Validation of a Model for the Formalization of Personal Learning Pathways Through Expert Judgment

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Personalized learning pathways enable students to take an active role in their learning. Therefore, the development of models that facilitate their design is crucial. This study aims to validate a model for formalizing personalized learning pathways for higher education students using the expert judgment technique. Two questionnaires were designed to validate content and internal consistency, respectively. The content was validated by a group of experts (n=12), while the internal consistency was validated by a nominal group (n=8). The results of content validity were satisfactory, and the level of agreement between judges, as measured by Kendall's W test, was statistically significant in the implementation (p=0.007) and reflection (p=0.035) phases. To increase internal consistency, the study recommends implementing a simplified implementation scheme, adjusting the start-up phase in the conditional components (teacher digital literacy and technological environment), and incorporating teacher-student co-design. The improved ACDGE model emerges as a standard for designing learning pathways for higher education, minimizing the need to search for solutions to known problems.

Keywords: personal learning pathway, expert judgment, content validity, design-based research, model

INTRODUCTION

Student-centered pedagogical paradigms encompass a variety of innovative methods that place students and their learning at the center of the educational process (Hoidn, 2020). This approach promotes students' active participation in their own learning and encourages critical thinking, while the teacher acts as a facilitator rather than a passive transmitter of learning (Dlalisa & Govender, 2020).

In this context, informal and implicit instructional strategies emerge to guide students in making decisions about the organization of their own learning (Agustini et al., 2021), as well as in the analysis and synthesis of learning content (Klemenčič, 2017). Among the many initiatives that promote student-centered learning, learning pathways stand out (Salinas et al., 2022).

Proprietary, an itinerary is a journey taken by the user within multimedia material (Adell, 1995). The earliest concepts were called sequences (Taba, 1974), activity sequences (Brusilovsky, 1992), flexible itineraries (Agudelo & Salinas, 2015), and personal learning pathways (Salinas et al., 2022).

As indicated by Villatoro and De Benito (2022), learning pathways function as:

1. A powerful organizer of the concepts/topics to be learned, the learning objects, and the assessments to be used.
2. A system of flexible learning sequences for understanding a specific topic.
3. An active methodology that adapts to students' interests and needs.

The review of the literature on the construction of learning pathways shows an interest in the implementation of intelligent adaptive systems, such as "algorithm-IA" (Nabizadeh et al., 2020), handmade implementation through repositories (Marcelo et al., 2011), graphical representation systems such as concept maps (Agudelo & Salinas, 2015), LMS implementation through Moodle (Salinas et al., 2022), and augmented reality (Buitrago, 2020). The aforementioned studies identify the technological configuration used to implement learning pathways as crucial to promote flexibility, adaptability, collaboration, academic self-regulation, agency, and co-design between teachers and students. Despite this, there is no concrete line of research that allows for the synthesis of a model that leads to the design of personalized learning pathways.

This has been discussed by Buitrago et al. (2021), who suggest that the diversity of studies in this context provides theoretical references that help enrich the state of the art in particular educational contexts, but without evidence of the development of formal models that lead to design.

In this regard, a model has been proposed to respond to the need to fill the gap in the field of the design of personal learning pathways, given that research on models that guide their elaboration is still in its infancy.

Consequently, the present research aims to validate a model to formalize personal learning pathways for higher education students. Considering the objective, this work answers the following research questions:

1. What is the content that should be part of the phases of a model to formalize personal learning pathways in higher education?
2. Which elements should be prioritized in the model?

BACKGROUND

ACDGE Model for the Formalization of Personal Learning Pathways

The ACDGE (Attributes, Components, Deliverables, process Groups) model was born after applying iterations of theoretical foundation and design. First, the literature review in the field of design of models for the development of personalized learning pathways has presented recent results, the product of works that seek to identify the characteristics necessary for their creation and that facilitate customization (Salinas et al., 2022) . In this sense, Villatoro and de-Benito (2022), propose a model that integrates the perspectives of self-regulation, technology and co-design. Such a model allows students to self-regulate their learning process and to be the main decision-makers in terms of knowledge acquisition.

In addition, other important findings have been identified that are not tied to a specific representational model. These include approaches to personalize learning sequences (Li et al., 2022), co-design (Salinas et al., 2022; Villatoro & de-Benito, 2022), differentiated feedback (Lindín et al., 2022; Raj & Renumol, 2022), and collaborative learning (Rahayu et al., 2022). These elements are considered fundamental to the design of personalized learning pathways and are frequently identified in the scientific literature.

The design process was initiated through the application of the Delphi technique, involving a group of experts (n=14) in the field. The main objective of this phase was the identification of a language for the construction of patterns and the definition of a systematic architecture that would provide suggestions for the design of learning pathways.

It is important to emphasize that the language identified during this process plays a fundamental role in facilitating communication between designers of different profiles and non-experts. In addition, this language allows the articulation and externalization of accumulated knowledge about successful experiences in solving recurring problems in the educational context (Gros et al., 2016; Seoane & García-Peñalvo, 2014).

