

## Development and Validation of a Measurement Scale for the Professionalization of University Students in Health Sciences

Marilou Bélisle , Géraldine Heilporn , Patrick Lavoie , Sawsen Lakhali ,  
Kathleen Lechasseur , Nicolas Fernandez , Marie-Eve Caty  et Tanya  
Chichekian 

Volume 45, numéro spécial, 2022

Translation Issue

URI : <https://id.erudit.org/iderudit/1110997ar>

DOI : <https://doi.org/10.7202/1110997ar>

[Aller au sommaire du numéro](#)

Éditeur(s)

ADMEE-Canada

ISSN

0823-3993 (imprimé)

2368-2000 (numérique)

[Découvrir la revue](#)

Citer cet article

Bélisle, M., Heilporn, G., Lavoie, P., Lakhali, S., Lechasseur, K., Fernandez, N., Caty, M.-E. & Chichekian, T. (2022). Development and Validation of a Measurement Scale for the Professionalization of University Students in Health Sciences. *Mesure et évaluation en éducation*, 45(spécial), 215–247. <https://doi.org/10.7202/1110997ar>

Résumé de l'article

*Cet article présente les résultats d'une étude ayant pour objectif l'élaboration et la validation d'une échelle de mesure de la professionnalisation des étudiants et étudiantes universitaires en sciences de la santé. Des éléments de preuve de contenu, de processus de réponse et de structure interne de cette échelle ont été apportés au fil de l'étude, entre autres grâce à une collecte de données auprès de 561 étudiants et étudiantes de premier et deuxième cycles provenant de quatre universités québécoises. Les analyses factorielles exploratoires appuient une structure interne à quatre facteurs, avec une très bonne cohérence interne. Un quatrième facteur (valorisation de la profession) s'ajoute aux trois facteurs (compétences, identité et culture professionnelles) énoncés dans le cadre conceptuel initial. Les analyses factorielles confirmatoires confirment cette structure ainsi que la relation entre ces quatre facteurs de premier ordre et un unique facteur de professionnalisation de second ordre. Cette échelle constitue un instrument robuste permettant d'étudier la professionnalisation des étudiants et étudiantes aux différentes étapes de leur formation en sciences de la santé.*

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## Development and Validation of a Measurement Scale for the Professionalization of University Students in Health Sciences<sup>1</sup>

**Marilou Bélisle**

ORCID: 0000-0003-0457-9139

*Faculté d'éducation, Université de Sherbrooke*

**Géraldine Heilporn**

ORCID: 0000-0002-7951-4420

*Faculté des sciences de l'éducation, Université Laval*

**Patrick Lavoie**

ORCID: 0000-0001-8244-6484

*Faculté des sciences infirmières, Université de Montréal*

**Sawsen Lakhali**

ORCID: 0000-0002-3914-3688

*Faculté d'éducation, Université de Sherbrooke*

**Kathleen Lechasseur**

ORCID: 0000-0002-1906-5870

*Faculté des sciences infirmières, Université Laval*

**Nicolas Fernandez**

ORCID: 0000-0002-3840-2641

*Faculté de médecine, Université de Montréal*

**Marie-Eve Caty**

ORCID: 0000-0003-3909-6639

*Département d'orthophonie, UQTR*

**Tanya Chichekian**

ORCID: 0000-0002-6156-0779

*Faculté d'éducation, Université de Sherbrooke*

1. The French version was published in issue 45(2) 2022: <https://doi.org/10.7202/1105562ar>



KEY WORDS: competencies, measurement scale, professional culture, professional identity, professionalization

*This article presents the results of a study aimed at constructing and validating a scale for measuring the professionalization of health sciences students. Evidence of the content, response process, and internal structure of the scale was provided throughout the study, including data collection from 561 undergraduate and graduate students from four Quebec universities. The results of an exploratory factor analysis indicated a very good internal consistency and support for a simple four-factor structure. Thus, a fourth factor (valuing the profession) was added to the three factors (professional skills, identity, and culture) set out in an initial conceptual framework. The results of a confirmatory factor analysis revealed that these four first-order factors were related to a single second-order factor of professionalization. This scale provides a robust instrument that can be used for studying the professionalization of students at different phases of their educational journey.*

MOTS CLÉS : compétences, culture professionnelle, échelle de mesure, identité professionnelle, professionnalisation

*Cet article présente les résultats d'une étude ayant pour objectif l'élaboration et la validation d'une échelle de mesure de la professionnalisation des étudiants et étudiantes universitaires en sciences de la santé. Des éléments de preuve de contenu, de processus de réponse et de structure interne de cette échelle ont été apportés au fil de l'étude, entre autres grâce à une collecte de données auprès de 561 étudiants et étudiantes de premier et deuxième cycles provenant de quatre universités québécoises. Les analyses factorielles exploratoires appuient une structure interne à quatre facteurs, avec une très bonne cohérence interne. Un quatrième facteur (valorisation de la profession) s'ajoute aux trois facteurs (compétences, identité et culture professionnelles) énoncés dans le cadre conceptuel initial. Les analyses factorielles confirmatoires confirment cette structure ainsi que la relation entre ces quatre facteurs de premier ordre et un unique facteur de professionnalisation de second ordre. Cette échelle constitue un instrument robuste permettant d'étudier la professionnalisation des étudiants et étudiantes aux différentes étapes de leur formation en sciences de la santé.*

**PALAVRAS-CHAVE:** competências, cultura profissional, escala de medição, identidade profissional, profissionalização

*Este artigo apresenta os resultados de um estudo que teve como objetivo a elaboração e a validação de uma escala para medir a profissionalização de estudantes universitários em ciências da saúde. Os elementos de prova de conteúdo, do processo de resposta e da estrutura interna desta nova escala foram fornecidos ao longo do estudo, entre outros, por meio da recolha de dados de 561 estudantes do primeiro e segundo ciclos de quatro universidades do Quebec. As análises fatoriais exploratórias suportam uma estrutura interna de quatro fatores, com uma coerência interna muito boa. Assim, um quarto fator (valorização da profissão) junta-se aos três fatores (competências, identidade e cultura profissionais) estabelecidos no quadro concetual inicial. As análises fatoriais confirmatórias também sustentam esta estrutura, bem como a relação entre estes quatro fatores de primeira ordem e um único fator de profissionalização de segunda ordem. Esta escala é um instrumento robusto que permite estudar a profissionalização dos estudantes nas diferentes fases do seu percurso de formação em ciências da saúde.*

## Introduction

Healthcare professionals have many roles and responsibilities in delivering quality, equitable and humane care. However, healthcare systems are subject to numerous pressures and constraints that accelerate the transformation of practice environments and generate a rapid increase in complexity, uncertainty, and ambiguity in professional practice. These pressures were exacerbated by the COVID-19 pandemic, which highlighted the limits of knowledge, experience, and standard practice in dealing with such crises. Training programs must, therefore, constantly adapt to the new realities arising from the rapid transformation of practice environments and professional practices.

