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The Effect of Design Thinking On the Implementation of a Constructivist Teaching Approach: Teachers' Perceptions

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***Abstract*— The higher education sector is undergoing profound changes today. It is indeed facing several challenges for many reasons. In this article, we combine the capabilities of design thinking with the principles of constructivist learning theory. Design thinking is an agile and human-centered innovation approach to solving complex problems in organizations, while constructivist learning is based on the idea that the learner develops his or her own knowledge based on a specific mental activity. We examine the impact of design thinking capabilities on the implementation of a constructivist pedagogical approach in higher education institutions. We conduct a quantitative study by administering a questionnaire to university professors to identify their opinions regarding the implementation of a constructivist pedagogical approach based on design thinking. A sample of 213 university professors responded to the questionnaire on a 7-point Likert scale.**

The results and future perspectives discussed highlight the importance of including the constructivist approach to develop 21st century skills in students by integrating design thinking as a flexible approach to facilitate the implementation of innovations.

Keywords: Design Thinking; Constructivist Learning; Higher Education; Pedagogical Innovation.

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I. INTRODUCTION

In an era marked by constant change, the 21st century students need to be equipped with many skills beyond technical ones in order to keep up with organizational and environmental changes.

A few years ago, learning was linear for both students and professionals. Today, it is becoming more and more unpredictable and it is rather in search of profiles with human qualities. These qualities are diverse and varied, such as autonomy, flexibility, teamwork, creativity, emotional intelligence, motivation, critical thinking, complex problem solving.

Confronted with these requirements, professors need to implement teaching methods that involve the student in the learning process and combine the technical and behavioral skills necessary for success.

Design thinking as an agile and human-centered innovation approach seems to be one of the most promising recovery paths to meet contemporary demands. Indeed, several authors have argued that the application of design thinking in organizations can help develop the skills needed to deal with complex problems and uncertain situations (Kurtmollaiev et al., 2018).

Relying on Design Thinking in the pedagogical approach could be a complement to technical and analytical approaches, involve students in the learning process and prepare them for a successful professional career (Glen et al., 2014).

In this perspective, several schools have incorporated design thinking into curriculum to enable students to be more innovative and creative (Beckman & Barry, 2007; Kimbell, 2011; Liedtka & Ogilvie, 2011; Boni et al., 2009; Glen et al., 2014).

Moreover, applying design thinking in learning processes also means revisiting teaching methods and adopting modern, and interactive teaching methods that enhance the student's personality and promote the 21st century skills, hence constructivist learning.

Constructivist learning is a learning theory developed by Piaget in 1923. This method is becoming more and more popular and used because of the current context and its positive impact on the learner. The objective of constructivist learning is to engage the student in acquiring knowledge, exploiting it in concrete cases and developing skills and feelings to overcome any learning ambiguity.

Design Thinking will allow us to evaluate the degree of appropriation of constructivist learning by professors in higher education institutions.

We assume that design thinking, being an agile, human-centered, complex problem-solving innovation approach, contributes to the application of a constructivist learning theory. Through our paper we investigate whether the capabilities of design thinking impact the dimensions of constructivist learning, namely student engagement, learning environment and the balance between construction and

destruction.

Aims and Research Question

Thus, we aim to address the following issue: **To what extent can design thinking capabilities improve the implementation of a constructivist teaching approach?**

To answer this question, the empirical study which we will conduct through a questionnaire, will be addressed to professors of higher education in a Moroccan university located in the city of Fez: The University of Sidi Mohamed ben Abdellah.

The aim of this study is to identify the opinion and perception of different professors of higher education on the influence of design thinking capabilities on the implementation of a constructivist pedagogical approach.

In Morocco, the higher education sector also faces a multitude of challenges and requirements that influence the soundness of teaching, which are:

- The need to teach soft skills.
- The need to provide students with professional experience in addition to theoretical skills.
- The obligation to master foreign languages and to introduce the student to entrepreneurship and innovation.