After identifying the relevant elements in the literature review and defining the pattern language to formalize the pathways, the general architecture of the model was designed. As a result, three phases were defined in the model: the initial phase, the implementation phase, and the reflection phase.

Initial Phase

The ACDGE model, in its initial phase, incorporates four conditional components previously implemented in technology acceptance models (TAM). These components, which have been replicated in other studies due to their rigorous validation by experts, include motivation, technological environment, teachers' digital literacy, and perceived usefulness. These components have been shown to be effective in the work of researchers such as Puentedura (2006), Piedrahita and Lopez (2008), Siemens and Tittenberger (2009), Koehler and Mishra (2009), Jung and Latchem (2011), and Sosa et al. (2018).

In the first phase of the ACDGE model, participants assess their level in each of the above components through a series of questions. The goal of this phase is to identify conditions that may facilitate or hinder the development of strategies to increase their motivation to create personal learning pathways.

Implementation Phase

The implementation phase consists of four building components: descriptive, pedagogical, organizational and technological. It also has twenty-four attributes, five process groups: initiation, planning, execution, monitoring and closure, and thirteen deliverables. Its main objective is to conduct strategic actions to achieve the following:

- Identify the topic, concept or didactic unit to be worked on (Salinas et al., 2022).
- Plan and create the learning and assessment objects to be used (Salinas & De-Benito, 2020).
- Organize each learning object in sequences according to the stages proposed by Conole (2013).
- Determine how to personalize the pathway (Li et al., 2022).
- Determine how to present and develop the pathway (Buitrago et al., 2021).
- Describe the technical resources, both software and hardware, necessary for the end users of the pathway (Salinas et al., 2006).

Regarding the definition of the components, the descriptive component includes the main characteristics that are usually used to describe the pathways, while the pedagogical component addresses methodological and pedagogical aspects related to the use of the pathways. The organizational component focuses on the classification of learning, activities and their relationship with the training modality, and the technological component focuses on the definition of the technical and technological requirements for the use of the pathways, as well as the necessary competencies of the teacher and the student.

In terms of process groups, initiation processes are those carried out to define a new learning pathway or the reuse of an existing one, identifying the requirements, scope, objectives and stakeholders. Planning processes focus on the design of activities, resources, and quality assessment in the design of a learning pathway. Execution processes are those required to complete the work defined in the learning pathway design plan to meet its requirements. Monitoring and control processes are needed to track, analyze, and regulate the progress of the learning pathway design. Finally, closure processes are those that are performed to formally complete or close the pathway design.