To prepare future healthcare professionals for these current and potential challenges, training programs are increasingly aimed at professionalizing students, with an emphasis on developing their competencies. The aim is to ensure that future professionals can mobilize their resources to act effectively in complex, sometimes uncertain situations. However, the actualization of their competencies is also influenced by their professional identity and culture, as well as by the contextual characteristics of their practice environments. Indeed, the deployment of their competencies is notably influenced by the demands and expectations placed on professionals, by local leadership, by the values conveyed by colleagues and the organization, by the policies governing practice and by the support offered in terms of human, financial, material, or other resources (Thomas et al., 2023). Consequently, the constant and rapid evolution of healthcare systems, as well as the diversity of contexts in which professionals will have to practice, make the professionalization process an important issue, to prepare future professionals who will need to demonstrate adaptability, flexibility, and autonomy (Barnett, 2012).

The process of professionalization in the health sciences is, therefore, an important concern for anyone responsible for educating, teaching, or supervising future professionals, particularly in a competency-based

program. How can we document or assess student professionalization over the course of their formal education? Although competency frameworks are used to establish the expected level at the end of a competency-based program, professionalization encompasses not only the development of competencies, but also the appropriation of the professional culture and the construction of a professional identity (Abrandt Dahlgren et al., 2006; Bélisle et al., 2020).

From a conceptual point of view, student professionalization is a polysemous concept with several associated meanings. Some authors (Abrandt Dahlgren et al., 2006; Brennan & Timmins, 2012; Dannels, 2000; Dryburgh, 1999; Du, 2006; Reid et al., 2011) use “professionalization” as a synonym for the construction of a professional identity, and often implicitly in association with the appropriation of the professional culture. Others (Prince et al., 2005; Schmidt et al., 2009; Vaatstra & De Vries, 2007) refer to it in terms of the professional competencies, skills, and attitudes that students develop during their education.

Although some research has focused on the effects of training modalities on the professionalization of healthcare students (Björkström et al., 2008; Briceland et al., 2020; Jubin, 2013; Yacobucci et al., 2022), empirical studies on the professionalization of individuals in a university context are still few and far between (Abrandt Dahlgren et al., 2006; Bélisle, 2011), and the very concept of professionalization is rarely defined. Three dimensions of professionalization seem to recur: 1) the development of professional competencies, 2) the appropriation of the professional culture and 3) the construction of a professional identity. As for the instruments used to measure one or more of the dimensions associated with professionalization, a literature review of empirical studies published in French and English between January 2000 and March 2023 in healthcare (Medline, PubMed, Cinahl) and education (ERIC, ProQuest) databases revealed the existence of seven tools developed in the health sciences. Six of these are used to assess specific professional competencies in either occupational therapy (Romero-Ayuso et al., 2021), nursing (Lachmann & Nilsson, 2021; Notarnicola et al., 2018) or physiotherapy (Martíáñez-Ramírez et al., 2022; Reubenson et al., 2020; Torres-Narváez et al., 2018). The seventh tool aims to measure professional identity and values in nursing (Nocerino et al., 2020; Weis

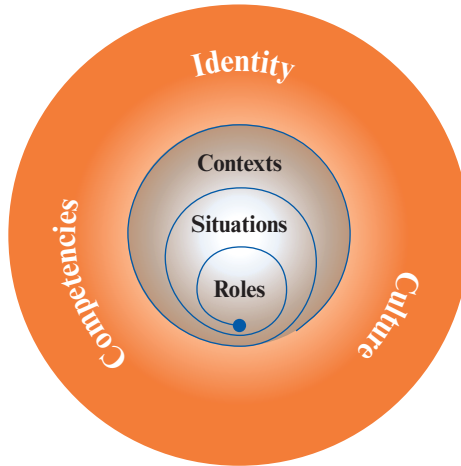
& Schank, 2009). However, these tools are limited to one or two dimensions, and therefore do not provide a comprehensive view of student professionalization.

A holistic study of professionalization, based on an explicit conceptual framework, will enable us to provide a picture not only of the competencies developed, but also of their interactions with the appropriation of a professional culture and the construction of a professional identity. To the best of our knowledge, since no instrument has yet been developed that measures these three dimensions, we sought to design a professionalization scale for health sciences students. This article presents the development and preliminary validation process of a scale designed to provide a comprehensive understanding of professionalization in a university context as well as highlight the effects of professionalizing programs on students.

### **Conceptual Framework**

Understood as a formal and informal process of professional socialization (de Swardt et al., 2014), professionalization begins, according to MacLellan et al. (2011), before formal training (pre-professionalization), takes shape during formal training (professionalization) and continues throughout working life (post-professionalization). In this study, we focus on the formal training phase; more specifically in the context of initial training. Through this dynamic and continuous process, the individual learns, cognitively and culturally, the ways of being, doing and acting that characterize a professional group (Abrandt Dahlgren et al., 2004). In a formal training context, professionalization of an individual, therefore, prepares them for a given professional practice and is the result of learning related to the development of professional competencies, the appropriation of the professional culture and the construction of a professional identity (Bélisle, 2011; Bélisle & Tardif, 2013; Bélisle et al., 2021; Bélisle et al., 2022). These three dimensions, illustrated in Figure 1 and briefly defined below, are fundamental to our understanding of professionalization to date. This conceptual framework has been developed and enriched in light of research conducted with engineering graduates (Bélisle, 2011), nursing students (Bélisle et al., 2020) and rehabilitation, pharmacy, and nursing educators (Bélisle et al., 2022) in professionalization programs.

