Operazionalization of the 4C-ID model in a practical context

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Abstract

The paper regards an experimental study of an instructional design (ID) model applied in the routines of a digital learning company for content production and course design. Given the complexity of adult learning, the study tried to identify an operative model that could support production process and at the same time ensure rich and engaging learning experiences. The model guarantees the possibility to evaluate learning objectives achievement of through the expression of the target knowledge/skills. Therefore, the ID model can be applied to both mandatory, self-enrolled and professional paths (in up-skilling and re-skilling courses).
The development of the model is based on the four-component instructional design (4C-ID) that represents the main structure for the design.
The paper presents a practical application of this model in a digital Italian company (Piazza Copernico srl) and explains the preliminary version of the model for future exploitations.

Keywords 1

Instructional design, four-component instructional design, 4C-ID, complex learning

1. Introduction

The design of a course is crucial process that includes different figures, from professors to lecturers, from company trainers to instructional designers. This task is the fundamental stage for the success of the teaching/learning practices, both in the face-to-face and in online modalities.

In the last years, online courses became even more popular, and their success is highly increased during the global pandemic [1]. The need of the teaching institutions to provide courses using digital tools boosted a rethinking and recovering of solid pedagogies. In many cases, courses tried to propose a blended nature [2], trying to maintain a non-digital component. This process pervades learning institutions of different field, from the universities [3,4] to the training in companies [5,6].

For a course design is important to guarantee the balance between two different learning activities: declarative learning and procedural learning [7,8]. The declarative learning belongs to all the learning activities that involves the students with books, videos, slides, presentations that are shown to them. In this case, the students learn from existing contents that could be shown with different modalities and tools. Students has the task to acquire the knowledge, with a transfer from the teacher (and the media s/he uses) to the student. The procedural learning requires a more active role for the students. The learner applies the acquired knowledge by a practical and laboratorial activities, in a learning by doing process. The main learning process of procedural knowledge is firstly knowing its associated declarative knowledge, and then knowing how to enact the skill via practice [9]. The procedural learning acquisition, involving a practical and active role require higher cognitive skills than declarative learning [10].

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When a instructional designer is developing a course should balance the two different learning modalities and this task is even more difficult when learning goes online, because procedural learning could be very difficult to be included.

Rooted instructional design methodologies are still present, in order to provide a clear direction in the course design. A methodological approach is represented by the Complex Learning, that is the integration of knowledge and attitudes finalized to the management to different skills [11]. The complex learning aimed at the training of complex skills and professional competencies. This approach is used for designing learning programs that cover a relevant span of time. The goal of the instructional designers is to achieve the learning transfer from the theoretical to the practical aspects. The results of these processes are unpredictable and provide a dynamic interaction. Nevertheless, this process could be managed applying the complex learning skills methodologies. In this view, the whole learning process is not a simple series of different learning practices but represents a continuous and fluid setting [12]. The fragmentation of complex learning tasks without a knowledge of the boundaries between the modules has a high degree of unsuccess. It is because it does not adhere to the real-work tasks: when a learner knows how to deal a specific activity, from its acquired knowledge, but does not know the interactions with the other parts, could have significative problems in applying it in the real field. This ambivalence represents the so called “Transfer paradox” [13].

The Instructional design (ID) theory supports the course designers in this process and a specific approach is called four-component Instructional Design (4C-ID) [13].

In the digital companies, the instructional design of courses and their digitalization from the traditional ones, is an open and daily challenge. The improvement under the technological side and the contextual events accelerated the process of the rethinking of the courses. These course providers need of rooted and well-structured methodologies, with schematic blueprint for a real use in practical contexts.

2. Instructional design and four component Instructional Design (4C-ID)

The 4C-ID model, was developed by Jeroen J. G. van Merriënboer, in partnership with Paul Kirschner [11,] is intensively used for the development of learning and training programs aimed at acquiring complex cognitive skills, starting from the fundamental stage of the Complex learning. [14].

