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Understanding the art of design thinking facilitation: a novel instrument for observing instructional strategies used by facilitators

Sharon Guaman-Quintanilla [1,2,✉], Isabel Alcivar [3] and Katherine Chiluiza [4]

[1] Escuela Superior Politecnica del Litoral, i3lab Entrepreneurship and Innovation Center, Ecuador,
[2] Ghent University, Department of Accountancy, Corporate Finance and Taxation, Belgium,
[3] Escuela Superior Politecnica del Litoral, Faculty of Mechanical and Production Sciences Engineering, Ecuador,
[4] Escuela Superior Politecnica del Litoral, Center of Information Technologies, Ecuador

✉ seguaman@espol.edu.ec

Abstract

Design Thinking (DT) is considered an innovative and effective pedagogical approach. To enhance the understanding of instructional strategies used by university DT facilitators, we developed the Design Thinking Facilitation Behaviour List, an instrument that matches strategies with observable behaviours in a DT course. We present the design process and validation of the instrument. Results show the instrument's effectiveness in capturing instructional strategies in a DT course, paving the way for future research and improved teaching practices.

Keywords: design thinking, instructional strategies, instrument, design education, higher education

1. Introduction

Design Thinking (DT) refers to a cognitive and practical approach that extends beyond the confines of the design domain (Johansson-Sköldberg et al., 2013). DT takes the methods and mindsets used by designers to solve real, ill-defined problems using a human-centred and prototype-driven strategy, working collaboratively (Benson and Dresdow, 2015; Brown, 2008; Carlgren et al., 2016). From an educational perspective, DT places the student at the centre of the learning process, and it has been associated with the constructivist theory of learning (Pande and Bharathi, 2020; Scheer et al., 2012). Constructivism posits that learning is not a mere transmission of knowledge but an active process where the student is the protagonist in the knowledge construction, and instruction plays an important role in supporting that process (Duffy and Cunningham, 1996). The latter means that in educational settings where constructivism is applied, teachers should assume the role of facilitators rather than traditional instructors (Murphy, 1997). Unlike the role of the facilitator in management, which can be summarised as helping others to help themselves (Rees, 1990), DT pushes the teacher to become a facilitator of constructive learning by creating a learning space that lets students navigate different mental models and methods. This requires a balancing act between instruction and construction and helps students convert abstract and general principles into meaningful practice (Scheer et al., 2012). However, that role has not been researched in depth yet. The existing body of literature on the role of facilitators in DT is limited, leaving a gap in understanding the specific activities and processes involved in DT facilitation (Mosely et al., 2018; Starostka et al., 2021). The expansion of DT has resulted in a significant body of literature that highlights the advantages of using this approach, either independently or in conjunction with other methodologies. These benefits include fostering the development of key students' skills, such

as problem solving, creativity, teamwork, empathy, as reported in a scoping review on DT in higher education by Guaman-Quintanilla, Chiluiza, et al. (2022). Nevertheless, most of the studies in the field of DT primarily focus on examining students' experiences and the outcomes of interventions. They often overlook the crucial aspect of elucidating the unique instructional tactics employed by facilitators during DT interventions, considering the inherent characteristics of DT.

The above reveals two relevant gaps to address, despite the growing popularity of DT: (i) insufficient research on DT facilitation in higher education settings; (ii) the lack of studies zooming in on what specific behaviours DT facilitators use during live classes. Hence, we pose the following research question: What are the behaviours that operationalise the teaching strategies used by the facilitators during a DT intervention?

