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INVERTED CLASSROOM TO ENHANCE ENGAGEMENT AND CRITICAL THINKING

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ABSTRACT
The Flipped Classroom or Inverted Classroom Model (ICM) has been gaining increasing attention in recent years. This student-centred pedagogical approach has been practiced in various educational fields, but minimally in design pedagogy. The aim of ICM is to *disrupt* the passive approach of conventional learning. The model seeks to engage students actively in their learning experience and *transform* the classroom setting into a participative, creative and dynamic environment which, in return, can *regenerate* critical and innovative ways of thinking. The paper aims to explore the implementation of ICM within a graduate design course. More precisely, it seeks to understand the implications and influence of ICM on students' learning experience, engagement, and critical thinking. By analysing students' answer to a short online questionnaire, we discuss the challenges and benefits related to the organisational dynamics of an ICM course, some consequences on learning outcomes and teamwork, as well as specifics related to the teaching approach. These will eventually help in finding ways to improve ICM as an innovative pedagogical strategy for future graduate design courses. In the end, the study suggests that an ICM-inspired seminar can not only help foster critical thinking, and class engagement, but also help students to develop collaborative skills. The learning experience shared in this paper is an attempt to establish a framework for future design educational practices, coupling the teaching of theoretical notions with active learning experience - most typical to designers.

Keywords: Inverted classroom model, design pedagogy, engagement, learning experience

1 INTRODUCTION
The Inverted Classroom Model (ICM), also known as Flipped Classroom is a pedagogical innovation to learning and teaching that has been mostly utilised in various disciplines of higher education – mainly including fields such as Science, Technology, Engineering, and Mathematics [1]. While ICM has received praise by many, there seem to be limitations to its application as the new pedagogical standard for learning and teaching. It is also noted that research on learning experiences have been mostly focusing on high school or undergraduate contexts. In that respect, we noticed that ICM has not been widely implemented and studied in design education.
More specifically, in this paper, we propose to explore the implementation of ICM in design education and study its inherent role in instilling reflective thinking in design practice. Ultimately, we aim to contribute to training students in becoming thorough researchers, professionals, and practitioners concurrently. In that sense, this study seeks to answer the following questions: (1) What implications could ICM have for design graduate courses? (2) How does this pedagogical shift affect students learning experience? (3) How can we enhance this approach to better support student success?
The first section of the paper introduces the theoretical groundings of the inverted classroom approach. Then, a few paragraphs will describe how this approach was tentatively applied as part of a graduate-level design seminar. Before presenting the research findings, the data collection process organised around an online questionnaire, is explained. The findings are presented in the fourth section of the paper, along with a discussion that sheds light on ways to improve ICM as a pedagogical tool for design graduate courses. The study concludes with a reflection on the limits of ICM, together with the implication for future use and research.

2 INVERTED CLASSROOM MODEL

Chen et al. [2] present inverted classroom as a form of "blended learning" in which both online and traditional in-person methods are alternatingly used for teaching. According to Green et al., [3], this educational model was first introduced by Colorado high school teachers, Bergmann and Sams. After experimenting with pre-recorded lectures and noticing their underlying benefits on student success, these teachers decided to further implement ICM, and promote it as an educational practice [4]. Similar initiatives have also taken place by other instructors as a way, to ensure the optimisation of student learning *beyond* the classroom setting.

In general, the aim of ICM is to disrupt the conventional and passive learning experience of students that restricts them to the boundaries of the physical classroom setting and places them as mere recipients of information. It relies on their engagement prior to the classroom, as they individually delve into the subject matter at their own pace and liking [5]. Out-of-class learning activities may include readings, narrated presentations, video-recorded lectures [6]; all of which are coupled with learning "incentives" like written assignments, discussions, or pre-class quizzes [7]. This tailored learning is followed by classroom activities where students get to apply what they learn, explore, collaborate with peers, and deliberate with professors. Such an approach builds on active learning in a collaborative and dynamic setting.

Numerous studies have revealed the benefits of the inverted classroom model on students as it increases their motivation [8], attendance [9], performance [10], satisfaction [11], and personal growth [12]. Hence, the approach helps foster the overall learning experience and promises to increase student retention and, most importantly, their success. The next section will introduce in more detail how the ICM approach was put into practice as part of a graduate level applied design course.