This model is a tool for course and instructional design in a modular sense. These learning resources are developed in order to boost the implementation of problem-solving strategies and their understanding and automation. The model proposes four main components for each learning task:

- Learning task;
- Supportive information;
- Procedural information;
- Part-task practice.

Each of these four pillars represents a specific moment for the design of any specific learning activity and are crucial for the development of learning task inventory. Below a brief description of each component.

Learning task: these are the learning activities that proposes practical and laboratorial learning experiences. These are conceived on real problem related to the field of learning/teaching where for the achievement of the solution are needed skills, competences, and attitudes. This starts from the holistic approach for the complex learning. The aim is to propose activities for an experiential learning in order to transfer in a real environment the competences learnt. The single learning tasks has a high variability and different structures that implies different solutions. The instructional designer should define learning task with a progressive increase of difficulty.

Supportive information: represents the learning resources showed during a learning task or immediately before in order to create the right context. These includes data that could be important for the student aimed at the management of the problem solving, elaboration and reasoning. The students need the supportive information for a progress into the learning tasks or for advanced solutions of these, allowing the creation of connections between different learning tasks.

Procedural information: are crucial for the execution of routine tasks. Using this information, the students are able to handle recursive procedures and for an improvement of the skills. The procedural

information is important as an explanation tool for a specific problem. A specific aspect of this information is their presence in the timeline, these should be shown just-in-time during a specific learning task when needed.

Part-task practice: these are a facultative asset. These represents activities that train part of specific competences, covering different dimensions of complex skills. The Part-task practices could be automatized and are needed for the execution of complex learning tasks. These are proposed when the student knows a specific routine and could be internally o externally to a specific learning task. A typical use is for the creation of recurrent skills inside the learning tasks.

2.1. 10 steps to complex learning

Based on the model a blueprint for complex learning is based on these four pillars. For the practical application of this model, in the literature is present a description of ten steps, that starts from the four pillar previously described, that aims for a correct design of learning courses. [11]. Each of part of the 4C/ID model (Learning task, Supportive information, Procedural information, Part-task practice) belongs to a specific design phase. The design of the learning tasks falls:

- in the step 1, the design of the learning tasks
- in the step 4, the design of the supportive information
- in the step 7, the design of the procedural information
- in the step 10 the design of the part-tasks practice. These 4 steps represent the essential steps for an instructional design to complex learning. Between these steps there are 6 facultative steps that could be executed when needed.

The step 2 and the step 3 refer to the "Learning tasks" cluster. This cluster composed by the first three item represent the backbone of the learning course.

The step 2 is called "sequence task classes" and it is aimed to organize and itemize the different learning tasks in clusters, from the easier to the harder.

The step 3, called "Set performance objectives" allows the definition of standards for the evaluation of a certain performance. In this way it is possible the evaluation of the learning results and for receiving an appropriate feedback.

The steps 5 and 6 refer to the "Supportive information" cluster and provide resources as scaffolding for the students in order to fill the gap about the learning tasks. If the materials are well developed, these two steps could be not implemented. If the learning material as supportive information are new, these steps could be useful for well definition with in-depth analysis of to-be-acquired mental models and cognitive strategies [15]. The results of the analysis of the steps 5 and 6 provide the elements for the design of the supportive information.

The step 5 is called "Analyze cognitive strategies" and defines how the learners could handle the learning tasks and how they solve a specific task in a specific knowledge field.

The step 6 is called "Analyze mental models". It describes the way to approach the learning tasks and allow a metacognitive approach on students' mental models related to the task.

The steps 8 and 9 fall in the "Procedural information" cluster, with the need to be just-in-time during the learning task when is necessary.

As in the previous cluster, if the learning resources are available, these two steps are not necessary, and the step 7 (Design of the procedural information) will update the material and will cover a correct assignment.