To answer the research question, we considered a DT course under the name "Analysis and Problem Solving", which is a mandatory course for all first-year students enrolled in all programs (Science, Technology, Engineering, Arts, Mathematics and Social Sciences) at a public Ecuadorian university. It lasts one academic semester, i.e., sixteen weeks. There are two class sessions per week; each session lasts 1.5 hours. Over 900 students enrol in the DT course each semester; they are normally split up and mixed into 30 course sections, with up to 36 students in each classroom. The DT model used in the course under study follows a six-stage doble-diamond model: Research, Empathise, Define, Ideate, Prototype, Validate. It is based on both the Hexagon model (Hasso Plattner Institute of Design at Stanford University, 2010) and the Double Diamond model (Design Council, 2007). The course facilitators come from a variety of backgrounds, and to facilitate this course, they must first complete and pass DT training provided by the university. The facilitators form six-student teams (per course section) that address different real-life problems using DT throughout the semester. Every team has a sponsor—an organisation (e.g., NGO, small business, company, etc.) that owns a problem and lets students explore and suggest a solution. Some examples of problem statements proposed by former sponsors have been "How might we increase the number of volunteers for our organisation?" or "How might we increase our engagement in social media?" This course is taught in classrooms with round tables, several whiteboards, a projector, flip charts, post-its, and low-prototyping materials. All course sections—and therefore all facilitators—apply the same design, contents, policy, and materials (including all session slides). Moreover, classes and class material are designed to be delivered following three key moments: recapitulation, teamwork, and socialisation. Before each class session, students must review the conceptual part of the topic of the day through videos posted on the institutional LMS platform. Therefore, in class, the facilitator no longer explains the topic from scratch but takes the time to synthesise the key concepts, resolve doubts, and provide more examples. Immediately after, the facilitator gives instructions about the class activity, where the student teams will apply the day's topic to their own projects. And finally, in the socialisation space, the teams show their progress and receive feedback from the teacher.

The purpose of this study is to propose an instrument named the Design Thinking Facilitation Behaviours List, which has been built to identify key behaviours used by DT facilitators. First, the list was created; next, it was tested and refined by observing selected recorded DT class sessions, facilitated by six teachers in a university setting. Observations provide an objective insight into classroom practice. For instance, Kane et al. (2011) argue that well-executed classroom observations, carried out by qualified professionals using an elaborated set of indicators, can identify effective teachers and teaching practices.

The paper will outline in detail the development process of the proposed instrument, the results of the interrater reliability test applied to it, and the final version of the Design Thinking Facilitation Behaviours List. Finally, the paper presents a discussion on the instrument's development, its implications, and avenues for future research.

2. Methodology

2.1. Participants

The sample consisted of six facilitators (4 females and 2 males) who teach the course "Analysis and Problem Solving" at an Ecuadorian university. The facilitators were asked to participate voluntarily. They were selected by convenience, keeping representation of gender, differences in academic backgrounds, and dissimilar years of teaching experience to capture various profiles. They had all

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completed and passed the university's DT course facilitator training. By the time of the observations, the youngest facilitator was 29 years old, and the oldest one was 55. There was a facilitator with 15 years of experience teaching in higher education institutions, while for the youngest one, it was her first time teaching at a university. Each facilitator had 34 students enrolled in their DT course sections, on average. Table 1 presents the demographic composition of the participants.

Table 1. Demographic composition of the observed facilitators

Facilitator code	Sex	Age	Years teaching the DT course	Years of teaching experience in HEIs	Primary field of expertise	Number of students enrolled in the class
F1	F	34	6	8	Business management	36
F2	F	45	6	15	Business management and Entrepreneurship	36
F3	F	32	3	6	Economy	36
F4	F	29	0*	0*	Economy and finance	29
F5	M	35	6	9	Marketing, tourism	33
F6	M	55	6	8	Computing Science and Entrepreneurship	36

* First time teaching a university course

2.2. Instrument development

Since no instruments are currently available to identify instructional strategies in a DT course, we utilised a nine-step approach for developing the Design Thinking Facilitation Behaviours List which is summarised in Figure 1. The details of these steps will be presented throughout this paper.