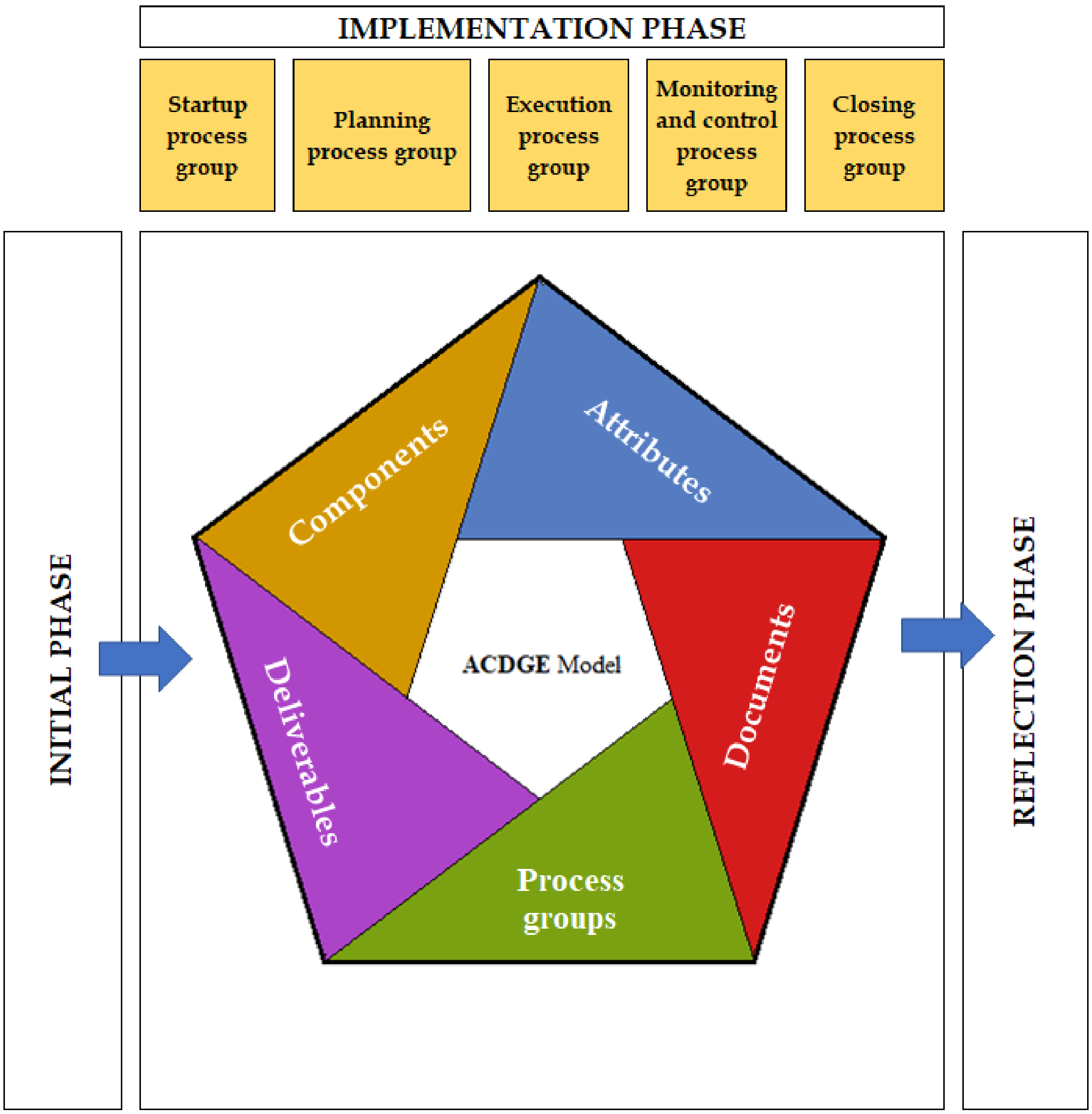
Reflection Phase

The reflection phase of the ACDGE model consists of six stages: description, feelings, evaluation, analysis, conclusions and action plan. The goal of this phase is for both teachers and students to engage in a cyclical process of deep and objective reflection, free of emotional influences, while designing their personal learning pathways.

This phase is based on the reflective model of Graham Gibbs (2008), which is represented by a generic cycle that can be applied to teachers' reflective practices (Yamamoto et al., 2010). Therefore, it is believed that the implementation of this model in the ACDGE can lead to deeper reflection by teacher-students in the design and implementation of their personal learning pathways.

Figure 1 shows the graphic representation that formalizes the essence of the practice in a compact form, seeking to integrate the aforementioned conceptual frameworks.

FIGURE 1
ACDGE MODEL SIMPLIFIED REPRESENTATION



METHODOLOGY

Considering the research objective, the Design-Based Research (DBR) methodology is employed, which provides a framework for studying the design and implementation of educational innovation through participatory and iterative processes (De Benito & Salinas, 2016).

Within the DBR research framework, Reeves (2006) and later De Benito and Salinas (2016) presented a model consisting of the following stages: a) problem analysis; b) theoretical foundation and design; c) implementation, validation, and redesign; and d) production of documentation and generation of design principles. This article presents the results of the model validation cycle.

To address the research questions, the expert judgment strategy was employed. For the first question, an "individual aggregation of experts" was performed without contact to analyze the content validity of each phase of the model. Among the advantages of this strategy, Cabero and Llorente (2013) emphasize the possibility of obtaining detailed and comprehensive information on a specific aspect, in addition to collecting informed opinions from people experienced in the subject.

Regarding the action plan to answer the second question, the nominal group technique was implemented. Here, experts provided individual feedback on internal consistency at each phases of the model. Dang (2015) determines that this technique produces semi-quantitative data whose analysis reveals significant interpersonal relationships of content among the participants, allowing agreement or prioritization to be reached according to their level of structuring (Cabrero & Infante, 2014; Gros, 2016).

Participants

To validate the content, a group of 12 experts (women=8, men=4) was formed. Their selection was determined by a series of structured criteria such as the biogram and the expert's competence coefficient (Cabero & Llorente, 2013). In the first criterion, a biography of the expert was elaborated based on his or her answers on aspects such as: experience as a researcher (more than 5 years), years of teaching experience (more than 10 years) and academic training (doctoral degree in education or educational technology). To obtain the second, it was necessary to self-assess their confidence in their knowledge of the subject (scale of 0 - 10), as well as the identification of sources that have contributed to their ability to argue on the subject (scale: high, medium, low).

Eight experts participated in the nominal group (women=4, men=4). The selection procedure responded to the following criteria: implementation of personal learning pathways in higher education courses (over 3 years), academic background (minimum: master's degree in education or educational Technology) and not participating in the content validation group.

Instruments

The ad hoc questionnaire for content validation was designed with the free software application "Lime Survey" and consists of three sections: 1) identification data; 2) assessment of the quality of the conceptual elements of the model; and 3) assessment of the overall quality of the model. In sections 2 and 3, the experts evaluated the model according to established criteria (See Table 1), on a scale of 1 to 5 (1=low to 5=high). On the other hand, qualitative judgments could be made in these same sections (reformulate, delete, add, etc.), to improve the model. The link to access the survey is available at https://tinyurl.com/ybtpm5c6.

TABLE 1
CRITERIA IMPLEMENTED IN CONTENT VALIDATION

Criteria	Definition
Pertinence	Correspondence between the content of the element and the function for which it will be used in the model.
Relevance	Degree of importance of the element within the model.
Clarity	The item is written in a clear and precise manner, facilitating its understanding by the respondents.