Figure 1  
*Conceptual framework of professionalization*



The first dimension of professionalization concerns the development of professional competencies by the future professional. A professional competency is a complex knowing how to act that calls on a set of internal (e.g., knowledge, attitudes, skills) and external (e.g., human, material) resources to resolve problem situations arising from professional practice (Bélisle, 2011; Tardif, 2006). The competencies to be developed may be cognitive (e.g., exercising clinical judgment, treating all activities with scientific rigor), methodological (e.g., coordinating care and services) or relational (e.g., collaborating with professional teams, exercising leadership). The development of a competency presupposes that it is exercised through problem situations that are sufficiently complex to require a range of resources, that it evolves over time and according to the situations experienced, and that it is evaluated or assessed based on criteria or indicators known in advance. Professionalization also includes the appropriation of the professional culture, i.e., learning about the set of values, norms, attitudes, and symbols (Greenwood, 1966; Kumpulainen & Renshaw, 2008) shared by members of the same profession. Appropriation is based on knowledge of the elements that characterize the profession, as well as



on an understanding of the profession in general and the roles played by professionals, but above all on the individual's positioning in relation to this professional culture. For example, the core values in healthcare are humanism, interdisciplinarity, interprofessionalism and equity. Finally, the professionalization process leads to the construction of a professional identity, i.e., a representation of oneself as a professional (Gohier et al., 2001) that changes throughout one's life, depending on contexts (Blin, 1997) and experiences (Legault, 2003). Its construction depends not only on the person's self-image as a professional, but also on their relation to the profession concerned, to society and, for students, to their training (Bélisle, 2011). The sense of belonging to a professional group and self-knowledge as a professional in the making are recognized as key components in the development of professional identity in nursing (Maginnis, 2018; Zarshenas et al., 2014). More than the sum of its component dimensions, professionalization is a global phenomenon that needs to be better understood to grasp its ins and outs.

This study builds on our previous research, which explored students' and teachers' understanding of professionalization in an initial training context, and identified the elements associated with the three dimensions of the professionalization process (professional competencies, culture, and identity). The aim of this study was to develop and validate a scale to measure the professionalization of students in health sciences. This scale will validate the conceptual framework of professionalization developed so far from the literature and our research. In addition, it will provide an overall picture documenting the professionalization process of students during and at the end of their training. In the future, this instrument could be useful for establishing links between dimensions of professionalization and pedagogical practices, thus encouraging educators to question the gaps between intended professional learning and that perceived by the main beneficiaries of health sciences programs.

## **Method**

The scale to measure the professionalization of university students in the health sciences was developed following the eight development steps proposed by DeVellis (2016), which consist of: 1) determining the purpose of the measurement; 2) generating an initial set of statements, hereinafter called items; 3) determining a measurement format; 4) having the initial

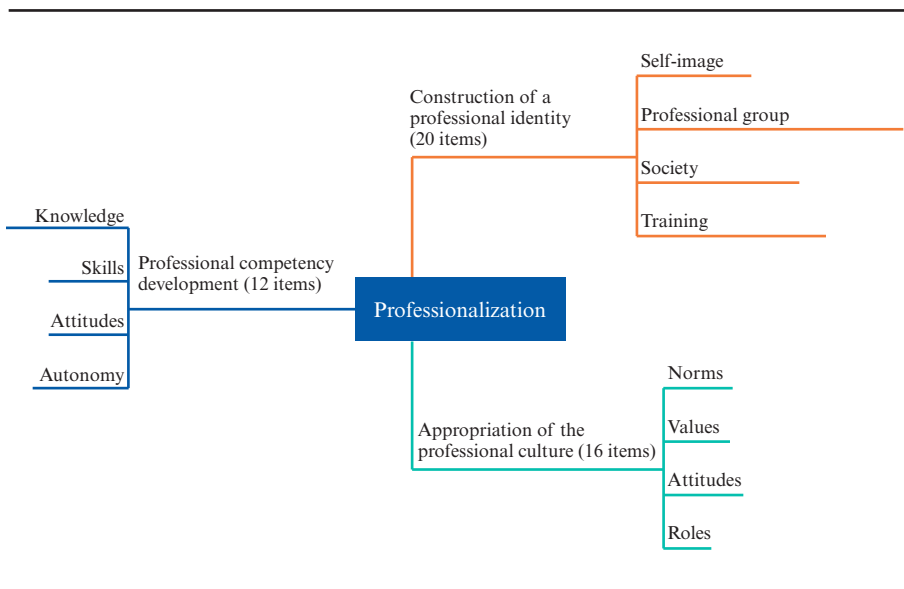
set of items reviewed by experts; 5) considering the inclusion of validation items; 6) administering the items to a sample of participants; 7) evaluating the items; and 8) optimizing the length of the scale.

**Designing the Measurement Scale (Steps 1 to 5)**

As the object of measurement is the professionalization of students (*Step 1*), the definition adopted is based on theoretical writings and empirical data from previously conducted phenomenological studies (Bélisle, 2011; Bélisle et al., 2021; Bélisle et al., 2022). Professionalization is defined as a dynamic learning process that prepares individuals for practicing a given profession and comprises three dimensions: 1) the development of professional competencies, 2) the appropriation of the professional culture and 3) the construction of a professional identity.

An initial pool of 47 items was generated (*Step 2*) from the definitions retained for each of the three dimensions and the underlying elements that had emerged from our research on professionalization. For each of the dimensions presented in Figure 2, the research team formulated 12 to 20 items, respecting the following three characteristics: specificity, conciseness, and clarity of each item (DeVellis, 2016).

Figure 2  
*Initial dimensions of the professionalization measurement scale*



As for the measurement format (*Step 3*), we chose the self-report method and asked participants to respond to each item using the seven-point Likert scale ranging from 1 = strongly disagree to 7 = strongly agree. This format is often used to measure participants' level of agreement with statements pertaining to their opinions or attitudes (DeVellis, 2016). The number of levels was chosen to allow for a wide variability in responses while avoiding a lack of discrimination or cognitive overload, as might be the case beyond seven levels (Streiner et al., 2015). The team also selected an odd number of response choices so that participants unsure of how to position themselves regarding a particular item could choose a neutral response (Sturgis et al., 2014).