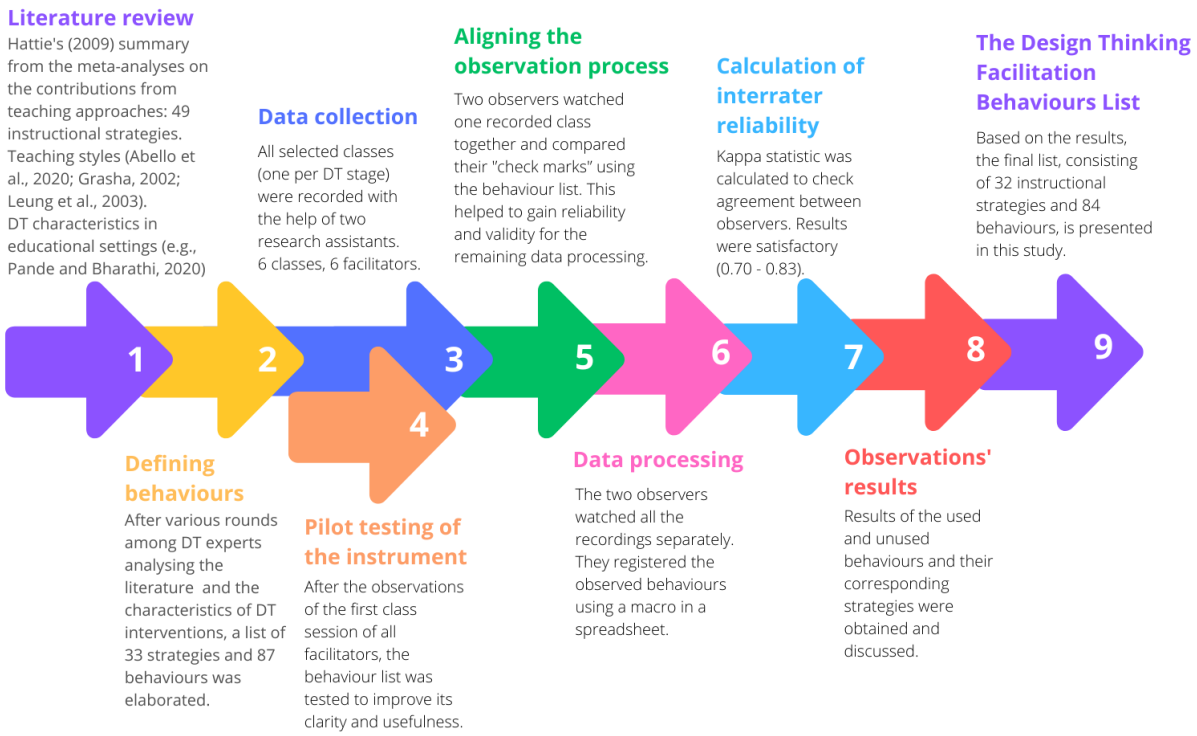

Figure 1. Instrument elaboration process

There are various instruments, especially questionnaires, that try to capture or evaluate what faculty do in a teaching context. For example, a popular instrument is the Grasha-Riechmann Teaching/Learning Styles Inventory (Grasha, 1996). This inventory is a self-reporting tool, which assesses instruction

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styles: Expert, Formal Authority, Personal Model, Facilitator, and Delegator. Teaching style refers to the consistent preferences that teachers demonstrate in their attitudes and behaviours during interactions with students in the context of teaching and learning (Grasha, 2002). There are other instruments such as the teaching style inventory (TSI) developed and validated by Leung et al. (2003) which is a self-rating instrument to assess teaching styles among tutors in problem-based learning. However, a problem with teachers filling out self-reported questionnaires, or being interviewed, is that teachers rarely declare they are below average, and everyone has a reason why their teaching approach is good enough (Hattie, 2009). There are other instruments that have tried to overcome that bias by asking the students to report their teachers' teaching style, such as the Teaching Styles Inventory for Higher Education (TSIHE) (Abello et al., 2019). The model is based on both a pedagogical and psychological perspective. Nevertheless, students in higher educational settings seem to also be biased when they are asked to evaluate their teachers through questionnaires (Braga et al., 2014). Therefore, observations can be a more objective way to understand the teacher's behaviours. Researchers suggest that an effective classroom observation should be performed around clear and objective criteria, in an environment of mutual trust and respect, by a number of trained observers, and by performing multiple observations throughout an academic term (Kane et al., 2011; Millis, 1992; Nilson, 2016).