2.1 Application of ICM at graduate level

A tentative application of ICM was integrated as part of a first-year graduate seminar. The seminar entitled "Innovative approaches for design" focused on design thinking and innovation. It was coordinated by the first author of this paper at the Faculty of Environmental Design at University of Montreal.

The seminar was composed of guided discussions amongst students, theoretical presentations by the professor, and a guest lecturer. The enrolled students came from different masters' programmes such as "Theories in design", "Design, creation, innovation", and "Urban planning". The class took place during the autumn semester of 2021, 3 hours every week for 10 weeks. The learning objectives of the seminar were: (1) to understand and acknowledge the recent developments related to design research, (2) to develop efficient collaborative mechanisms, (3) to be able to understand and co-construct a complex problem and identify innovative solution paths, (4) to learn about the various design processes and approaches and use them in appropriate contexts, and (5) to mobilise innovative approaches to deal with ill-defined problems.

For 7 weeks, classes followed the ICM structure and asked for some preparation from both students as well as the professor. As a first step, the inverted structure of the course required preparatory work from students before each class. Each week, two journal articles were suggested as readings to the students. The readings treated topics such as design thinking, innovation, ill-structured problems, and design process. Before the beginning of each class, a 200-word summary of each article as well as three questions related to the topic, had to be submitted online. These questions were compiled to acknowledge students' inquiries on the article's subject before some of these questions were randomly distributed among small teams of students. About 45 minutes were allocated for team discussions while the professor went from team to team to interact and stimulate these discussions. Teams were asked to schematise their ideas and present their conclusions to the class. Once this preparation was done in the first part of each seminar, the students were well-prepared and ready to receive a short, and more traditional lecture-style teaching. As students were aware of the content in advance, they were able to discuss, ask questions, or comment on the course material. The last 3 weeks of the seminar's weekly schedule encouraged students to get together to carry out various exercises to apply the knowledge acquired on processes and innovative strategies according to different complex situations.

3 DATA COLLECTION

The data collection organised as part of this research is based on a qualitative approach. A short questionnaire aiming to get a sense of students' learning experience of the studied ICM design graduate

seminar was introduced. The questionnaire was sent out to students by email via Google Forms a few weeks after the end of the semester and was administered in French. It was composed of 5 open-ended questions pertaining to the students' level of engagement, the challenges they faced, and the development of their critical thinking (questions are translated and presented in the next section). In total, 9 students out of 19 answered the questionnaire anonymously.

4 DATA ANALYSIS

This section will present the distillation of the research results according to the five questions of the questionnaire. These serve as a synthesis of the student's appreciation of the seminar and point to both positive and negative aspects of their learning experience. Before sharing this synthesis, the following Figure 1 identifies the variety of terms used by the respondents in the questionnaires (in alphabetic order) to describe their experience of the seminar.

Learning experience	Engagement	Critical thinking	Challenges	Improvement
Autonomy	*Active participation*	*Appropriation*	*Collaboration difficulties*	*Defining concepts from the start*
Beneficial	*Dynamic*	*Autonomy*	*Divergent views*	*Develop a common vision*
Chaotic	*Emotional commitment*	*Brainstorm in groups*	*Diversity of concepts*	*Discussions*
Connected-	*Framing of discussions*	*Build your own argument*	*Diversity of members*	*Diversity*
Different	*Improvisation*	*Confrontation*	*Evaluation criteria*	*Explanations of concepts*
Disorganized	*Investment*	*Discovery*	*Fast communication*	*Evaluation criteria*
Familiar	*Routine*	*Diversity of opinions*	*Fast pace*	*Frequent and quick returns*
Freedom	*Speaking*	*Expression*	*Further explanations*	*Global feedback at the start of the course*
Good	*Stimulating*	*Flexibility*	*Insecurity*	*Learning objectives*
Initiative	*Time and energy*	*Influence of others*	*Integration*	*Links between theory and the real world*
Interesting	*Time-consuming*	*Judgment*	*Large group*	*Number of people per team*
Memorable	*To ask questions*	*Knowledge transfer*	*Listening*	*Quantity of concepts*
Personal	*True interactions*	*Left to himself*	*Multidisciplinary*	*Time allocated to activities*
Positive		*Put into practice*	*Opinions left out*	
Proactive		*Redirects*	*The team at the heart of the project*	
Stimulating		*Strong critical thinking*	*Time and schedule*	
		The emergence of points of view	*To be in the dark*	
		Theory enrichment	*Understanding of texts*	
			Work habits	

Figure 1. Overview of the vocabulary used by the respondents

Q1. How did you find this learning experience?