The initial pool of items (*Step 4*) was reviewed by five people with expertise in the competency-based approach or in professional education in a university context. Using a three-level response scale (1) disagree, 2) neither agree nor disagree, and 3) agree), they independently examined each item based on the following two criteria: the relevance of the item to the theoretical construct, and the clarity of the item. If the expert disagreed or neither agreed nor disagreed, an explanation was requested. After compiling the responses obtained from the experts, the team modified the initially formulated items for all three dimensions. Thus, a few items were reformulated for greater clarity, 10 items whose relevance did not meet with consensus were eliminated, and 11 items were added to better reflect the dimensions studied. A joint working session with the experts and the research team then took place to present the modifications made to the pool of items and to approve, through a consensus between the five experts, the 48 items selected for the measurement scale.

The 48 items selected were prevalidated with a small sample of 39 physiotherapy students. No modifications were necessary, reflecting the respondents' good understanding of the scale items.

As professionalization is not considered a sensitive topic, no items designed to measure possible social desirability bias were included (*Step 5*). Furthermore, to the best of our knowledge, no student professionalization scale has previously been presented in either French or English. We were, therefore, unable to include another scale to provide evidence of the new scale's relationship with other professionalization variables.

### ***Administering and Evaluating the Scale (Steps 6 to 8)***

To test the professionalization scale (*Step 6*), we targeted students from 12 health sciences programs at four Quebec universities. These programs were selected on the basis of three criteria reflecting characteristics of professionalizing education (Bélisle, 2011): (a) preparing students for practicing a given profession; (b) providing a clear and explicit output profile (e.g. competency framework); and (c) implementing active learning methods (e.g. simulation, problem-based learning, case study, clinical placement) throughout all years of the program.

Following the authors' (Costello & Osborne, 2005; DeVellis, 2016; Yong & Pearce, 2013) recommendations for validity testing, we aimed for a ratio of five to ten participants per item, equivalent to a minimum of 240 participants for the 48 items of the measurement scale. After the project was approved by the local research ethics committee, each program manager invited their students to participate in the online questionnaire presented on the SurveyMonkey platform. Data collection took place in the spring and summer of 2021. The principal investigator and research professionals, all external to the study programs involved in the research, managed and processed the data.

After data cleaning<sup>1</sup>, the initial sample comprised 561 participants, representing a response rate of 12%. This sample was then subdivided into two samples of equivalent size by a random data selection procedure in SPSS software ( $n_1 = 290$  and  $n_2 = 271$ ) so that exploratory and confirmatory factor analyses could be carried out on different samples, as recommended in the literature (Fokkema & Greiff, 2017; Worthington & Whittaker, 2006). These sample sizes met the minimum recommended ratio of 5:1 to the number of initial items in the measurement scale. In addition, several researchers (Beavers et al., 2013; Maccallum et al., 1999; Worthington & Whittaker, 2006) maintain that samples of 150 to 200 participants are adequate if the communities and saturations obtained on the factors are sufficiently high.

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1. Potential outliers from two participants were deleted according to Mahalanobis distance analysis (Tabachnick & Fidell, 2007). All items in the scale were set as mandatory answers in SurveyMonkey, which avoided dealing with missing data.

Chi-square tests of independence ( $\alpha = 5\%$ ) showed that there was no significant difference between the two samples for *Gender* ( $p = 0.17$ ), *Age* ( $p = 0.47$ ), *Year* ( $p = 0.15$ ) and *Previous Work Experience* ( $p = 0.32$ ). Table 1 shows the majority of participants identify as female ( $n_1 = 85.59\%$ ;  $n_2 = 79.92\%$ ), were between 21 and 25 years of age ( $n_1 = 63.53\%$ ;  $n_2 = 69.80\%$ ) and had no previous work experience ( $n_1 = 69.78\%$ ;  $n_2 = 76.52\%$ ).

Table 1  
*Sociodemographic characteristics of participants*

Features	$n_1 = 290$		$n_2 = 271$	
	<i>n</i>	%	<i>n</i>	%
<b>Gender</b>				
Female	225	85.59	195	79.92
Male	41	15.41	49	20.08
<b>Age</b>				
≤ 20 years	52	19.55	39	15.92
21-25 years	169	63.53	171	69.80
26-30 years	31	11.65	26	10.61
≥ 31 years	14	5.26	9	3.67
<b>Year of Program</b>				
First year	109	40.67	81	32.53
Second year	60	22.39	58	23.29
Third year	59	22.01	57	22.89
Fourth or fifth year	40	14.93	53	21.29
<b>Previous Work Experience</b>				
None	187	69.78	189	76.52
1-5 years	63	23.51	42	17.00
6-10 years	14	5.22	12	4.86
≥ 11 years	4	1.49	4	1.62

Note: Some participants did not respond to the sociodemographic items which were at the end of the questionnaire. The percentages in this table were calculated on valid responses.

To evaluate the scale items (*Step 7*), the first sample ( $n_1 = 290$ ) was subjected to preliminary analyses (asymmetry, normality, item-item, and item-scale correlations), thus guiding the subsequent evaluation process. Exploratory factor analyses (EFA) were then conducted using SPSS 25 software to determine the factor structure of the data. Optimization of

the scale length (*Step 8*) was also carried out at this stage, according to the saturation of the items with their factor. Then, an internal consistency analysis was performed for each factor of the resulting scale. Subsequently, confirmatory factor analyses (CFA) were conducted on the second data sample ( $n_2 = 271$ ) to confirm the previously identified factor structure (Worthington & Whittaker, 2006). These confirmatory analyses were performed using EQS 6.2 software (Bentler, 2006).