We needed to develop an instrument that could be useful given the expected role of a DT facilitator. As stated earlier, DT falls under the constructivist theory umbrella, which entails the adoption of a student-centred learning approach. According to Goodyear and Dudley (2015), in student-centred courses, teachers assume an active role in the teaching and learning process. They provide an educational setting that fosters cooperation among students. Part of their role as facilitators is to engage in interactions with students when they encounter obstacles, but also to interpret, comprehend, assist, and foster the ongoing process of learning. Consequently, educators are required to consistently assess the ongoing context, implement various interactional methods, including both direct and indirect behaviours, and assess the effectiveness of these strategies on how well students are doing in class. Besides, in this context, Duffy and Cunningham (1996) stress that teachers play the role of coaches to guide learners. Furthermore, the impact that a methodology has on students is influenced by didactic actions (Valcke, 2019). Didactic actions refer to every action in which someone teaches and someone learns something (Sensevy, 2012). This concept can be divided into five components: learning objectives, learning materials, instructional strategies (didactic forms of work), media, and assessment (Valcke, 2019). Since the DT course under study is uniform, the learning objectives, learning materials, media, and assessment are the same across classes and facilitators. As a result, it is expected that these common components do not impact students differently. However, there is one component that does differ in the DT course under study: the instructional strategies used by the facilitators. Instructional strategies refer to the set of materials and methods employed to facilitate students in reaching the intended learning goals (Hill and Jordan, 2021). The process of adopting the right teaching strategies for a given educational setting needs to take into account the type of learning that is expected, the student group, and a variety of practical conditions, including the size of the class (Weston and Cranton, 1986). Therefore, after conducting a literature review, we chose Hattie's work (2009) as our baseline to develop our instrument. His book synthesises more than 800 meta-analyses into the factors influencing the achievement of students and highlights the power of teachers and feedback. Hattie (2009) divides the instructional strategies into nine categories: (a) strategies emphasising learning intentions; (b) strategies emphasising success criteria; (c) strategies emphasising feedback; (d) strategies emphasising student perspectives in learning; (e) strategies emphasising student meta-cognitive/self-regulated learning; (f) implementations emphasising teaching strategies; (g) implementations that emphasise school-wide teaching strategies; (h) implementations using technologies; and (i) implementations using out-of-school learning. Categories "g" and "i" were excluded since those strategies did not fit the scope of the present study, which is focused on observing live DT classes, as part of a formal DT course in a university setting. Next, to translate the remaining seven categories and their corresponding 49 strategies into observable, specific, and DT nature-related actions, we developed a list of facilitators' behaviours. The development of that list was based on three main factors. First, inventories of teaching styles reported in the literature (Abello et al., 2019; Grasha, 1996; Leung et al., 2003). Second, the DT characteristics and materials (e.g., Hasso Plattner Institute of Design at Stanford University, 2018; Pande and Bharathi, 2020). The abovementioned literature review is presented as step 1 in Figure 1. The third factor relied on the vast

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experience of DT experts who had been teaching DT since 2017 at university level (see Figure 1, step 2). Also, valuable help was received by two graduate students pursuing a degree in education (research assistants, onwards). The result was an initial checklist of 87 specific behaviours that facilitators may perform during a DT class. These 87 behaviours were in line with 33 of the instructional strategies categorised in Hattie's (2009). The rest of the process is explained in the following sections.

2.3. Data collection and procedure

2.3.1. Setting up

Once the instrument was developed and the six facilitators accepted being observed during their DT classes, the following steps were followed: First, one classroom was chosen to set up three cameras, which would record the classes from three different angles (Figure 2). One camera pointed to the facilitator's desk, another one was set up at one corner to record the whole classroom, and a third one pointed to one whiteboard to closely record the work of one student team during the class. All the cameras were set up before each class started, and they did not interfere with the class delivery. Also, a professional mini wireless Lavalier microphone was available to capture the facilitators' voice clearly (all facilitators used it in all recorded sessions). Next, before the semester started, the participants' classes were assigned to that classroom.

Figure 2. Three angles recorded during each class session, at the same time

2.3.2. Data collection and pilot testing of the instrument

Six class sessions of the six facilitators participating in the study were recorded (Figure 1, step 3) during the second semester of 2022 (October 2022–January 2023). This study obtained ethical clearance from the university's Ethics Committee, and consent forms were applied to facilitators and students involved in the observations. There was one class selected (topic) to record for each DT stage: research, empathise, define, ideate, prototype, and validate. In sum, 36 class sessions were recorded. The whole session (up to 90 minutes) was recorded in each case. The two research assistants helped set up the equipment for recording.

After the observations of the first class session of all facilitators (six in total), a pilot test of the instrument was performed (Figure 1, step 4). Given the educational background of the two research assistants, they were asked to take handwritten notes during the first six class sessions while they were happening live. They were also asked to observe those recordings and use the instrument (checklist) separately. Next, the research team met to check and improve the clarity and usefulness of the instrument. One of the insights obtained was how crucial it is for DT specialists who are knowledgeable about the local context and the course under observation to conduct the observations.