In this very sense that the present work is centered around the following points: firstly, it will present design thinking and the constructivist teaching approach and, secondly, it will present the impact of design thinking capacities on the implementation of a constructivist teaching approach within higher education institutions through the presentation of the results of this study.

II. THEORY AND METHOD

In this section, the theoretical and methodological principles used in this study are outlined, starting with a description of design thinking and constructivist learning, continuing with sample and data collection and finally, concluding with descriptions of the thematic analysis conducted.

Design Thinking

Since the emergence of the concept of design thinking, a number of authors have attempted to provide definitions:

- Design thinking refers to a human-centered approach to innovation that relies on non-linear thinking that alternates between divergent and convergent thinking (Brown, 2008). Brown also adds that the goal of design thinking is to propose innovative solutions that balance three key points: viability, feasibility and desirability (Brown, 2008).
- Buchanan also defines design thinking as an innovation approach to solving complex problems within organizations (Buchanan, 1992).
- Design thinking is also defined as a process whose objective is the creation of solutions that do not rely solely on analytical and traditional methods. Creativity, systems thinking, iteration and flexibility being its key tools, this innovation approach can be useful in many areas (Koria et al., 2011)

Overall, we can say that design thinking is an innovation approach that takes the human as a starting point throughout its entire approach, which is based on creativity, collaboration, iteration, the right to make mistakes and flexibility, regardless of its field of application.

Moreover, the achievement of Design Thinking is based on a set of essential steps that constitute our research variables in this article: Empathize, Define, Ideate, Prototype and Test.

The figure below illustrates the stages of design thinking presented by the d. School of Stanford University:

These steps are carried out in a non-linear way and are a continuous, iterative learning process until the most effective solution is achieved (Van Pelt & Hey, 2011). Ideas are co-constructed and improved as they are prototyped and tested. By the same token, (Gillibert et al, 2016) argued that a creative solution "needs to be prototyped, experimented with, improved and tested again. It is therefore its experimentation that will make it evolve test after test, to obtain the solution that will finally be implemented."

The first step of design thinking, "Empathy", goes beyond quantitative and qualitative studies to understand the customer's needs. This stage is based on the study of feelings through ethnographic studies, observations, interviews and an immersion in the world of customers to whom the solutions will be addressed for a total experimentation in their everyday life.

Next come the "Definition" and "Ideation" stages, which evolve together with constant iteration and overlap between the stages until the problem-solution pair is well defined (Cross, 2001). The definition of the problem and the possible solutions is essentially based on brainstorming sessions, collaboration and close co-creation among all the project's stakeholders.

The fourth step is related to "prototyping", which involves prototyping the ideas provided in the third step through digital or physical artifacts.

The objective of these artifacts is to make the ideas tangible and to collect the customers' opinions on the proposed solution during the last stage, "Testing" (Brown, 2008).

Iterative work is conducted during these stages until the most effective solution is obtained (Schweitzer et al., 2016)

Constructivist Learning

Piaget, the founder of the constructivist learning theory, states that if today we are looking for student profiles with so-called "key" skills that will enable them to deal with the complex problems of today's environment, we are supposed to focus first on the learning environment because teaching skills such as creativity and critical thinking are linked to the integration of the constructivist approach in learning environments (Rhinow et al., 2012) ;

Constructivist learning can be defined as a theory of self-learning where the learner constructs and reorganizes

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knowledge based on individual experiences (Kolb, 1984). The implementation of this approach contributes to the creation of a learning environment that breaks with traditional linear learning methods and reconfigures the teacher-student relationship.

According to (Freire, 2000), the constructivist learning theory is based on the principle that knowledge is not a capacity that some people have and others do not, but rather the acquisition of knowledge is constructed based on the exchange of ideas between individuals and the formulation of problems according to their experiences and points of view. The principle of constructivist learning is based on a set of steps that individuals put in place to seek, create, and reorganize knowledge in an individual way (Freire, 2000; Kumar Shah, 2019).

In light of all of the above definitions, we can say that the constructivist learning theory presents a double challenge for both teachers and students. The latter must learn to juggle and balance between classical pedagogical knowledge, their own experiences, and the cultural and social context in which ideas appear, all of which serve to moderate and guide understanding (Windscbitl, 1999).