The model consistency validation seeks to examine the balance between phases-stages (Goodyear & McAndrew, 2013), the visualization of the key theoretical elements (Goodyear & Yang, 2009) and the degree of consensus among judges with each of the conditions of the model (Gros, 2016). Considering the above aspects, an ad hoc questionnaire was designed in "Lime Survey", composed of 5 open-ended questions, which would be used with the nominal group.

The link to access the survey is available at https://tinyurl.com/y2a6ajon.

Procedure

The experts who would participate in the content validation were contacted via email. After their acceptance, they received the instructions and material (ACDGE model implementation guide and link to the validation questionnaire). Here the twelve selected experts completed the questionnaire anonymously.

Once the previous stage was completed, the internal consistency validation was developed, starting with the call for the nominal group. After their acceptance, the group was invited via email to answer the questionnaire and, simultaneously, summoned to a synchronous group interview for a "nominal group session".

The answers to the questionnaire were recorded before the group interview, by means of a digital "Post-it" in the online platform "Lucidchart" in a test version, guaranteeing the anonymity of each expert. Consequently, at the beginning of the nominal group session, the instructions of the process were transmitted:

1. Reading aloud each statement provided in the form.
2. Clarification of statements to merge, add or delete.
3. Consensus evaluation and ranking.

The consensus evaluation and ranking phase was conducted by making individual judgments on a Google Forms form. This process was applied to each statement once phases 1 and 2 had been executed. Consensus was evaluated on a scale of 1 to 9 (1 = Strongly disagree to 9 = Strongly agree), considering that the statement responds in a relevant way to the question. In the ranking, the five most important statements of each question were selected, and a judgment was made on a scale of 1 to 5 (1 = least important to 5 = very important).

The data collected in the two questionnaires were statistically processed with the IBM SPSS program (version 25). Subsequently, to determine the level of agreement in content validity, the coefficient of variation (CV) was calculated for each criterion in the three phases of the model. Here it was considered an acceptable level when the value does not exceed 40% (García-Ruiz & Lena-Acebo, 2018; Reguant-Álvarez & Torrado-Fonseca, 2016). In addition to the above, the inter-judge agreement coefficients were obtained for the three phases of the model. Therefore, Kendall's non-parametric W test was applied, which examines the degree of association between k sets of average ranks of the evaluations made by the 12 experts. Kendall's coefficient of concordance is interpreted by rejecting the hypothesis that the ranks are independent and do not agree, when $p< 0.05$ (Zamora-de-Ortiz et al., 2020).

In order to achieve consensus among the nominal group judges, we followed the scale recommended by Their and Mason (2019). Consensus was reached when a specific proportion of judges (e.g., 6 out of 8) scored a given category within the same 3-point range (4-6 = acceptable; 7-9 = satisfactory). Additionally, ranking was obtained by summing up the scores assigned by judges to all the answers for the same question.

RESULTS

The results are presented below according to the research questions.

Question 1: What Is the Content That Should Be Part of The Phases of a Model to Formalize Personal Learning Pathways in Higher Education?

The content validity collects the opinions of the 12 selected experts, so that the topics that make up the model can be considered in the criteria of relevance, pertinence and clarity.

In Table 2, it can be seen that the element "technological environment" of the initial phase ($M_{clarity}$ = 4.33 and $CV_{clarity}$ = 0.27), received a lower evaluation compared to the other elements belonging to the same phase. The same was reported in the implementation phase for the element "components" ($M_{clarity}$ = 4.17 and $CV_{clarity}$ = 0.22). In the Reflection phase, several items received similar ratings in terms of mean (M = 4.25) and coefficient of variation (CV = 0.28); however, emphasis should be placed on the item "Conclusions" because its standard deviation (SD = 1.24) indicates that the experts' ratings cover a wider range of values.

Now, the results lead to the conclusion that the ratings provided by the experts are satisfactory, considering that the CV does not exceed the reference value proposed by García-Ruiz and Lena-Acebo (2018) and Reguant-Álvarez and Torrado-Fonseca (2016).

Turning to the evaluation of the degree of concordance between the average ranks of the evaluations made by the experts, table 3 shows the Kendall's W coefficients and the test that allows contrasting the hypothesis of the existence of significant concordance between the experts. It can be seen that there is a statistically significant agreement between the mean ranks for relevance, pertinence and clarity in the implementation and reflection phases (g.l = 2; $p < .05$). Likewise, the strength of agreement interpreted from the Kendall's W coefficient indicates that the levels of agreement are moderate, following the recommendations of Zamora-de-Ortiz et al. (2020).