2.3.3. Data processing

Since all the sections and facilitators of the DT course under study follow the same contents, materials, and structure, we decided to apply the instrument in the three main class moments, taking a five-minute time lapse in each one, as follows: recapitulation of concepts (15' to 20'), teamwork (45' to 50'), socialisation and feedback (75' to 80'). Two DT experts with extensive experience in DT in terms of teaching, researching, and training trainers were the designated observers for watching the class recordings and using the instrument by registering (putting check marks) the observed behaviours in the list.

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The two observers watched one recorded class together and then compared their check marks using the behaviour list after each time lapse (Figure 1, step 5). This step led to a discussion to revise the underlying individual interpretation of the observed behaviours when just one of the observers marked a specific behaviour. For instance, when students were working in teams autonomously, i.e., without the guidance of the teacher, one observer interpreted that situation as evidence of the behaviour "The facilitator lets the students think and work individually and independently"; in other words, only one observer put the check mark. Then, both observers analysed the situation and agreed that observing autonomous teamwork would be a way to let students think and work individually and independently. This practice helped to gain reliability and validity for the remaining data processing, as well as to improve the description of the behaviours. Also, the observers agreed on two relevant insights: i) the descriptions of the behaviours in the list were practical in terms of mapping the instructional strategies applied by facilitators during a DT intervention; and ii) using the list is an interesting exercise for reflection about one's own teaching practice.
Next, the two observers processed the recorded sessions separately. They registered their observations in spreadsheet files that contained the Design Thinking Facilitation Behaviours List, using a macro configured as a checklist (Figure 1, step 6). The full list is presented in the Results section.

3. Results

To understand whether the Design Thinking Facilitation Behaviours List allows for consistent scoring by different observers, we tested the interrater reliability of the instrument using Cohen's kappa statistic (Figure 1, step 7). We calculated the Cohen's kappa score by DT facilitator and DT stages (Table 2). The overall kappa statistic value considering all observations is 0.76. This value indicates a substantial agreement between both observers, considering the interpretation of values by Landis and Koch (1977). These values still indicate acceptable levels of agreement for stricter interpretation thresholds (McHugh, 2012). When looking at agreement in observations per DT stage, the kappa statistic value ranges from 0.71 to 0.83. When looking at agreement in observations per facilitator, the kappa statistic value ranges from 0.70 to 0.83. These results suggest the proposed instrument allows for consistent rating among different observers, allowing its use for other similar contexts in which DT facilitation is under analysis. In the case of the facilitator F3 (Table 2), the kappa value reported for the Research class session is 1. This is the class session that was used by the two observers to align the observation process (see Section 2.3.3). The objectivity of the Design Thinking Facilitation Behaviours List was ensured by (a) determining the behaviours list based on a validated list of instructional strategies; (b) allowing for yes/no answers only on the spreadsheet scoring file; (c) including one class session from each DT stage; and (d) considering an heterogenous group of DT facilitators to conduct observations.

Table 2. Kappa values for each class observation

Facilitator code	Research Session	Empathise Session	Define Session	Ideate Session	Prototype Session	Validate Session	All Sessions
F1	0.77	0.66	0.72	0.69	0.72	0.75	0.72
F2	0.82	0.76	Data not available*	0.71	0.75	0.78	0.77
F3	1.00	0.71	0.81	0.77	0.72	0.86	0.81
F4	0.79	0.65	0.64	0.70	0.67	0.74	0.70
F5	0.76	0.62	0.81	0.69	0.75	0.77	0.74
F6	0.83	0.95	0.76	0.85	0.79	0.81	0.83
All Facilitators	0.83	0.72	0.75	0.73	0.73	0.79	0.76

*For facilitator F2, there is no kappa value reported for class session corresponding to the Define stage. Although data was collected during the observation period, that file was found corrupted during the data processing.