## Results

Chi-square tests of independence ( $\alpha = 5\%$ ) showed no significant difference between the two samples for Gender ( $p = 0.17$ ), Age ( $p = 0.47$ ), Year ( $p = 0.15$ ), and Previous Work Experience ( $p = 0.32$ ), avoiding a possible bias in the results obtained from the two samples. Thus, the evaluation of the professionalization scale is essentially based on the results of the EFAs conducted on the first sample ( $n_1 = 290$ ), followed by the results of the CFAs performed on the second sample ( $n_2 = 271$ ). Prior to these factorial analyses, which revealed the validity of the scale for the proposed use, we carried out descriptive analyses (which can be consulted in Appendix A) and some preliminary analyses of the data.

### *Preliminary analyses (n1)*

Most items showed a slight negative skewness (mean skewness - 0.87, minimum - 1.80). The significant results of the Shapiro-Wilk test ( $p = 0.000$ ) also support the hypothesis of non-normality of the data.

Following a preliminary review of the data, two of the 48 items (CU12 and ID11, see Appendix A for the wording of each item) were eliminated because they had low item-scale correlations (full correlations of corrected items  $< 0.40$ ), as well as a very large number of item-item correlations below 0.32 (DeVellis, 2016; Pituch & Stevens, 2016).

The other items showed item-scale correlations fluctuating between 0.42 and 0.76 (mean 0.62). However, no item had a correlation greater than 0.80 with another item, and the data showed no sign of multicollinearity (Bourque et al., 2007; Tabachnick & Fidell, 2007).

### ***Exploratory Factor Analyses (EFA) (n1)***

We first verified how the data fit with the EFAs. The Kaiser-Meyer-Olkin (KMO) index  $0.95 \geq 0.7$  suggested excellent item fit with underlying factors (Beavers et al., 2013; Bourque et al., 2007). Also, Bartlett's sphericity test produced a significant result ( $p = 0.000 < 0.05$ ) confirming that the matrix of observed correlations was not an identity matrix and therefore factorizable (Beavers et al., 2013).

Assuming correlation between relative dimensions of the theoretical construct of professionalization, we extracted factors using principal axis factoring with oblique (oblimin) rotation (Worthington & Whittaker, 2006). The initial EFA resulted in seven factors with eigenvalues of 19.58, 3.41, 2.25, 1.86, 1.37, 1.25 and  $1.08 > 1.00$ , explaining a total of 61.50% of the shared variance in the data (after rotation). However, these seven factors did not have a clear conceptual meaning, according to the shape matrix after rotation. Moreover, the scree plot suggested a structure of four or five main factors instead. Therefore, new exploratory factor analyses (EFA) were conducted by forcing the number of factors in order to determine the structure that made the most sense from a conceptual standpoint. The examination of the structure with five factors was inconclusive, however, as the fifth factor only contained two items following the process of eliminating items that did not have sufficiently high communalities or factor loadings ( $> 0.40$ ).

In the four-factor structure, five items (CO1, CU14, ID5, ID10, ID2) were deleted because they showed weak communities with the other items after rotation ( $< 0.40$ ) (Worthington & Whittaker, 2006). One item (CO11) was also eliminated because it showed no significant saturation (0.40) with any factor (Worthington & Whittaker, 2006). At this stage, the rotating shape matrix showed a simple four-factor structure that can be easily interpreted from a conceptual point of view. These explained 43.13% (15 items), 6.67% (9 items), 4.60% (4 items) and 3.52% (11 items) of the partial variance of the data, for a total of 57.93% after rotation (61.96% before rotation). The first factor (F1) concerns the acquisition of knowledge and the development of competencies useful in practicing the profession. The second factor (F2) refers to the construction of professional identity, in particular preferred roles, and approaches, as well as knowledge of one's own strengths and weaknesses. The third factor (F3) corresponds to how

the profession is understood and valued by society and other professional groups. Unlike the initial conceptual framework of professionalization, the EFAs indicate that this factor, originally considered an element of professional identity, is clearly distinct from the other factors. The fourth factor (F4) refers to the appropriation of the professional culture: knowledge, adoption and implementation of the norms, rules, and core values of the profession.

Given the high number of items for factors F1 (professional knowledge, competencies, and preparation), F2 (professional identity) and F4 (professional culture), which resulted in a fairly long measurement scale of 40 items, we proceeded to optimize the length of the scale (DeVellis, 2016; Worthington & Whittaker, 2006). As a result, eight items (CO8, CO12, CU9, CU13, CU15, ID1, ID6, ID17) with factor loadings below 0.50 were removed. The resulting scale featured 13 items for F1, 6 items for F2, 4 items for F3, and 9 items for F4, for a total of 32 items that explained 60.33% of the shared variance of the data after rotation. Table 2 presents the saturations and communities after rotation ( $h^2$ ) and the squared multiple correlation ( $R^2$ ) of the final scale.

Factor F1, the acquisition of knowledge and development of professional competencies, showed a strong correlation with the factor of professional culture appropriation (F4,  $r = 0.65$ ), and a moderate correlation with the factors of professional identity construction (F2,  $r = 0.34$ ) and valorization of the profession by society (F3,  $r = 0.41$ ). The factor of professional identity construction (F2) was weakly correlated with the factor of valorization of the profession by society (F3,  $r = 0.14$ ), but showed a moderate correlation with the factor of professional culture appropriation (F4,  $r = 0.47$ ). Finally, the factor of valorization of the profession by society (F3) was moderately correlated with the factor of professional culture appropriation (F4,  $r = 0.36$ ).

Internal consistency analysis was conducted for each factor of the resulting scale. The resulting Cronbach coefficients, 0.95 (F1), 0.87 (F2), 0.88 (F3), and 0.92 (F4), confirm very good internal consistency ( $\alpha = 0.93$  for the entire scale). Except for one item (ID16), all the items also had multiple correlation squares ( $R^2$ ) with values greater than or equal to 0.50, indicating a good proportion of common variance with the other items in the factor they belong to (DeVellis, 2016; Worthington



&Whittaker, 2006). Item ID16, on the other hand, had a squared multiple correlation of 0.32 and lower saturations and communities after rotation than the other five items relating to the factor of professional identity construction (F2). It will, therefore, be monitored in further analyses. Furthermore, an examination of the correlation matrix revealed that item CO4 from F1 had correlations greater than 0.60 with two items (CU5 and CU8) from F4. This item will also be monitored (Dussault et al., 2007).