TABLE 2
DESCRIPTIONS OF THE ELEMENTS AT EACH PHASE OF THE MODEL

Phases	Elements	Pertinence			Relevance			Clarity		
		M	SD	CV	M	SD	CV	M	SD	CV
Initial phase	Motivation	5.00	0.00	0.0	4.92	0.28	0.06	4.67	0.49	0.10
	Technological environment	4.75	0.62	0.13	4.83	0.57	0.12	4.33	1.15	0.27
	Teachers' digital literacy	4.92	0.28	0.06	4.92	0.28	0.06	4.58	0.90	0.20
	Perceived usefulness	4.92	0.28	0.06	4.83	0.38	0.08	4.75	0.45	0.09
Implementation phase	Attributes	4.67	0.65	0.14	4.67	0.49	0.10	4.42	0.90	0.20
	Building components	4.67	0.65	0.10	4.75	0.45	0.09	4.17	0.93	0.22
	Process groups	4.75	0.45	0.09	4.58	0.66	0.14	4.42	0.79	0.18
	Deliverables	4.83	0.38	0.08	4.83	0.57	0.12	4.50	0.79	0.18

Phases	Elements	Pertinence			Relevance			Clarity		
		M	SD	CV	M	SD	CV	M	SD	CV
Reflection phase	Description	4.83	0.38	0.08	4.92	0.28	0.06	4.25	1.12	0.26
	Feelings	4.75	0.45	0.09	4.75	0.45	0.09	4.25	1.12	0.26
	Evaluation	4.75	0.45	0.09	4.92	0.28	0.06	4.33	1.12	0.26
	Analysis	4.83	0.38	0.08	4.92	0.28	0.06	4.25	1.21	0.28
	Conclusions	4.92	0.28	0.06	4.83	0.38	0.08	4.42	1.24	0.28
	Action Plan	4.92	0.28	0.06	4.92	0.28	0.06	4.25	1.21	0.28

In contrast, the initial phase obtained a significance $p > .05$ and low concordance strength (Kendall's W = .103), accepting the hypothesis that there is not enough evidence to conclude that the assessments among experts are associated.

TABLE 3
SUMMARY OF KENDALL'S W-TEST FOR EACH PHASE OF THE MODEL

Phase	Kendall's W	Asymptotic Significance
Initial phase	.103	.291
Implementation phase	.419	.007
Reflection phase	.279	.035

The above results are consistent with the observations received for the initial phase. From this perspective, the annotations are oriented to contextualize the teacher and seek a balance between theory and practice. In this regard, one expert mentions: "I think it is convenient to put the reader in context, something that allows him/her to have a location from the theory presented in the practical that he/she could face" (EXP 1)[1].

Another group of observations converge in the need to review the conditional components technological environment and digital competence of teachers, to facilitate their understanding and the purpose of their inclusion in the model. Here an expert indicates: "The items technological environment and teaching digital competence should be expanded more, presenting more practical and indicative elements of use" (EXP 8).

Along the same lines are the following appreciations:

> "From the definition of personal learning pathways it does not follow that they have to be based exclusively on digital elements, so perhaps the model could be revised to make it clear that these are fundamental elements, or perhaps the element "technological environment" could integrate the non-technological, considering resources in general" (EXP 2).

> "Regarding the teaching of digital literacy, it is implied that if the teacher obtains less than B1 in the self-assessment, he/she cannot continue with the process. I think he/she could continue and maybe the experience would help him/her to improve his/her level of competence" (EXP 10).

For the implementation phase, the observations aim at simplifying the number of deliverables in order to obtain a concrete and illustrative guide. In this respect, one expert mentions: "I doubt if I understand the elements "process" and "deliverable" and although it is probably me who does not understand them, perhaps the clarity with which they are presented should be improved" (EXP 3).

The above is also pointed out by an expert:

> "In the design of guides, learning resources, learning environments, etc., a maxim must be applied: better if simpler. The guide in these pages becomes so complex that designing a path becomes a tedious and costly task. The former discourages, the latter discourages. If someone has to follow this guide to design a learning pathway, he or she will have lost interest and enthusiasm before reaching the halfway point. I think the mistake is to turn the guide into a theoretical text on design" (EXP 6).

Finally, other observations attribute positive ratings to relevance and wording, as noted below: "This part is very good, clear and precise" (EXP 1). "The phases are relevant [...] The whole evaluation and monitoring process is evident" (EXP 5), "I think the document is clear" (EXP 9), "The elements are well described, [...]" (EXP 7).

Question 2: Which Elements Should Be Prioritized in the Model?

Table 4 shows the metrics obtained in the consensus evaluation (Cons) and ranking (Rank) phases for each statement through individual assessment. It should be noted that the number of statements generated per question is uneven, due to the relative importance of certain elements that emerged in the read aloud and statement clarification phases.

For questions 1 and 2, the experts produced (9) statements, ranking in the satisfactory consensus range (7 - 9) five statements per question. For questions 3 and 4, the experts generated (5) statements, being only in the satisfactory consensus range (4) statements per question. In the case of question 5, the experts formulated (6) statements, including (3) in the satisfactory consensus range.

Turning to the hierarchy, the weightings for question 1 show that the range of statements considered to be of high priority is (26 - 13), including (4) of the (5) consensus statements. This is explicitly presented in R5 (Cons = 7.25 - Rank = 9), and this indicates that there is a formulation of essential elements in the statement that are shared by the judges, but considered of low prioritization compared to other statements.