The step 8 is called "Analyze cognitive rules", where the designer specifies the condition-action pairs that manage routine behaviours.

The step 9 is called "Analyze Prerequisite knowledge" works on the correct use of the correct cognitive rules related to the previous competences learnt by the students.

The final category "Part-task practice" has not additional tasks and represents the final one: step 10. In this case, this step designs additional activities aimed at providing a very high level of confidence in executing a recurrent task. This aspect is crucial when those skills could cause danger to life and limb, loss of expensive or hard to replace materials, or damage to equipment if not carried out properly and quickly. [11].

2.1.1. ID matrix: objective and functions

The need of adopting and customizing a design model in a digital learning company concerns both typically organizational issues about production and more typically training issues. Under the organizational point of view, the need to adopt an innovative and agile model concerns:

- allowing a homogeneous course design of the courses, beyond the differences and background of the different instructional designers,
- giving a reference design tool for course updates and evolutions, but also for any customization requested by the client,
- focusing on a unique reference system for micro-design training and assessment tools,
- capitalizing experience and codify a "learning task inventory" to reuse over time.

Adopting an agile and flexible model also means encouraging an approach that shows all possible training solutions, that can be creatively selected, without losing the coherence of the intervention. From the purely training point of view, the advantages of this method concern new and interesting opportunities to:

- mapping training and evaluation decisions and building complex and articulated interventions for different difficulty, guidance and support levels,
- encouraging an approach of concrete demonstration of competence and focus on expected behaviour rather than on formal objectives,
- having an open but experience-oriented intervention system,
- referring to a learning map to be used to organize all project phases (from the content production, evaluation system, tutoring system, delivery rules in LMS),
- adopting, in addition to summative assessment models, continuous monitoring tools as progressive assessment.

From the organizational and training needs, basic model requirements were identified in:

- methodological accuracy and integrity,
- manageability and adequate design effort,
- adaptability to different contents,
- adaptability to different training methods.

2.1.2. Learning Activities Inventory

When an instructional designer creates a learning activities inventory has to cover four main aspects listed below: [11]

- Variability; for a correct transfer of the learning and in order to prevent that the competences are learnt but with a great difficulty of application in real field, it is essential that the learning tasks differ among them. This variability should be under different aspects, as the type of exercise, the dimension of the learning tasks, etc.. The final goal for the student is to extract more general information from the active learning and from different tasks
- Task classes: this is another important aspect of the instructional design. The student could find huge hurdles if the learning tasks are immediately difficult. The tasks should have a gradual increase, starting from the simpler learning tasks to the activities that involve a more complex analysis and acquisition of knowledge. The task classes should be conceived in line with the flow, typical in gamification [16, 17]. The tasks should be designed balancing the knowledge of the learner with the difficulty of the tasks, when the learner is in the initial stages, its competence and skills are low and the learning tasks that it could handle needs to have a congruent level, at the same time when the competences improve, the tasks should not be too easy, maintaining an engagement for the student. The learning categories for each activity are called task class. Each task class have exercises at the same level.

- Support and guidance: the support is product-oriented, because the focus is on the learning outcomes, while the guidance is process-oriented, and the main aspect to be covered is on the learning processes of the student. The support and guidance should be not homogeneous across the course. Their impact would decrease when the student is more confident and has learnt more elements. In each activity the support and guidance should have a slope, with a continuous decrease.
- Supportive versus procedural information: the first one is important for the non-recurrent tasks and explain how is organized a learning domain and how deal with it. The supportive information is the base to facilitate the development of new mental schemes that are useful for potential crosslink between arguments and previous cognitive schemes. All these information is transversal for all the learning activities. On the contrary, the procedural information is relevant for the recurrent tasks, that are reproduced as routines.

2.2. ID model operazionalization

During the research, a first version of the design model was created. In the tools all theoretical ideas and didactic choices are collected and condensed into a single design matrix. For the creation of this file the authors used the ten steps 4C/ID model described above. In this section we show the different parts of the files without the order of development (all the steps of the methodology were followed in the current order).