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Results of the used and unused behaviours and their corresponding strategies were obtained and discussed, which helped refine the final version of the Design Thinking Facilitation Behaviours List (Figure 1, steps 8 and 9). From the 33 strategies, 32 strategies were applied at some point during DT facilitation by at least one DT facilitator. In terms of behaviours, all of them were executed by at least one facilitator during at least one class session, except for two behaviours. Further results from data processing are outside the scope of the present manuscript. The final version of the list, presented in Table 3, consists of 32 instructional strategies and 84 behaviours. Notice that there are three behaviours that overlap since they are observable actions that depict the application of more than one strategy.

4. Discussion and conclusion

In this paper, we provide the Design Thinking Facilitation Behaviours List, an instrument that combines teacher's dynamics and existing materials in the literature as well as DT teaching experience, to match pedagogical theory with DT facilitation practice (i.e., operationalisation of instructional strategies associated to a DT intervention). We identified that 32 of the 49 instructional strategies reported by Hattie (2009) are present during DT facilitation, during different moments of the class session, for the different DT stages, for a DT course proved to impact in student's learning process in developing creativity, problem-solving and teamwork skills (Guaman-Quintanilla, Everaert, et al., 2022a, 2022b).

The design process of the instrument follows a deductive approach to build on existing teaching theory and instruments (Abello et al., 2019; Grasha, 1996; Hattie, 2009; Leung et al., 2003). Other researchers followed this approach (e.g., Van der Lans et al., 2018). The high reliability of the Design Thinking Facilitation Behaviours list is supported by three aspects: i) We adapted teacher behaviours from existing, reliable instruments to operationalise Hattie's instructional strategies. ii) The instrument passed through various iterations, including DT expert reviews and pilot testing, which helped to contextualize instructional strategies to DT facilitation. This validation practice is shared with other existing studies (Arbabisarjou et al., 2020; DeMonbrun et al., 2017). iii) Classroom observations were made by external, expert observers, avoiding bias from self-reports and student perspectives, thus promoting objective data collection (Kane et al., 2011; Millis, 1992; Nilson, 2016).

Two practical implications unfold from the Design Thinking Facilitation Behaviours List. First, it is a self-explanatory instrument for DT facilitators, enabling a smooth, observation-based measurement of whether a particular instructional strategy is applied or not during a DT class session. The latter is particularly useful since most of faculty at university level do not have a formal background in Education. The research team was able to conduct observations with significant agreeableness (validated by calculated kappa values). Second, this instrument adds to the existing material on DT facilitation, since it serves as a self-reflection tool for DT facilitators looking to: i) connect what they do in class with research-based instructional strategies (awareness), and ii) learn about instructional strategies that they do not apply while teaching and wish to implement (improvement). As reported in previous sections, the observers in the study found themselves reflecting on their own DT practice as they processed the data.

The are some limitations in this study. The Design Thinking Facilitation Behaviours List has only been validated in a DT course with the specific characteristics mentioned in previous sections of this paper.

To gain external validity, future research should focus in evaluating the usefulness of this instrument to study other DT courses taught in higher education settings or in other levels of education, as well as courses where DT is only used as a teaching approach but not taught per se. New validation efforts should also involve external observers whose experience in DT practice and facilitation comes from different course settings. Since the aim of this paper was to present the Design Thinking Facilitation Behaviours List, classroom observations were used to test and refine the instrument only. Therefore, this study does not yield by itself any insights regarding which strategies were the most used by DT facilitators in each of the DT stages and class moments. Nevertheless, such findings will be shared in an upcoming paper. Future research could also investigate whether DT facilitators are using different instructional strategies and why, which instructional strategies are more effective to attain the expected learning outcomes, and related topics.

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Table 3. Design Thinking Facilitation Behaviours List