Six respondents out of 9 were in favour of this learning approach. In fact, their appreciation of this learning experience was expressed using words such as "autonomy", "liberty", "initiative", and "self-organisation". One participant highlighted how the approach helped in adopting a "proactive mindset instead of a reactive mindset". Yet, four respondents out of nine mentioned that they felt rushed in learning the class material and did not have enough time to participate actively to class discussions on theoretical notions.

Q2. Compared to a standard lecture teaching formula, did the seminar's approach contribute to create a different level of engagement on your part?

All respondents found that this learning approach promoted their engagement in class. The students mentioned that the seminar's approach encouraged them to get prepared and actively participate in class activities. It also contributed to create a "dynamic", "collaborative", "stimulating", and "engaging" learning environment. One student highlighted that "the improvised aspect [of the seminar] was extremely engaging on an emotional level, compared to a standard theoretical seminar."

Q3. Did you find that this learning experience favoured the development of critical thinking?

Seven respondents out of nine strongly expressed that the seminar supported the development of their critical thinking skills. Through their answers, we believe that the theoretical component of the seminar also played a role in developing these high-level skills. However, three respondents also noted that the theoretical concepts discussed in class could have been implemented more proactively as part of hands-on activities to better support their comprehension of the theory and its impact on design activities. The dichotomy between theory and practice will be discussed in more detail in the discussion of this article.

Q4. Did you encounter any challenges or difficulties over the weeks? Which ones? How could these challenges or difficulties be avoided?

Four of the respondents mentioned difficulties regarding their work in class. In fact, two of them found that the discussions within teams of five to six were difficult as they did not favour the convergence of

ideas and opinions. On the other hand, two other students mentioned that they experienced challenges regarding their comprehension of the proposed readings – especially when the papers presented complex theoretical notions that were new to them. Moreover, the time factor was a recurrent topic in the answers of the respondents. Students felt like they always needed "more time" to have additional discussions, explanations on theoretical notions or models, and practical tools or approaches.

Q5. If this learning approach was to be repeated in the future, do you have any suggestions for improving its design or your learning?

A suggestion common to all respondents was related to time allocation. They wanted to have more time for team discussions with the participation of the professor, allowing them to address questions and deeper understanding of the concepts presented in each article. One wrote "structure discussion periods with the supervision of the professor". The other time-related suggestion was to allow periods, each week, for applying the theoretical learnings into practice. We grouped other comments into two categories: one is related to course content and the other related to class organisation and dynamics. Figure 2, presented in the next section illustrates these findings. The synthesis of the questionnaire's answers leads us to note that the students appreciated globally their inverted classroom experience, but that specific improvements could enhance the impact on learning. The next section will discuss a few recommendations and their potential impact on the seminar's dynamics.

5 DISCUSSIONS

The seminar was implemented for the first time as part of a new curriculum for a master's programme. To improve the seminar for future implementations, as identified in the answers of the respondents, we will need to target both content and class organisation (Figure 2). Some of these recommendations are discussed in the present section, and target: the organisational dynamics of the seminar, difficulties relating to understanding key concepts, team management issues, and the division between theoretical concepts and practical applications.

Course content	Class organisation and dynamics
	Student-teacher dynamic
Clarify the evaluation criteria and learning objectives	*Allocate more time for frequent feedback*
Elaborate on the link between theory and practice	*Allow more time for the practical/concrete application of theoretical notions*
Explain the concepts to the entirety of the class instead of to certain groups	*Allow more time for in-class activities (explanations and discussions on concepts with the teacher)*
Limit the number of concepts/theoretical notions in the course	**Groups dynamic**
	Diversify the members of the group
	Limit the number of people per group

Figure 2. Two shortlists of recommendations (in relation to question 5 of the questionnaire)

(1) Organisational dynamics of the seminar. Working on the basis of action-research, the seminar was planned broadly at the start of the semester and was adjusted according to class feedback. The action-research process is defined by a four-step cycle: planning, acting, observing, and reflecting [13]. Stringer [14, pp. 8-9] describes action-research with a "basic routine" composed of three interrelated actions: look, think, and act – which "should be read as a continually recycling set of activities".