The authors created it as a Microsoft Excel worksheet, this first version is intended to provide an agile tool in the experimental stage. After an adequate use and the collection of improvement inputs, a new software version will be realized to give instructional designers a more advanced tool.

The Microsoft Excel file consists of several parts, of which the central part is a "design matrix". The file consists of several spreadsheets, divided into:

- “operative spreadsheets" in which the instructional designer can operate,
- "support spreadsheets" that collect all the design model information used in the "design matrix".

Table 1
Operative spreadsheets

Operative spreadsheets	
General Information	Provides summary information about Project Management (start/delivery date, budget, order code, preliminary indications).
Project Analysis	Briefly contains preliminary scenario information, as: training method, type of content, number of participants, skills entry levels, objectives and organization goals, but also planned budget. A calculated field summarizes estimated costs given by Instructional Design choices.
Job, Skills, Design	Shows the spreadsheet with the design matrix (explanation below).

Table 2
Support spreadsheets

Support spreadsheets	
Performance assessment	Contains the “evaluation methods inventory” (linked in the design matrix) and provides

	indication of measurement scales, control and delivery models.
Learning activities inventory	Includes the “training methods inventory” classifying each method by number of participants, delivery models, delivery times and budget estimation.
Evaluation model	Reference for multidimensional assessment (linked in the design matrix)
Objective_lexicon	Utility for the action verbs that can be used to write learning outcomes in the design matrix.

The design matrix sheet called "Job, skills, design" is explained through its different parts corresponding to the design phases.

The name of this section highlights the purpose of the tool. It links the instructional design with professional role and target skills by a strong reference to experiential learning.

Starting from the professional role analysis (job description and skills mapping), the first activity is to define the learning outcomes based as training objectives.

	Canale scelto	Blended (full digital)		
	dal ruolo ai comportamenti osservabili in esame			
CODICE	MACRO ATTIVITA'	MICRO ATTIVITà	LEARNING OUTCOME COMPORTAMENTO OSSERVABILE (action, standards, conditions,tool&objects)	Attività Ricorrente / non ricorrente
	Definire la metodologia del corso	Selezionare il metodo coerente con la numerosità di partecipanti, il tempo e il budget a disposizione	Essere in grado di valutare le variabili specifiche di ogni singolo contesto formativo per selezionare, tra i metodi coerenti, il metodo più adeguato ai vincoli della situazione (tempi, costi, somministrazione, risorse disponibili).	Non ricorrente

Figure 1: Screenshot of the design matrix sheet called “Job, skills, design”. The contents are in italian.

First, we must describe work activities of the target job profile, both at macro and micro level (it means analytically describe activities to be carried out). After this, the micro-activity is linked to "observable competent behaviour" in a unique way to and it represents the learning outcome and objective of training. The learning outcome / objective is defined by the concepts of: action, standard, conditions, tools&object.

At this stage the distinction between recurring and non-recurring activities is relevant, which will be fundamental in the definition of training activities.

It should be noted that a job of the role can be divided into several micro-activities, some of which can be of a recurrent type and therefore represent preliminary activities or entry requirements to the course.

Recurrent activities, developed in the step 10 for the design of the Part-tasks practices, are the routine activities that are part of the work (e.g. in the activity of "monitoring new tenders and contracts", the routine component of the activity is the part of "access to the monitoring platform, display of new

reports and consultation of information". While the non-recurring activity is "the analysis of the single tender matching the requested characteristics ".

The second section deals with the possibility of coordinating the definition of learning outcomes with a set of taxonomies and skills frameworks. For now, 6 different taxonomies have been integrated in the model:

- Bloom Taxonomy of teaching objectives
- ECF: ICT skills (e-CF 3.0 CWA Part 3)
- CEFR: language skills
- Key competences for lifelong learning
- Entrecomp: entrepreneurial skills
- Digcomp for digital skills.
- All these frameworks are valued and filled out according to the aims and requests of the course in design.