### ***Confirmatory Factor Analyses (CFA) (n2)***

To confirm the internal structure of the scale obtained, CFAs were conducted on the second data sample. Given the non-normal distribution of the data (Byrne, 2006), the maximum likelihood estimation method with the Robust option was applied using EQS software. The fit of the theoretical structural model to the data (comparison between hypothetical and observed covariance matrices) was assessed, considering various recommended statistics and indices (Byrne, 2006; Jackson et al., 2009). The Satorra-Bentler chi-square value is presented first (Satorra & Bentler, 1988); scientific literature recommends an  $\chi^2/df$  ratio below three for an acceptable model (Jöreskog, 1993; Schreiber et al., 2006).

The comparative fit index (CFI) and non-normed fixed index (NNFI) were used to examine how the theoretical model fits the data: a structural model is considered good when indices are above 0.90 (Bentler & Bonett, 1980; McDonald & Ho, 2002) and very good above 0.95 (Hu & Bentler, 1999; Schreiber et al., 2006). The standardized root mean square residual (SRMR) and root mean square error of approximation (RMSEA) were used to assess the fit of the theoretical model with the data, which are considered acceptable under 0.08 and very good under 0.06. Statistics and fit indices are reported in Table 3 for the models tested.

Table 2  
*Saturations, communalities after rotation ( $h^2$ ),  
 and squared multiple correlations ( $R^2$ ) of the final scale*

	F1	F2	F3	F4	$h^2$	$R^2$
CO2 I develop the competencies targeted by my program.	0.57				0.63	0.61
CO3 I acquire useful knowledge for practicing my profession.	0.79				0.63	0.66
CO4 I acquire useful attitudes for practicing my profession.	0.57				0.67	0.65
CO5 I acquire useful skills for practicing my profession.	0.66				0.64	0.63
CO6 I acquire the required autonomy for practicing my profession.	0.65				0.51	0.56
CO7 I put into practice useful knowledge for my profession.	0.72				0.70	0.71
CO9 I put into practice useful skills for my profession.	0.66				0.71	0.73
CO10 I put into practice useful competencies for my profession.	0.63				0.61	0.62
CU1 I acquire knowledge about my future profession.	0.76				0.65	0.67
CU16 I practice roles that I will be able to fulfill in my profession.	0.54				0.57	0.57
ID18 I feel that the program prepares me for practicing my profession.	0.82				0.69	0.69
ID19 I feel that the program helps me develop my autonomy.	0.61				0.56	0.60
ID20 I feel that the program provides me with authentic learning experiences, either real or simulated, akin to those encountered by professionals in my field	0.75				0.60	0.65
ID3 I have a clear idea about what I want to do in my profession.		0.66			0.46	0.63
ID4 I know which role I want to play in my profession.		0.77			0.63	0.71
ID7 I have a clear idea about the approach I intend to adopt in my professional practice.		0.60			0.60	0.51
ID8 I know my strengths as a professional.		0.71			0.59	0.62

Table 2 (next)  
*Saturations, communities after rotation ( $h^2$ ),  
 and squared multiple correlations ( $R^2$ ) of the final scale*

	F1	F2	F3	F4	$h^2$	$R^2$
ID9 I know my weaknesses as a professional.		0.57			0.50	0.54
ID16 I feel capable of practicing my profession.		0.53			0.43	0.32
ID12 I feel that my profession is clearly understood by society.			0.74		0.58	0.54
ID13 I feel that my profession is clearly understood by other professional groups I will work with.			0.82		0.68	0.63
ID14 I feel that my profession is valued by society.			0.72		0.58	0.56
ID15 I feel that my profession is valued by other professional groups I will work with.			0.87		0.78	0.66
CU2 I know the attitudes to adopt in my profession.				0.64	0.56	0.53
CU3 I know the core values of my profession.				0.74	0.59	0.60
CU4 I adhere to the core values of my profession.				0.82	0.65	0.60
CU5 I put into practice the core values of my profession.				0.68	0.64	0.61
CU6 I know the core values of my program.				0.62	0.49	0.50
CU7 I adhere to the core values of my program.				0.70	0.64	0.61
CU8 I put into practice the core values of my program.				0.62	0.64	0.64
CU10 I adhere to the norms/rules of my profession.				0.74	0.51	0.53
CU11 I put into practice the norms/rules of my profession.				0.58	0.59	0.53
Explained variance (%)	43.20	7.46	5.64	4.03		

Note: The translation from French has not been submitted for transcultural validation.

Table 3  
*Statistics and Fit Indices for Theoretical Models Tested Against Empirical Data,  
 Based on Results of Confirmatory Factor Analyses*

	Satorra-Bentler	$X^2/df$	NNFI	CFI	SRMR	RMSEA
Model 1	$X^2 (458) = 771$	1.68	0.83	0.84	0.075	0.050 [0.044; 0.056]
Model 2	$X^2 (450) = 622$	1.38	0.90	0.91	0.069	0.038 [0.030; 0.045]
Model 3	$X^2 (420) = 583$	1.39	0.90	0.91	0.069	0.038 [0.030; 0.045]
<b>Model 4</b>	<b><math>X^2 (422) = 577</math></b>	<b>1.37</b>	<b>0.92</b>	<b>0.93</b>	<b>0.073</b>	<b>0.035 [0.026; 0.042]</b>
<b>Model 5</b>	<b><math>X^2 (391) = 519</math></b>	<b>1.32</b>	<b>0.92</b>	<b>0.93</b>	<b>0.074</b>	<b>0.034 [0.026; 0.042]</b>
<b>Model 6</b>	<b><math>X^2 (393) = 519</math></b>	<b>1.32</b>	<b>0.92</b>	<b>0.93</b>	<b>0.075</b>	<b>0.034 [0.026; 0.042]</b>

All the models tested showed a Satorra-Bentler  $x^2/df$  ratio of less than 2, which can be described as excellent, an acceptable SRMR of less than 0.08 and a very good RMSEA of less than 0.06. However, the initial theoretical four-factor structure (Model 1) did not reveal an acceptable fit to the data, as the NNFI and CFI values were below 0.90. Lagrange multiplier tests then led to the addition of eight covariance parameters between the residuals of conceptually similar items that fell within the same scaling factor. This time, the resulting model (Model 2) showed a just acceptable fit to the data, with NNFI and CFI values very slightly above 0.90 and an excellent RMSEA. As a follow-up to the internal consistency analyses on the first sample, in which we had determined that the CO4 and ID16 items should be monitored, theoretical models were also built without the CO4 item (Model 3), without the ID16 item (Model 4) and without both the CO4 and ID16 items (Model 5). The fit indices obtained indicated that these models showed a better fit to the empirical data, particularly Models 4 and 5 (see Table 3 for detailed index values). Finally, a second-order model was also tested, in which the four first-order factors were linked to a single second-order professionalization factor (Model 6). Items CO4 and ID16 were not part of this model. The fit indices obtained for the second-order model (Model 6) were almost identical to those obtained for the corresponding first-order model (Model 5). This suggests that a second-order model yields equivalent results to a first-order model, so either one can be used depending on the specific research objectives.