Furthermore, the implementation of constructivist education is based on three essential principles that constitute our research variables in this article, namely (Rhinow et al., 2012):

- The student engagement
- The learning environment
- The balance between instruction and construction

Hypotheses

Taking into account all the considerations above, our study proposes to investigate professors' perceptions of the impact of design thinking capabilities on the implementation of a constructivist teaching approach in higher education.

In order to provide a theoretical framework, we formulate the following hypotheses

H1: Empathy positively impact the implementation of the constructivist approach in higher education settings;

Empathy positively influences student engagement (H1a); Empathy positively influences the learning environment within a constructivist teaching approach (H1b); Empathy positively influences the balance between instruction and construction in a constructivist teaching approach (H1c)

H2: Define positively impact the implementation of the constructivist approach in higher education settings

Define influences student engagement in a constructivist teaching approach (H2a); Define positively influences the learning environment in a constructivist teaching approach (H2b); Define positively influences the balance between instruction and construction in a constructivist teaching approach (H3a)

H3: Ideate positively impact the implementation of the constructivist approach in higher education settings;

"Ideate" positively impact student engagement in a constructivist teaching approach (H3a); "Ideate" positively influences the learning environment in a constructivist teaching approach (H3b); "Ideate" positively influences the balance between instruction and construction in a constructivist teaching approach (H3c);

H4: Prototype positively impact the implementation of the constructivist approach in higher education settings;

"Prototype" positively influences student engagement in a constructivist teaching approach (H4a); "Prototype" positively influences the learning environment in a constructivist teaching approach (H4b); "Prototype" positively influences the balance between instruction and construction in a constructivist teaching approach (H4c);

H5: Test positively impact the implementation of the constructivist approach in higher education settings;

"Test" positively influences student engagement in a constructivist teaching approach (H5a); "Test" positively influences the learning environment in a constructivist teaching approach (H5b); "Test" positively influences the balance between instruction and construction in a constructivist teaching approach (H5c);

The diagram below constitutes our conceptual framework and summarizes the different components of design thinking and their links with the constructivist teaching approach, which constitutes our second variable.

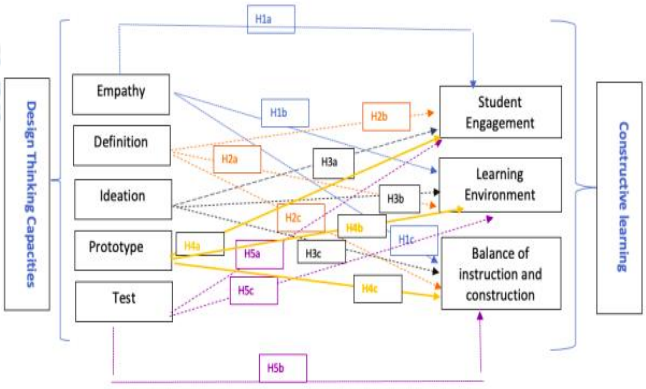

Figure 1 : Conceptual Framework

Student engagement is an extremely important part of the constructivist learning process. This engagement depends on several factors, such as the student's personal skills, the teacher's skills and attitude, the perception of other classmates(Abdullah et al., 2012). Design thinking skills such as empathy, for example, can also contribute significantly to student engagement. (Richardson et al., 2012) state that students are more likely to be engaged in the learning process when they have a positive and close relationship with the teacher. An emphatic teacher increases student engagement, improves outcomes and the learning

environment(Wang et al., 2022). In addition to empathy, immersing the student in the process of solving problems contributes significantly to the student's learning, autonomy and initiative (Haley et al., 2021). The learning environment is also an essential criteria for the implementation of constructivist learning (Rhinow et al., 2012). Class size, equipment (e.g., lighting, basic equipment), group size, etc. are important elements that strongly influence student motivation and engagement. S According to (Honebein, 1996), a constructivist learning environment should be based on the following elements: Embed learning in realistic and relevant contexts; Engage the student in a problem-solving process to test different ideas and increase their understanding; Involve students in the learning process and allow them to define their own learning objectives; Implement learning through social interaction among stakeholders: Teachers and Students. As we argued earlier, the balance between instruction and construction is also critical to the success of constructivist learning. Although the teacher's role is limited to facilitating learning and not transmitting it, the teacher must also ensure good construction of learning. Finding a balance between instruction and construction is a major challenge for teachers. A successful course is one that manages to balance instruction and construction, according to (Rhinow et al., 2012) "Instruction by construction."