Inquadramento competenze									
					DIGCOMP				
RIF. BLOOM rivisitato	e-CF Quadro europeo delle competenze ICT	QCER Quadro comune europeo di riferimento	Competenze Chiave Europee (Key Competences)	ENTRECOMP)	AREA DI COMPETENZA DIGITALE DIGICOMP	COMPETENZA DIGITALE	DESCRIZIONE DELLA COMPETENZA	LIVELLO SCELTO	DEFINIZIONE LIVELLO
Valutazione					RISOLVERE	5_3_Utilizzare_in_modo_creativo_le_tecnologie_digitali	Utilizzare gli strumenti e le tecnologie digitali per creare conoscenza e innovare processi e prodotti.	8	A un livello avanzatissimo e super specializzato, sono in grado di: - creare soluzioni per risolvere

Figure 2: The image shows the second section that deals with the possibility of coordinating the definition of learning outcomes with a set of taxonomies and skills frameworks.

Learning TASK + valutazione		
LEARNING TASKS / ATTIVITA' DIDATTICHE	**PERFORMANCE ASSESSMENTS**	**Strumento per la valutazione**
ANALISI WHAT IF - Distinguere tra diverse tipologie di strumenti di formazione digital, definire le caratteristiche peculiaridel metodo in base allo scendario disponibile	Dati 3 casi l'utente è in grado di compiere la scelta del metodo motivandola rispetto alle variabili fornite	griglie auto-valutazione - checklist

Figure 3: Third part of the design matrix named “Learning Task and Performance assessment”

Third part of the design matrix regards the definition of each “Learning task and Performance assessment”. This is the central part of the 4C/ID model adopted, developed with the first three steps

(Design the learning tasks), because it allows to combine in a single learning outcome both the experiential learning activity and its evaluation tool. The unification of these two activities has some fundamental advantages.

First of all, it allows to identify learning activities that are strongly connected to the job, such as exercises, simulations, and experiments, in which experience is put into play as is the learning main vector. On the other side, it allows to base the evaluation system design directly on the practical activity, rather than on the dimension of knowledge. And that moves evaluation from focusing on conformity (in accordance with course design system, alias "assessment on contents") to focusing on the real objective, as job behaviours' improvement (expected performance).

In addition to the ordinary summative assessment, this method also enriches the evaluation results, by providing the adoption of:

- progressive assessment models,
- self-evaluation protocols.

In practice it's necessary to proceed first to the choice of the learning task, and therefore to move on to the performance assessment and the related evaluation tool.

After this, all information about learning task is to be defined. Starting from the learning task declination as experiential and inductive activity, it is classified by the type of learning task:

- Self-evaluation,
- Exercise & practice
- Explanation
- Self-study
- Materials

And then the specific learning activity is selected. The tool uses the support sheet "Learning Task Inventory" to propose a set of possible delivery activities to be chosen and micro-designed.

The selected learning tasks must match variability and increasing level of complexity criteria. In the case of activities at the same level of complexity, variability between learning tasks must be guaranteed.

Tipo learning task (illustrated problems, analogous task, workout example, reverse task, imitation task, goal-free problem, completion task	Attività di erogazione	Definizione attività	Strumenti Proposti	CLASS TASK (o SUBTASK) Support & guidance - difficoltà incrementale e minore guida)	Codice del learning task precedente

Figure 4: The image represents the categories to be filled in the sheet: when the instructional designer chooses a learning tasks as to define the "Class task" included the level of support & guidance.

Identifying a learning task, the CLASS TASK level, based on one of the four aspect for the creation of learning task inventory, must be defined in terms of the level of Support & Guidance (high, medium, low, none). It must progressively decrease according to the increase in user skills. The user progressively becomes competent and autonomous during the course. In the spreadsheet it is possible to link a learning activity to a previous and propaedeutic one.