Item factor loadings are illustrated in Figure 3 for the first-order model (Model 5) and in Figure 4 for the second-order model (Model 6), without CO4 and ID16, as are correlations between factors. The four factors also

Figure 3  
*Item Loadings on Factors and Correlations between Factors for the First-Order Model (Model 5)*

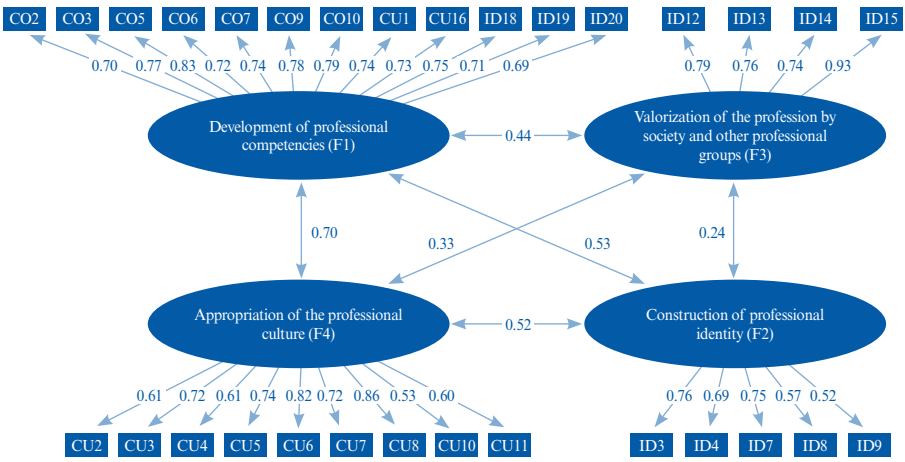
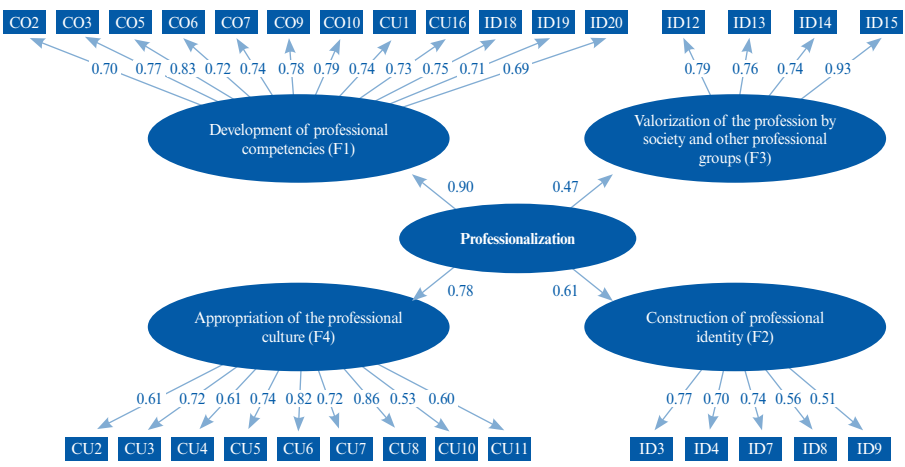


Figure 4  
*Item Factor Loadings and Correlations Between Factors for the Second-Order Model (Model 6)*



showed very good internal consistency, with Cronbach's coefficients of 0.94 (F1), 0.83 (F2), 0.86 (F3) and 0.89 (F4). The item-item correlation matrix for R2 is presented in Appendix A. This revealed that correlations between items in the same factor were generally higher than with items in other factors. No item from one factor had a correlation greater than 0.60 with an item from another factor. In addition, all the full correlations of the corrected items (item-scale) were greater than 0.50, indicating a good correlation between items belonging to the same scale factor.

## Discussion

We tested the professionalization measurement scale with undergraduate and graduate students in health sciences at four Quebec universities in accordance with the recommended practices for developing such a scale (AERA, 2014; DeVellis, 2016). During the development phase of the new scale, we provided evidence of the content (literature review, determination of the object of measurement, item generation, and review of the pool of items by experts) and response process (choice of self-administered questionnaire and measurement format). Analyses of two samples of equivalent size from the collected data then provided evidence of the internal structure. EFAs of the first sample identified four main dimensions in the internal structure of the scale. They were tested using CFAs on the second sample, providing more evidence of the factorial structure of the scale for measuring the professionalization of health sciences students.