To sum up, the authors believe that the capabilities of design thinking help in the development and implementation of a constructivist teaching approach. These capabilities encourage students to discover, to be creative, to be critical... Design Thinking makes it easier for the teacher to implement a constructivist learning process. Through our empirical study, we will attempt to explore the context of Moroccan higher education. To date, very few studies have been initiated in this area, which constitutes an opportunity for us to explore a new teaching method in Moroccan universities, particularly the University of Sidi Mohamed Ben Abdellah in Fez.

III. METHODS

The sample chosen for our research is made up of teachers from different institutions of the University Sidi Mohammed Ben Abdellah (USMBA); we collected 213 responses.

Our objective was to address the impact of design thinking capabilities on the implementation of a constructivist pedagogical approach, by identifying the perception of the main instigators, namely the teachers that we have grouped into different categories:

- Full Professors (Professeur de l'enseignement supérieur, P.E.S);
- Associate Professors (Professeur habilité P.H):
- Assistant Professor (Professeur Assistant, P.A);
- Part-time Professor (Professeur Vacataire);

The responses obtained stem from the twelve USMBA institutions, which confirms a certain rationality and a coherent and realistic distribution of the results. These institutions are as different as they are complex in the learning methods used; this is often due to the type of access of the institution in question; a faculty with open access will undoubtedly not have the same pedagogical approach as an institution with closed or regulated access. It also depends on the domain and the disciplinary field of the different institutions.

In addition, the Covid-19 crisis conditioned our survey and constituted a significant obstacle that we were able to overcome thanks to the online administration method.

The survey was conducted between November 2021 and April 2022.

The procedure that we will choose is based on the administration of a questionnaire constructed through literature review. According to Evrad and All (2000), the methodology is of paramount importance to develop a questionnaire; we followed a simple and precise approach to have consistent responses in three key steps:

- Define the necessary information;
- Choose the mode of investigation best suited to the context;
- Establish coherent measurement scales for the variables.

Our target audience is the professors of the various USMBA institutions.

The chosen management mode is the administration of the questionnaire online with the objective of collecting a maximum of responses; this method is more efficient in a context of health crisis and it has several advantages:

- It allows keeping the anonymity for the respondents, thus ensuring the veracity of the answers;
- It is less costly for the researcher and the respondent (the cost is almost zero);
- It is fast and allows approaching a majority of people;
- The collection of responses is performed automatically and instantaneously.

To conduct our empirical study, we administered a questionnaire as specified where we used a seven-point Likert scale ranging from "Strongly agree" to “Strongly Disagree" to "Strongly Agree".

We measured all our variables by performing a double analysis:

- An exploratory factor analysis to clean up our measurement scales: AFE
- A confirmatory factor analysis to evaluate the reliability and validity of our variables and to test our variables: CFA

To carry out this study, we used two software programs: SPSS 25 and AMOS 21.

IV. RESULTS

Design thinking is represented by 5 variables: “Empathy”, “Define”, “Ideate”, “Prototype” and “Test”. To measure these variables, we mobilized several variables based on the work of several authors (Adams et al., 2011; Brown, 2008; J.

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Blizzard et al., 2015). After performing the EFA we eliminated items with low representational quality < 0.5: items that deteriorate Cronbach's alpha, items with saturation < 0.5, and factors returning a significant percentage by the EFA.