For learning activity classification (managed with the step 2 of 4C/ID) the tool automatically incorporates all the information in terms of effort and costs estimate of each activity.

In fact, the sheet "learning task inventory", every activity is classified with information about:

- participants (for all, single, small group, class group)
- in presence and/or digital
- type of delivery and digital content support (in house/outside, videoconference, AR, VR, bulletin boards, collaboration tools, presentations, editing tools, ... etc.)
- teacher / subject expert availability
- design and delivery effort estimate for classroom activities
- design and delivery effort estimate for digital activities
- estimated costs for classroom activities
- estimated costs for digital activities

Last step is the definition of Procedural information (typically those given in digital tools and platforms), designed in the step 7. These are all the information that support students in the routine activities related to the learning task and concern:

- Procedural information: those are essentially help information and/or synthetic instructions (step 7)
- Cognitive rules: those are information about how to practically manage the give exercise (step 8)
- Constituent knowledge: those are the fundamental knowledge at stake in the performance of the test (step 9)

The final step is the definition of the Part Task Practice (step 10 of the design) for the activities defined as recurrent. In this case the sub-activities to be trained and/ or guaranteed to enable the student in the execution of the task are indicated. As well as the technical abilities, soft skills can also be indicated.

Then it is necessary to explain problem solving activity requested by the learning activity under 4 different conditions:

- Supportive information: information about how to manage the activity (examples, process diagrams, theoretical model, useful information, etc.),
- Support & Guidance: feedback indications, with contextualized suggestions for resolving the activity,
- Cognitive strategy: rules and problem solving process implied in the exercise,
- Mental model: (knowledge map): structure of information related to the problem.

For schematizing the components of the 4C/ID model and the elements of the design matrix, we refer to the pyramid of Miller [18] for evaluation: (1) Knows, (2) Know How, (3) Show How, (4) Does. It is clear from this schematization that experiential learning tasks are positioned at the top of the pyramid. At levels 3 and 4 there are more experiential activities and objectives.

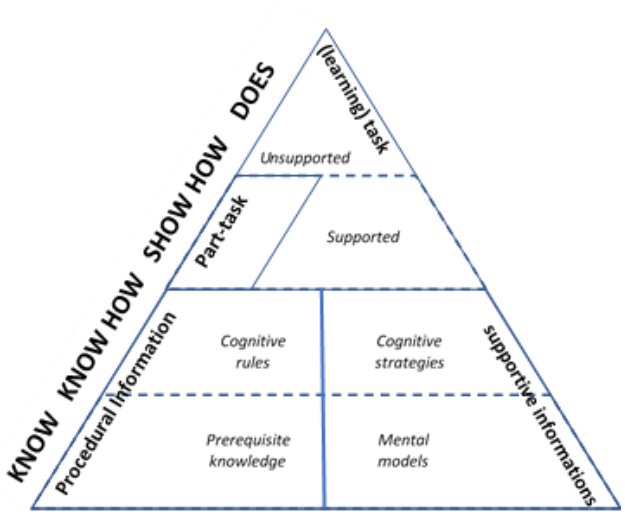

Figure 5: Pyramid of Miller [18] for evaluation.

Procedural information (in recurrent components) and part-task practice, concern useful knowledge for the activity execution.

Supportive information concern about information and cognitive strategies related to problem solving that are the basis of the execution of the learning task.

There is a substantial evolution of digital learning from a content-oriented approach to an experience-oriented approach. This means strongly moving the instructional design from the verification of the teachings to the evaluation of real tasks execution in a perspective of people readiness to job challenges. An experiential approach not only adapts to adult education, but especially in digital contexts.

3. Conclusions and next steps

The experimentation of the 4C/ID model was immediately interesting for the important focus on experientiality and evaluation models that allow the company instructional designers to focus on target behaviors rather than on content.