Category n=7	Strategies n= 32	Behaviours n = 84
Strategies emphasizing learning intentions	1. Formulating learning goals	1. The facilitator verbally explains clear goals for the students' learning.
	2. Offer advance organizers (done before/beginning of the class)	2. The facilitator presents a short summary of the previous lesson at the beginning of the class session. 3. The facilitator presents a summary of recently learned content (in general, not only previous lesson).
	3. Using concept maps/mind maps (anytime, subset of advance organizers too)	4. The facilitator uses concept maps/mindmaps (in addition to the slides).
	4. Respecting the hierarchy of learning goals and knowledge	5. The facilitator distinguishes between knowledge and learning objectives. For instance, facilitator explains to the students why the content is important (or how they can use it) for achieving certain learning objectives (techniques and/or skills related). 6. The facilitator promotes analysis and critical thinking (e.g., by asking higher-order thinking questions) when he/she identifies that the claims upon which an argument is built require it. 7. The facilitator explains some content by breaking it down in smaller parts, in order to make it clearer for the students.
Strategies emphasizing success criteria	5. Mastering Learning	8. The facilitator asks questions to check whether the students have understood what was taught. 9. The facilitator presents examples in different contexts (i.e., besides the ones in the course slides) to help students check if they have understood the concepts. 10. The facilitator gives the students problems or examples that require them to use what they have learned in different situations. 11. The facilitator makes sure students understand material before moving on to new material (e.g., by asking questions to the students). 12. The facilitator repeats information when he/she consider it is necessary. 13. The facilitator shows students how and what to do in order to master the course content (tools and techniques).
	6. Worked examples (example solutions, half completed tasks)	14. The facilitator uses examples (personal experiences, recent videos, magazines, newspapers, etc.) to demonstrate or clarify a topic.
Startegies emphasizing feedback	7. Giving feedback	15. The facilitator gives constructive feedback in general (addressing the whole class). 16. The facilitator spends time advising students on how to improve their work on individual and/or group projects. 17. The facilitator gives frequent verbal comments on their performance. 18. The facilitator gives students feedback when their performance is unsatisfactory, pointing out what's incorrect or what should be improved. 19. The facilitator gives students personal support and encouragement to do well in this course. 20. The facilitator observes students when they are working on tasks and provides immediate feedback. 21. The facilitator provides praise for good work. 22. The facilitator uses the information from evaluations to come up with ways to make sure students get the help and feedback they need. For example, the facilitator talks about the results of quizzes students took on the course LMS (before class) and does something about it, like explain the topic, give a new example, give advice, etc.
	8. Test taking and coaching	23. The facilitator tells students what is expected of them when they get a test, quiz, or assignment. 24. During class, the facilitator covers the course material that students will be tested on during their project development and presentation.
	9. Formative evaluation	25. The facilitator evaluates to determine whether or not the class as a whole is learning the material taught. E.g., using open-ended questions or other testing tools like Kahoot. 26. The facilitator evaluates to see whether a student is grasping the work and where his difficulty lies, if any (e.g., asking questions to a specific student to check if the student understood the task). 27. The facilitator evaluates to motivate the students to put forth their best efforts to learn the matter at hand (e.g., motivating students when they answer correctly or do something good). 28. The facilitator uses different methods to evaluate the students (more than one). 29. The facilitator assigns homework.
	10. Attention to questioning	30. The facilitator asks the students to answer the questions in a general way or asking someone specifically. 31. The facilitator asks controversial or challenging questions during class.
	11. Fast and immediate response to learners	32. The facilitator helps the students learn from the mistakes they have made. 33. The facilitator answers the students' questions directly (not applying other strategies to make students find or deduct the answer by themselves).
Strategies emphasizing student perspectives in learning	12. Time on task (efficient use of time)	34. The facilitator follows the class flow (as indicated in the plan). 35. The facilitator allocates time for questions.
	13. Spaced practice	36. The facilitator presents instructions or tasks for which there is no immediately obvious solution.
	14. Intensive practice	37. The facilitator asks students to complete a task in as little time as possible.
	15. Peer tutoring	38. The facilitator limits his role as a teacher letting students to act as co-teachers (peer tutoring) for clarifying a topic or doubt. 39. The facilitator stimulates cooperation and encouragement between the students instead of competition.
	16. Mentoring of learners	40. The facilitator tells the students how they are doing in class, in terms of performance. 41. The facilitator models appropriate ways for students to think about issues related to the class content. (E.g., by explaining stepwise how he would address a problem related to the class topic). 42. The facilitator encourages the students to learn from the mistakes they have made.