Other particular cases to highlight were presented for statement R1 of question 3 (Cons = 6.75 - Rank = 28) and statement R3 of question 5 (Cons = 5.38 - Rank = 22). This result can be explained because there is low shared understanding among the experts (Thier & Mason, 2019).

TABLE 4
CONSENSUS AND RANKING RESULTS

Answer	Question 1		Question 2		Question 3		Question 4		Question 5	
	Cons	Rank	Cons	Rank	Cons	Rank	Cons	Rank	Cons	Rank
A1	7.25	26	7.25	15	6.75	28	6.25	18	6.75	16
A2	8.00	22	5.75	7	7.88	22	8.00	28	6.00	16
A3	8.25	20	6.63	11	7.88	25	8.25	27	5.38	22
A4	6.88	8	5.75	13	7.25	19	7.00	21	8.38	23
A5	7.25	9	8.25	24	8.75	26	7.25	26	7.38	20
A6	8.38	17	8.50	14	---	---	---	---	8.13	23
A7	6.63	13	7.00	14	---	---	---	---	---	---
A8	5.00	4	6.88	8	---	---	---	---	---	---
A9	5.38	---	8.38	14	---	---	---	---	---	---

Table 5 shows the coding that emerges from the prioritized hierarchical statements. Coding is the process that groups the information obtained into ideas, concepts or themes that have similarities discovered by the researcher (Villatoro & De Benito, 2022).

TABLE 5
CODES USED FOR THE STATEMENTS PRIORITIZED IN THE NOMINAL GROUP

Code	Explanation
Clarity	Seek that the reader reads and understands without difficulty some attribute / component / phase of the model
Describe	Convey the most salient information and features with examples
Reduce/Simplify	Find a way to synthesize some attribute/component/phase of the implementation guide
Adjust	Adapt/redefine a model element
Incorporation	Add elements that do not exist in the model
Specify	Specify data or details about the model

According to the statements generated for question 1, the code that appears repeatedly is incorporation (n=2), followed by clarity (n=1), reduce/simplify (n=1) and specify (n=1). In terms of incorporation, the experts emphasize the need to add a guiding or focus question for the pathway, as well as a list of deliverables to provide a general connection of all the steps involved in the pathway design. Similarly, the clarity and reduce/simplify codes converge on the need to unify the deliverables in order to reduce their number.

In relation to the code to specify, the experts focus on the need to visualize in the guide, details on the technologies used to implement pathways (Moodle, Blackboard, Canvas, etc.), in view of the fact that each LMS has its own modes or procedures of organization.

For question 2, the code with the highest frequency is reduce/simplify (n=3), again prioritizing the reduction of the number of deliverables. The codes adapt (n=1) and incorporate (n=1) are related to the design of a “mock-up” that guides the step-by-step construction of the pathway from a visual representation.

In the case of question 3, the incorporation code (n=3) prioritizes the need to add learning achievement to the evaluation attribute. Likewise, the experts emphasize that the implementation guide should include a pantry of specific strategies for configuring the pathways together with a glossary for the appropriation of a language of patterns for the design of learning pathways. For the code specify (n=2), the experts propose to analyze the technical or technological feasibility of carrying out pathways that consider sequences based on intelligent (adaptive) systems that teachers would like to implement.

In question 4, the code specify (n=3), followed by reduce/simplify (n=2) are included in the set of statements prioritized by the experts. In general, it is considered that the design aspects of the pathway are theoretically sustainable; however, the relevance of the ACDGE model in practice may be affected, given the complexity in visualizing the design of personal learning pathways. Therefore, they propose as a solution to work on the courses in a collegial way.

Finally, in question 5, the code “reduce/simplify” (n=4) appears as an essential element in the statements on this question. Here, the recommendations converge on the development of an optimized version of the model and the inclusion (n=1) of an attribute focused on teacher-student co-design for the generation of personal learning pathways.

Adjustments Applied to the ACDGE Model as Recommended by Experts

The implementation of content validity and internal consistency allowed for the optimization of the ACDGE model in its components, process groups, attributes, and deliverables. Specifically, in each validation process, experts made different recommendations related to reformulating the initial phase in the conditional components, simplifying the deliverables, developing a graphical representation that guides the implementation process, and including teacher-student co-design.

Conditional Components

Digital literacy and the technological environment are two fundamental components in the implementation of the ACDGE model. In the revised version of the model, changes have been made to these components in order to improve the quality of digital teaching and to better adapt to the needs of teachers and students.

Regarding digital literacy, the revised version states that teachers need to have a B1 integrator level of digital literacy or higher, according to the European Framework for Digital Literacy for Teachers DigCompEdu, to implement the ACDGE model. However, considerations for the reformulation of this component focus on viewing self-assessment of the use of digital technologies for teaching as an opportunity to identify teachers’ strengths and limitations. It is also suggested that training cycles be implemented to improve teachers’ digital skills and adapt digital strategies to their personal learning paths.