- Empathy: For the variable, empathy, we mobilized 12 items. After cleaning, we were able to eliminate 7 items and we kept 5 items (KMO = .878); (Bartlett's test of sphericity = .000); (Cronbach's alpha coefficient = .941) (Table 1 summarizes the obtained results)
- Define: To measure "Define" variable, we mobilized 9 items based on the research of several authors (Adams et al., 2011; Brown, 2008; J. Blizzard et al., 2015). After cleaning, we were able to eliminate 3 items and kept 6 items (KMO = .899); (Bartlett's test of sphericity = .001); (Cronbach's alpha = .909) (Table 2 summarizes the obtained results)
- Ideate: To measure "Ideate" variable, after cleaning we were able to eliminate 7 items and we kept 4 items (KMO = .799); (Bartlett's test of sphericity = .000); (Cronbach's alpha coefficient = .837) (Table 3 summarizes the obtained results)
- Prototype: To measure "Prototype" variable, we mobilized 6 items; after cleaning we were able to eliminate 2 items and we kept 4 items (KMO = .740); (Bartlett's test of sphericity = .000); (Cronbach's alpha coefficient = .794) (Table 4 summarizes the obtained results)
- Test: To measure "Test" variable, we mobilized 6 items. We kept all the analyzed items (KMO = .869); (Bartlett's sphericity test = .001); (Cronbach's alpha coefficient = .913) (Table 5 summarizes the obtained results)

Constructivist learning is represented by 3 variables: student engagement, learning environment, balance of instruction and construction.

- Student engagement: We measured student engagement by mobilizing 12 items based on the work of several authors (Hunt, 2003; Gijbels et al., 2006). After cleaning, we were able to eliminate 6 and keep 6. The results obtained are as follows (KMO = .887); (Cronbach's Alpha = .868); (Bartlett's Sphericity Test = .000) (Table 6 summarizes the obtained results)
- Learning environment: We measured the learning environment by mobilizing 6 items based on the work of several authors (Hunt, 2003; Gijbels et al., 2006). After cleaning, we kept all the items analyzed. The results obtained are the following (KMO = .858); (Cronbach's Alpha = .863); (Bartlett's Sphericity Test = .000) (Table 7 summarizes the obtained results)
- Balance between instruction and construction: We measured the balance between instruction and construction by mobilizing 6 items based on the work of several authors (Alanazi, 2019). After cleaning, we kept the set of analyzed items. The results obtained are as follows (KMO = .859); (Cronbach's Alpha = .870); (Bartlett's Test of Sphericity = .000) (Table 8 summarizes the obtained results)

After cleaning the measurement scales using exploratory factor analysis, we conducted a confirmatory factor analysis to test the validity of our factor structure. This analysis was conducted in AMOS 21 using the LISREL method which is based on the maximum likelihood approach (Hoyle, 1995). The indicators used to verify the goodness-of-fit of the measurement model are: the χ 2 test, CFI, NFI, RMSEA. We also performed tests to verify the viability of the model: Jöreskog's Rhô (Roussel & El Akremi, 2002), the T-test, Average variance extracted. The results obtained confirm the validity and reliability of our variables. Indeed, the coefficients of representativeness are all higher than 0.5, which is satisfactory**.** The T-test is very representative since it presents a value higher than 1.96. Also, the average variance extracted (AVE) presents a largely acceptable value higher than 0.5. Finally, the coefficient of Rhô of Jöreskog registers a good value since it is superior to the threshold 0,7. However, the "Ideate" variable does not meet the criteria of adjustment of the measurement model, the RMSEA is not representative and the AVE is lower than 0.5. The viability of the construct is not confirmed; this is possibly due to the lack of adequacy of the theoretical data with the empirical data.

Next, we checked the causality between our variables in order to test our research hypotheses under the AMOS 21 software. At this level, we mobilized the following indicators: regression coefficients, Critical Ration and the significance coefficient. For all the hypotheses tested, the results are conclusive (t>1.96; the coefficient of significance <0.5). Finally, the coefficient of Rhô of Jöreskog registers a good value since it is higher than the threshold 0.7. However, the variable "Ideate" does not meet the criteria of adjustment of the measurement model; the RMSEA is bad and the AVE is lower than 0.5 (Figure 5; 6 & Table 13; 14 summarizes the obtained results). The viability of the construct is not confirmed. This may be due to the lack of adequacy of the theoretical data with the empirical data.