This opportunity represents an important vector for transforming learning programs in a new blended/hybrid perspective by strongly focusing on methods rather than on tools functions and power. Today, for a digital learning company, it becomes increasingly important to propose complex training programs without constraints of technological chances or barriers due to users' level of digitalization. It is also strategic enhancing the experiential learning methods to rapidly increase the learning impact on operative results in companies.

The paper proposes a practical guide for instructional designer, with a tool created on the 4C/ID model. The tool aims to be a simple and useful device for learning provider, in the definition of a course considering contextual aspects of the design, including budgeting, management of resources and incidental issues, starting from the Complex Learning methodology.

For those reasons, the research next steps will concern:

- the practical experimentation of the design model on specific needs in a real client context, evaluating its implementation and the outcomes regarding the learning objectives,
- the theoretical study on how effectively analysing learning impact on professional and organizational goals.

4. References

[1] Lynch, M. (2020). E-Learning during a global pandemic. Asian Journal of Distance Education, 15(1), 189-195.

[2] Limone, P., & Di Fuccio, R. (2021). teleXbe 2021-The role of technologies in education and new trajectories of blended learning. In Technology Enhanced Learning Ecosystems for Blended Education - teleXbe, vol-2817, ceur.

[3] Toto, G. A., & Limone, P. (2020). Hybrid digital learning environments for college student education. In Second Symposium on Psychology-Based Technologies Psychology-Based Technologies PSYCHOBIT 2020, vol-2730,. ceur.

[4] Limone, P.(2021). teleXbe 2021- Towards a hybrid ecosystem of blended learning within university contexts. In Technology Enhanced Learning Ecosystems for Blended Education - teleXbe, vol-2817, ceur.

[5] Calvo, S., Lyon, F., Morales, A., & Wade, J. (2020). Educating at scale for sustainable development and social enterprise growth: The impact of online learning and a massive open online course (MOOC). Sustainability, 12(8), 3247.

[6] Beinicke, A., & Bipp, T. (2018). Evaluating training outcomes in corporate e-learning and classroom training. Vocations and learning, 11(3), 501-528.

[7] Anderson, J. R. (1982). Acquisition of cognitive skill. Psychological Review, 89, 369–406.

[8] Schunk, D. H. (1996). Learning theories (2nd ed.). Englewood Cliffs, NJ: Prentice-Hall.

[9] Hong, J., Pi, Z., & Yang, J. (2018). Learning declarative and procedural knowledge via video lectures: Cognitive load and learning effectiveness. Innovations in Education and Teaching International, 55(1), 74-81.

[10] Anderson, J. R. (1995). Cognitive psychology and its implications (4th ed.). New York, NY: WH Freeman

[11] Van Merriënboer, J. J., & Kirschner, P. A. (2017). Ten steps to complex learning: A systematic approach to four-component instructional design. Routledge.

[12] Ragan, T. J., & Smith, P. L. (2004). Conditions Theory and Models for Designing Instruction.

[13] Kirschner, P., & Van Merriënboer, J. (2008). Ten steps to complex learning a new approach to instruction and instructional design.

[14] Van Merriënboer, J. J., Kirschner, P. A., & Kester, L. (2003). Taking the load off a learner's mind: Instructional design for complex learning. Educational psychologist, 38(1), 5-13.
[15] Van Merriënboer, J. J., & Kester, L. (2014). The four-component instructional design model: Multimedia principles in environments for complex learning.
[16] Csikszentmihalyi, M. (2000). *Beyond boredom and anxiety*. Jossey-Bass.
[17] Csikszentmihalyi, M., & Csikzentmihaly, M. (1990). *Flow: The psychology of optimal experience* (Vol. 1990). New York: Harper & Row.
[18] Miller, G. E. (1990). The assessment of clinical skills/competence/performance. *Academic medicine*, *65*(9), S63-7.