Regarding the technological environment, the revised version of the ACDGE model states that the provision of a technological environment is the responsibility of educational institutions and that its implementation in the classroom can generate significant changes in teaching practice. In the considerations for the reformulation of this component, it is emphasized that the technological environment should be composed of the most appropriate technologies for the design, adaptation and use of resources and materials that support learning. In addition, it is emphasized that the assessment of the technological environment is an opportunity for teachers and students to learn, know, and participate.

In summary, the considerations for reformulating the components of digital literacy and technological environment in the ACDGE model focus on adapting these areas to the needs of teachers and students, promoting self-evaluation and continuous training, and valuing technology as an opportunity for learning and participation.

Simplification of Deliverables

According to expert recommendations, it is important to simplify the implementation guide for the ACDGE model. As a result, a new version of the model has been produced, which includes a checklist of deliverables to be produced for each phase (n=3). This new version has a more formative and progressive approach, preserving all the theoretical foundations of the first version in freely accessible annexes. In addition, it includes a graphical representation that guides teachers and students to create a personal learning pathway.

Graphic Representation of the ACDGE model

Following the recommendations of experts, a graphic representation of the ACDGE model (See Figure 2) was implemented to guide the formalization of a personal learning pathway. It should be noted that this new model representation was designed as a recipe, where the components are the ingredients and the strategies for sequencing the elements of each phase are assimilated to the recipe instructions.

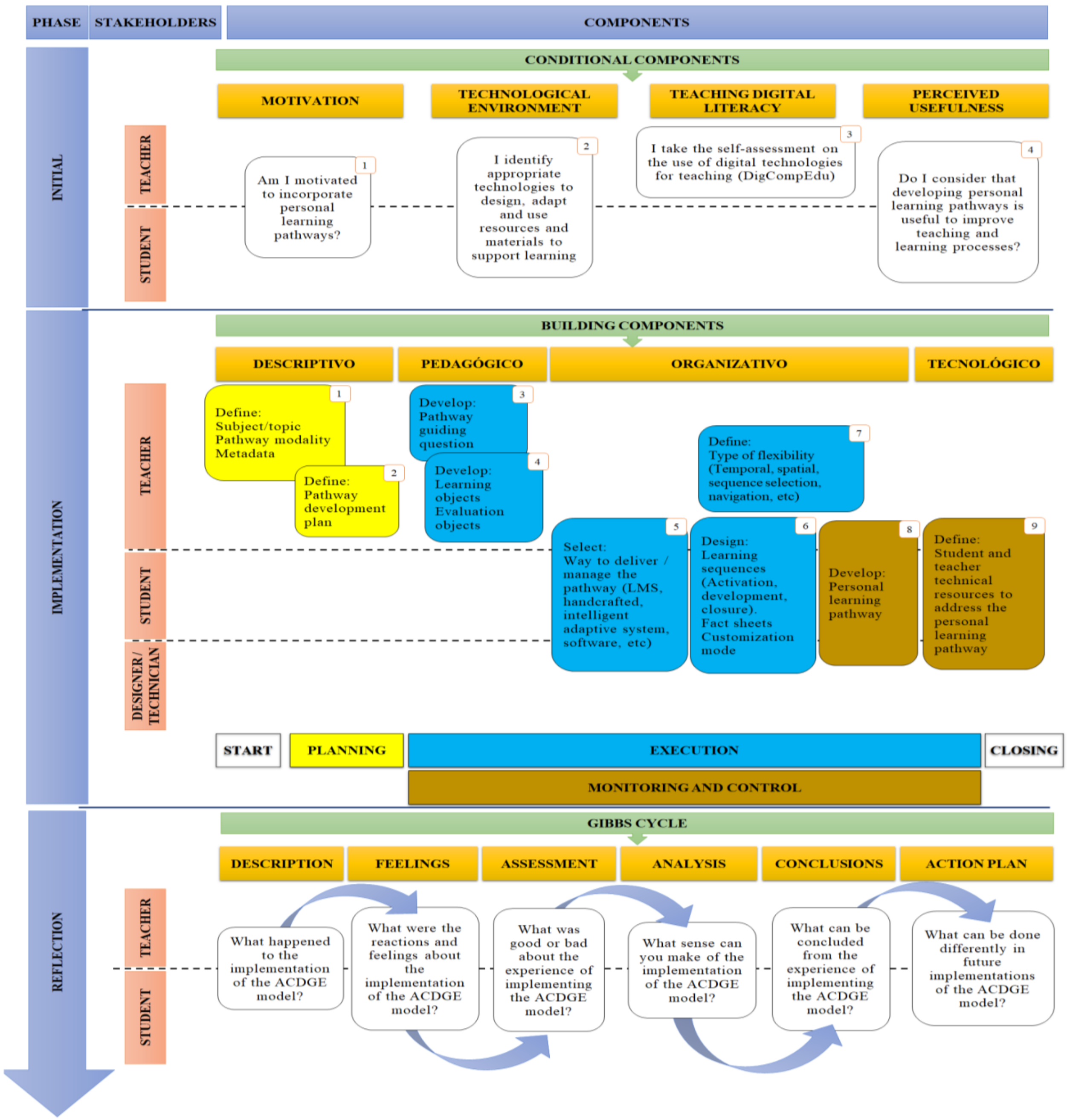
Likewise, the model is predominantly represented by a linear sequence scheme, whose navigation through the attributes of each component of the model is linear, and the sequentiality is limited to numbers that indicate the route to follow.