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V. DISCUSSION

The objective of our study is to analyze the existing relationship between design thinking abilities and constructivist learning. The quantitative results obtained show that design thinking capabilities facilitate the implementation of a constructivist teaching approach, improve student engagement, learning space and facilitate

the balance between instruction and construction. This supports the recommendations of (Rhinow et al., 2012) that design thinking builds skills and competencies by relying on an iterative and agile approach and design thinking;

Overall, our study provides evidence for the effect of design thinking capabilities, it also provides general support of the theoretical model that (Rhinow et al., 2012) outlined. We have found a positive impact of empathy on dimensions of constructivist learning (Student Engagement; Learning Environment; Balance between construction and instruction). In some respects, this finding is logical because empathy helps students recognize and appreciate other people's ideas and values, contributing to their moral development (Thompson, 1986). Our results show also, a positive impact of definition on constructivist learning. In design thinking, the definition stage consists of thinking and analyzing all the information that comes out of the empathy phase and focus on the learner's needs (von Thienen et al., 2018). The definition phase creates a competitive environment based on collaboration and critical thinking. As for the variable "Ideation", we were not able to test the effect of this variable on constructivist learning. In the statistical results obtained, the theoretical model of the variable "Ideation" did not fit the empirical model; the viability and reliability of the construct was not confirmed. An explanation for this result might be that in our study, the measurement of " Ideation" relied on self-reports by university teachers. This may also be due to a contamination effect, the participants having already answered the questionnaire may influence the answers of the other respondents. Another explanation of this results might be the lack of a culture of innovation, imagination and creativity. We have found also that "Prototype" and "Test "on constructivist learning. This supports the recommendations of (von Thienen et al., 2018) that the realization of a prototype represents creation of new perspectives and knowledge. A prototype can also help all the stakeholders in developing metacognition and reflection. In the same line of thought, the variable "Test" enhances the development of constructivist learning. The " Test" provide : social interaction, experiential learning, personal relevance (von Thienen et al., 2018).

VI. PRACTICAL IMPLICATIONS

Jointly, this study has some theoretical implications. This study contributes to existing research on design thinking, outlining a very interesting field of study to support it theoretically, such as constructivist learning.

As our results suggest, such universities can improve their chances of implementing a constructivist teaching approach by building on the different steps of design thinking and actively collaborating with students around them.

Our findings also provide some evidence to help and implement a series of practices for the promotion of engagement of students, balance between instruction and construction and learning environment. By practicing the different capabilities of design thinking (Empathy, Ideation, Definition, Prototype and Test), teachers can enhance the implementation of constructivist teaching. The impact of design thinking on education is promising. Design thinking makes it easier for teachers to set up a creative and collaborative environment. It also facilitates for teachers the engagement of students by involving them in the learning process. Our study provides an innovative and interesting theoretical framework for initiating pedagogical innovation in higher education institutions in Morocco. Our study also emphasizes the importance of revisiting and overcoming linear and traditional teaching methods. These methods are not helping the student to develop certain attitudes that he/she needs in order to cope with contemporary demands.

VII. LIMITATIONS AND FUTURE RESEARCH

The main limitation of this study is the subjectivity of the respondents' answers when filling out the questionnaire.

Another limitation is that the research was conducted only in the context of Fes Morocco, so it is recommended that other studies be carried to generalize the results. Another limitation of our study is that we put all faculties in the same category. The implementation of the constructivist approach differs from one discipline to another. The teaching of mathematics, for example, is not like the teaching of management sciences. Our study might also be treated in a qualitative approach to give teachers the opportunity to express themselves more deeply and explore other disciplinary fields. Future studies should also enlarge the sample to include other participants such us students, which would lead to more general conclusions.

Despite these limitations, the obtained results are relevant, as this is one of the first studies to explore design thinking in the context of a constructivist teaching approach within Moroccan higher education institutions.

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