatsapp configure it as a medium for sharing references, ideas, and informal conversations about the project. In turn, Google Drive, with its high degree of "Rehearsability" and "Reprocessability" (and its tools, such as Google Docs) can be perceived as a platform for the collaborative construction of the document, as well as the storage of project-related files, whether textual or visual.

An interesting aspect of the results concerns the use of Pinterest during the project. This social network is dedicated to the creation of mood boards, so it is reasonable to assume that the use of this media was motivated by the student's need for references and visual inspiration for their projects. This assumption is supported by a significant increase in the use of Pinterest in the Conceptual Phase (as opposed to the Informational Phase) and the clamming of authors such as Löbach (2001) and Baxter (2011) who state that concepts for solutions can be generated aided by visual references. This assumption may also be true - to a lesser extent - with Behance (project sharing platform) and Dribbble (artistic content community), even with them sharing a similar response frequency for all project phases.

The findings in this paper are, to some extent, consistent with those found by Aritz, Walker, and Cardon (2018) that show Google Docs as being the primary media used by students in our study. According to the study Google Docs (90.8%), e-mail (82.8%), video conferences (51.5%), text messages (41.6%), and phone calls (23.3%) are the most commonly used media by students. Also, our results showed a lower frequency of use of videoconferences, text messages, and telephone calls than the frequencies for these media found in the study by Aritz; Walker; Cardon (2018), and beyond that, our study showed a high frequency of students who do not use such media for academic purposes (It is worth noting that the study by Aritz, Walker, and Cardon (2018) does not specifically address the development of creative projects).

An assumption to explain this scenario may be the fact that students prefer to use their time for the projects via face-to-face meetings in the classroom instead of in the virtual environment. Despite not having the habit of carrying out videoconferences, those students who carry out them, usually use specific media for virtual meetings such as Google Meet and Microsoft Teams. This may be perceived as an adequate choice, due to the fact that virtual meetings tend to have degrees of efficiency equivalent to face-to-face meetings when the suitable media for that purpose is chosen. (Standaert; Muylle; Basu, 2022).

The findings concerning collaborative strategies for document construction in a virtual environment are similar to those found by Onrubia; Engel (2009) and Sundgren; Jaldemark, (2020), who found that students often use more than one strategy to build the same document. Another point to emphasize is that students prefer "parallel construction" processes (as defined by Onrubia; Engel, 2009).

With regard to student satisfaction, the data found in Section 3 of the form indicate that students are satisfied with the progress of the Design Practice subjects, as well as their individual performance in the learning process. The averages with a number above 4 on items 5, 6, 10, 11, and 16 of Table 6 illustrate this level of satisfaction. Despite general satisfaction with the subject, it is possible to assume that students are dissatisfied with the teaching dynamics proposed for the subjects, which would explain the low averages in items 9, 12, and 15 in Table 6.

Based on the results, it is possible to observe that students have a higher degree of satisfaction with items related to the subjects' learning objectives, the teachers' competence/knowledge, as well as their own learning. Another interesting aspect to be noted is that the average of item 16 is higher than that of item 8, that is, students believe that the learning process in the subject improves their professional skills more than their knowledge about the design process.

Still, in terms of satisfaction, data from our study show that the dimensions of "Tangibles" and "Competence" obtained the highest general averages of satisfaction, whereas the study by González-Marcos et al. (2016) discovered that the dimensions of "Competence" and "Responsiveness" obtained the highest general averages of satisfaction for their experimental group.

The data for dissatisfaction or neutrality for the items in Table 6 suggests that students' dissatisfaction with some items may be related to the short duration of the course (from the students' perception), or to the dynamics proposed by particular teachers, or even to the fact that all Design Practice subjects have the same syllabus (although different objectives and design problems). Despite these assumptions, it is worth noting that detailed investigations into the reasons for the answers provided by the students were not conducted, and thus there is no way to determine with certainty what is causing this dissatisfaction. Furthermore, the neutrality of agreement with statement 1 in Table 6 may have influenced the low level of satisfaction in all the items with the lowest average.

Dissatisfaction or neutrality with some items may be a consequence of the dynamics of the PBL itself, which, as suggested by Markha; Larmer; Ravitz (2008) should use knowledge from other subjects of the program. Since de PBL will not necessarily present new theoretical knowledge to the student, who in turn should be their own information search agent for the execution of the project.

## 6. CONCLUSION

The present paper clarified issues regarding collaborative teamwork strategies in virtual environments within the scope of design education. Initially, were identified a wide variety of media used for project execution in design education in a virtual environment, in this scope Google Drive and WhatsApp were the most used media. Furthermore, was observed that a specific media/platform may be used in all 3 phases of the design project, and when this happens, the frequency of usage may differ for each stage. Pinterest, for example, was used more during the creative / idea generation and finalization/design specification stages than in the stage for information/data searching. Another important factor found is the large number of students who do not customarily participate in videoconferences or phone calls.

For the collaborative construction of documents, it was observed that students often use parallel construction strategies, in which team members work in parallel, and later, combine the result of their individual productions, without there being, necessarily, collaboration in the elaboration of the individual parts. A combination of strategies was also observed, with the most frequently used being those in which each student inserts a part of the assignment and the final document is formed by joining the different parts of the same assignment, in conjunction with the strategy in which each student presents a complete task and the final document is composed by extracting parts of each of the assignment to compose the final document.



In terms of student satisfaction, although satisfied with the PBL-based subjects, this satisfaction appears to have been negatively influenced by the time available to complete the project and the balance between theory and practice.

Despite the findings, it is worth noting that the current study did not investigate the reasons for media selection by the students, the choice of collaborative processes, or the specific events that triggered satisfaction or dissatisfaction with the subjects. As a result, it is not possible to precisely state the students' motivations, and it is suggested that future studies that delve into these aspects be conducted.

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