Teacher-Student Co-Design

A relevant aspect that emerged during the validation process is related to the inclusion of collaborative design or co-creation, applied to the formalization of personal learning pathways. According to Villatoro and De Benito, citing Bovill and Bulley (2011), this concept is related to the participatory design of the course content or topic, the objective of the work to be done, the teaching approach, the learning pathways and the evaluation.

Considering the above context, the new version of the ACDGE model clearly shows how the collaborative design between teachers and students intervenes in aspects of execution, monitoring and control of the elaboration of the learning pathway. This can be seen in the graphical representation of the model (See Figure 2), where the dotted lines of each phase indicate which components can be intervened by the different actors.

FIGURE 2
GRAPHICAL REPRESENTATION OF THE ACDGE MODEL



DISCUSSION AND CONCLUSIONS

This research presents the validation of a proposed model for the formalization of personal learning itineraries in higher education. The purpose of this model is to establish a standard for the generation of new itineraries and to minimize the repeated search for solutions to already known problems in this context. However, it should be noted that it is not possible to generalize its use, since a model does not have the same utility in different educational contexts (Pinto-Santos et al., 2022).

The ACDGE model is derived from mapping and analyzing the literature together with inductive construction based on expert consultation. Consequently, it is necessary to contrast the conditions of the model (phases, components, process groups, and deliverables) with external benchmarks unrelated to the research process. Therefore, in this work, we present the first step in validating a model, "the validity of content and internal consistency." It should be clarified that successive external and internal validations are required; that is, implementing other iterations based on the data obtained in educational practice (Zamora-de-Ortiz et al., 2020). In this sense, the interaction of teachers and students with the new version of the ACDGE model will provide relevant information to evaluate its strengths and weaknesses and, therefore, promote student-centered learning.

In terms of results, the validity of content on relevance, significance, and clarity for each element of the initial, implementation, and reflection phases obtained a satisfactory level of agreement. This was reflected in the low dispersion of data (coefficient of variation (CV) in each element. Although this test is most appropriate for this type of study (López-Gómez, 2018), the calculation of Kendall's W coefficients along with qualitative assessments shows the importance of identifying elements that lead to simplifying the implementation guide and reformulating the conditional components of the technological environment and teaching digital literacy.

Based on the above, the simplification applied to the implementation guide of the ACDGE model is the result of formalizing a process of acquiring best practices, that is, the application of a trial-and-error design pattern (Laurillard, 2012). It should be noted that the intention of simplification is not reduced to cutting parts, but its refinement was achieved through iterative cycles of implementation, validation and redesign (De Benito et al., 2010).

As for the recommendation regarding the conditional components that do not allow ACDGE to be implemented, they are reformulated so that they can be overcome by applying the model itself and become cyclic reflection phases, as recommended by Sosa et al. (2018).

In line with the qualitative results identified in the nominal group, it was possible to prioritize the elements, subsequently called categories (n=6), that must be intervened to give greater consistency to the ACDGE model. These changes generate a more robust model that modifies the role that teachers play in student-centered learning environments and comes closer to personalized learning, the development of skills for self-regulated learning, and student agency.

We emphasize that the proposed suggestion to incorporate adaptive intelligent systems for itinerary design is included in the guide as adaptive itineraries, but is not related to the first, which are data-based, as it is a technology that still has problems with content curation (Buitrago et al., 2021).

Regarding the graphical representation of the ACDGE model, a useful tool was developed to express and communicate the goal of the model. Graphical representations are a fundamental tool for establishing relationships between instances of a model (Piedrahita & López, 2008), often using frameworks to shape theoretically nebulous ideas and concepts (Siemens & Tittenberger, 2009). At best, a graphical representation that achieves a holistic perspective on the implementation of personal learning pathways may be unattainable. However, its design captures multiple perspectives (planning, flexibility, adaptability, democratization of knowledge, etc.) necessary for the design of personal learning itineraries (Pérez-Garcias et al., 2022).

Finally, it is recognized that content validity through expert judgment has limitations related to judges' ratings. This is because the judgments may be subjective or the interpretation of the construct may not be appropriate (Bessa et al., 2021). An alternative solution that minimizes bias was to consider having experts provide opinions on the inclusion/exclusion/modification of items.

In conclusion, these findings leave a shareable model that is responsive to the purpose for which it was designed, with a structure that has content relevant to its context and beneficial to its intended use. There is an open path in two lines of action: a) the continuity of validity studies in new iterations of the implementation, validation, and redesign cycle for the new version of the model, and b) the development of new knowledge about the implications of incorporating the ACDGE model in contexts other than higher education.

ENDNOTE

1. To protect the confidentiality of the participants in this study, they will be identified as experts (EXP), along with a number assigned according to the order in which they completed the instrument.

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