As such actions were being guided by the professor, some students felt that the course was *disorganised.* This was a reaction to the adaptation of course content which was adjusted throughout the semester in response to student reactions. In that sense, action-research asks for an ease with improvisation, managing unexpected events, and rapid responses to questions and time management issues. Students are often much more comfortable with detailed and structured activity instructions and evaluation grids, which offer clear guidelines to perform according to a course requirement. Still, the overall students' appreciation ranged from a positive perspective, defined by individual autonomy, to a negative perspective, characterised by an impression of a lack of organisation.

(2) Difficulties understanding key concepts. These difficulties could be explained by the fact that (a) most students were French educated, and English was their second language, and (b) the background education of students were professional studies with no or very little experience in reading scientific articles. The course content is aimed at demystifying and offering a theoretical understanding of notions discussed by design researchers (i.e., Cross, Dorst, Schön, Valkenburg, Hobday, et al., Lorenz, von Stamm, and Kvan). The following notions were elaborated on: "*design thinking*", "*design processes*",

"*innovation*", "*wicked problems*", "*interdisciplinary collaboration*", "*co-reflexive practice*", "*framing and reframing*", "*problem setting*", "*problem finding*" and "*critical thinking*". As these notions are complex, connected to each other, and can have many angles and interpretations, students had to, not only achieve a broad understanding of these notions but also understand the relationship between them and their implication in design practice. One student suggested to develop, with her team, a lexicon of definitions of important words. This request shows that students can be uncomfortable with less clear, unstable, and multifaceted definitions.

(3) Team management issues. Singh et al. [15] note that familiarity of teammates does contribute positively to facilitate team collaboration as teammates are more aware of each other's patterns, forces, and expertise. Within this case, team management issues seem to be related to the unfamiliarity of teammates as students came from different backgrounds, fields of study, and countries. These differences may have contributed to the need for more team support.

(4) Theoretical concepts and practical applications. A last general observation as a result of our analysis regards the division between the comprehension of theoretical notions and their application as part of class activities. In educational research, knowledge can be distributed across five types: scientific, applied, strategic, praxis, and practical knowledge [16]. The seminar played on varieties of these types. First, scientific lectures were used to guide discussions and class interactions. Second, applied and practical knowledge was solicited through class activities, which also asked for strategic thinking through critical thinking. Although both theoretical and practical applications asked students to be proactive, it might also be a cause of stress as students had to navigate between a plurality of knowledge types.

6 CONCLUSIONS

The overall student perceptions of the "Innovative approaches for design" seminar were mainly positive. This proves the benefits of the ICM approach, compared to other traditional learning methods. As this study revealed, this innovative approach not only helped in promoting student engagement and participation but also improved their critical thinking. Through student questionnaires, we were able to identify some of the gaps that could enhance this pedagogical approach for future graduate design seminars. These include giving more prominence to understanding complex notions, managing teamwork, applying theoretical notions, and clarifying seminar structure and organization; all of which could help in better supporting student success. Theoretical class discussions and practical group activities allowed for the development of students' collaborative skills through informal confrontations which encouraged to negotiate their way toward a common understanding and reaching consensus [17]. Future research may benefit from looking at how ICM could be used as a tool to promote cross-collaboration between graduate design students.

As an educator, the first author of the paper looked at this opportunity through the lenses of action-research, as explained earlier. She approached the planning and the implication of the course, on the one hand, based on her pedagogical knowledge and experience, and on the other hand, from her practice as educator and a designer. Elements of uncertainty and uniqueness, as explained by Schön [18] were present during the sessions and had to be dealt with. Uncertainty of the situation was about problems that could not be predicted (i.e., activities that took more time than planned, class questions that broaden the discussions). The situation of uniqueness (i.e., teams that were not functional) were presenting themselves and she needed to find ways to work with them as she couldn't apply any rules or procedures to manage them. We believe that by explaining and reflecting on these situations, with students, these complex and unique situations can be transformed into experiences that are useful and enriching. The ICM created the space for reflection on "knowing-in-action" [18] and the opportunity to learn for future situations.

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