Strategies emphasizing student meta-cognitive / selg-regulated learning.	17. Teaching metacognitive strategies	43. The facilitator makes the students reflect on their thinking (e.g., by using open-ended questions). 44. The facilitator asks questions that emphasize self-checking or evaluation of students' strengths and weaknesses. 45. The facilitator explains the benefits of using a strategy by explaining the reasons why applying a tool or strategy (in DT) is useful. 46. The facilitator models metacognitive strategies and explains his thought processes (i.e., strategies to reflect, using his own process as an example). 47. The facilitator lets the students make plans related to how they are going to apply the topic in their projects during the class and the following weeks. 48. The facilitator asks questions that make the students reflect on the problem.
	18. Promote self-verbalization and self-questioning	49. The facilitator asks students to present their thinking or reasoning about any general topic (e.g., opinions, beliefs, etc.) 50. The facilitator asks students to explain how they solved a problem or completed a specific task. 51. The facilitator uses evaluative exercises and/or tests that allow students to evaluate their own progress.
	19. Promote student control over learning	52. The facilitator takes on the role of facilitator of the students' own inquiry. 53. The facilitator pays attention to students when they state their opinions and doesn't interrupt them while they are talking (maintains eye contact, asks questions). 54. The facilitator asks for feedback from students on his teaching ability. 55. The facilitator lets the students work on course projects alone with little supervision from him (i.e., the teacher only approaches students on demand). 56. The facilitator is just an observer during group discussion. 57. The facilitator lets the students' actions affect how the class flow unfolds. E.g. When the facilitator notices that students are not responding correctly (or at all) to his questions, he can decide to change the plan for the class and do it in another way).
	20. Adapting interventions to learners' individual differences (aptitude treatment interaction)	58. The facilitator offers bonus points. 59. The facilitator tries to find a level that works for most of the students in terms of how the content is presented and how the lesson is given.
	21. Adapting instruction to learners' learning style	60. The facilitator uses teaching goals and methods that address a variety of students learning styles. (To be specified from the actual observations.)
	22. Individualized instruction	61. The facilitator gives different work to teams who have difficulties learning and/or to those who can advance faster. 62. The facilitator offers bonus points. 63. The facilitator helps students who need it in a personalized way.
Implementations emphasizing specific teaching strategies	23. Reciprocal teaching	64. The facilitator enables the students to take turns (leading the dialogue) to present their opinions, ideas or summarizing their work done during the session.
	24. Direct instruction	65. The facilitator uses traditional methods of teaching where students are expected to be passive recipients of knowledge. 66. The facilitator shows students how they can use various principles and concepts in a one-way direction. 67. The facilitator provides direct instruction about what students are supposed to do during the class activity.
	25. Adjunct aids (additional examples)	68. The facilitator relates the topic of the class to current, real-life situations.
	26. Inductive teaching	69. The facilitator gives the students problems or examples that require them to use what they have learned in different situations. 70. The facilitator asks controversial or challenging questions during class.
	27. Inquiry-based teaching	71. The facilitator guides students' work by asking questions, exploring options, and suggesting alternative ways to do things.
	28. Problem-solving teaching and problem-based learning	72. The facilitator asks students to decide on their own procedures for solving complex problems. 73. The facilitator encourages students to develop their own ideas about content issues. 74. The facilitator gives the student a problem to understand and solve (besides the project topic). 75. The facilitator gives his opinion about the problem to the students. 76. The facilitator discusses the advantages and disadvantages of different problem-solving strategies with the students. 77. The facilitator gives students suggestions or even possible solutions to solve problems. 78. The facilitator points out the right direction to solve problems.
	29. Cooperative learning	79. The facilitator makes sure there is balanced performance in the group; i.e., all group members participating. 80. The facilitator lets the students work in small groups to come up with joint solutions to a problem or task.
	30. Competitive learning	81. The facilitator encourages the groups to work harder to reach a goal that is competitive. 82. The facilitator stimulates actions that increase the probability of one's own success and reduce other individuals' chances of success.
	31. Individualistic learning	83. The facilitator lets the students think and work individually and independently.
Technology-based instructional approach	32. Web-based online instruction	84. The facilitator guides students through one or more online learning experiences. E.g. using Kahoot or mentimeter during class.

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Overall, this work provides an instrument that matches research-based instructional strategies with observable behaviours that DT facilitators may apply during in a DT course. It serves as a starting point to closing the gap regarding what specific behaviours DT facilitators do during a DT intervention, contributing to better understand Design Thinking education. The Design Thinking Facilitation Behaviours List provides a common ground for future self-reflection and peer-to-peer discussion around what should a DT facilitator do—and be trained at—to teach DT effectively.

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