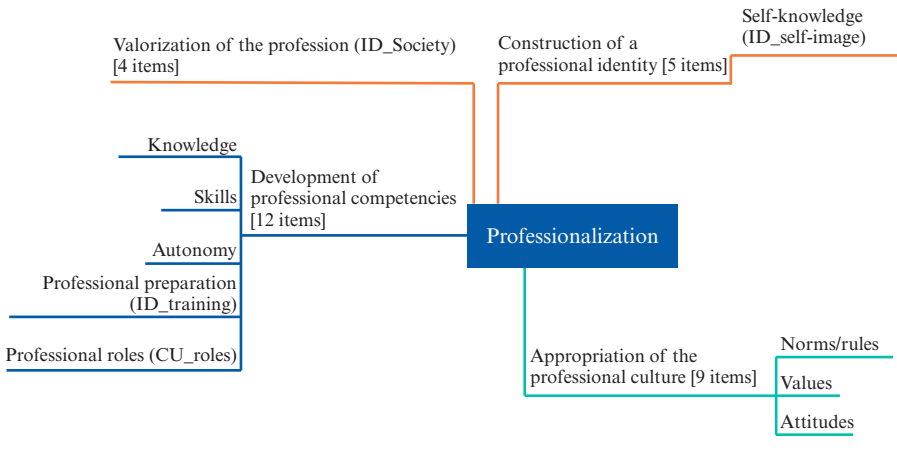
In terms of the initial conceptual framework, Factor 1 included items corresponding to the elements of the *professional competencies* dimension, to which have been added, however, items previously associated with the *professional culture* dimension (CU1. Knowledge of the profession; CU16. Practice of professional roles) and the relation to training of the *professional identity* dimension (ID18. Preparation for professional practice; ID19. Developing autonomy; ID20. Realistic or work-like situations). Thus, the knowledge that a student perceives they possess about their profession (CU1) is an integral part of their knowledge base, an internal resource essential to the development of competencies (Tardif, 2006), while the practice of professional roles (CU16) undoubtedly calls for the implementation and development of competencies. According to the CFAs, the *professional identity* dimension was the one that most modified the initial conceptual framework, since the items referring to it were split into three distinct factors. In fact, the identity

items associated with the relation to training (ID18, ID19, ID20), which refer to the feeling of professional preparation, were now conceptually linked to Factor 1, i.e., the *competencies development* dimension.

As for the items in Factor 2 (*professional identity*), which correspond to elements associated with self-image (ID3, ID4, ID7, ID8, ID9), they were clearly differentiated from the items in Factor 3 (*valorization of the profession by society and by other professional groups*), which relate to the relation with society (ID12, ID13, ID14, ID15). As illustrated in Figure 5, the results of this study revealed that the concept of professionalization is based on the following four dimensions: 1) the development of professional competencies, 2) the appropriation of professional culture, 3) the valorization of the profession by society and other professional groups, and 4) the construction of a professional identity. Three of these dimensions (F1, F2 and F4) correspond to the cognitive, cultural, and identity-related learning identified by Abrandt Dahlgren et al. (2006) and Reid et al. (2011), who qualitatively and longitudinally studied identity formation in students from three professional fields through their developmental trajectory from the university context to the workplace. Qualitative research on the professionalization of university students has shown that socio-professional experiences influence professionalism and ethics (Briceland et al., 2020), that clinical placements influence the development of practical, communication and collaboration competencies (Yacobucci et al., 2022), and that the learning contract influences the development of competencies. While other research (qualitative, quantitative and mixed) has focused on the effects of training programs, either on competency development and labor market readiness (Prince et al., 2005; Schmidt et al., 2009; Vaatstra & de Vries, 2007) or on the construction of a professional identity (Björkström et al., 2008; Dannels, 2000; Dryburgh, 1999; Du, 2006), only our earlier studies (Bélisle, 2011; Bélisle et al., 2021) covered all the dimensions associated with the professionalization of university students.

The length of the scale was optimized by considering the consequences of using the new scale, which had to be short to complete. In the end, the scale contained 30 items, which is a reasonable length. Even though around twenty items were removed from the original pool of items, each factor retained a sufficient number of items to cover each dimension well. The scale can also be administered longitudinally, thereby making it possible to document an evolutionary trajectory of professional learning achieved at different points along the training path rather than a portrait.

Figure 5  
*The four dimensions of the validated professionalization measurement scale*



### *Limitations and Future Research*

Despite the robustness of the results, this study has certain limitations. First, the measurement scale was only tested on health sciences students. Most participants were women in their first year of study, between 21 and 25 years of age and had no previous work experience. Other sociodemographic samples and training programs may provide different results. Thus, to generalize the data, further exploratory and confirmatory factor analyses of the theoretical model would be necessary with different students in other professionalization programs, for example in engineering or humanities. The items about the dimensions of professionalization are sufficiently generic for the scale to be used in professionalizing education for other fields. It would, however, be essential to consider the results in the context of the field and training program being tested. Evaluation of the invariance of the scale over time would also allow for analysis of the trajectory of professional learning at various stages of education.

Also, although the samples used for exploratory and confirmatory factor analyses in this study satisfied the minimum requirement of five participants per item, the samples were not very large. Several hypotheses were presented to explain why the participation rate was lower than we expected. The data were collected between April and July 2021. The transition from abnormal pandemic conditions to more normal conditions may



have affected recruitment: disrupted organization and cognitive overload for students, gradual return to normal activities, absence due to labor shortages in the health system, among others. Recruitment may also have been affected by other occupations, such as the end of the academic year, summer jobs, internships, and the like, which coincided with the administration of the questionnaire.

However, the fact that two samples were used to perform exploratory and then confirmatory analyses provided strong evidence of the factor structure of the professionalization model. The resulting model included four clearly identified dimensions which, in most cases, were moderately correlated with each other. Future studies could provide further evidence for the factor structure of the model, while examining the interrelationships between its different dimensions in greater detail. For example, it would be useful to understand the exact role played by how society and other professional groups understand and esteem the profession in the overall model. It would also be interesting to determine whether acquiring knowledge and useful competencies for the profession precedes the appropriation of the professional culture or the construction of a professional identity. In particular, are some dimensions more developed in the first years of the training, and others afterwards, or do they all develop at a similar rate throughout the program? A longitudinal study would document the evolution of the professionalization process in university students and provide greater depth of understanding about its dynamics. The results of the professionalization scale could improve coherence between the learning objectives and the pedagogical practices in professionalizing programs.

## **Conclusion**

In the absence of instruments for studying the professionalization of individuals in a holistic way, this study, which aimed to develop and validate a scale for measuring professionalization, contributes to a better understanding of the very concept of professionalization, at least in the field of health sciences training. The measurement scale will be useful for research teams and practitioners to measure student professionalization. The confirmatory and factorial analyses confirmed that the student professionalization process includes four distinct dimensions: (a) development

of professional competencies; (b) appropriation of a professional culture; (c) construction of a professional identity, and (d) valorization of the profession by society and other professional groups. Using the scale and interpreting the detailed results will be useful for educators to improve coherence between learning objectives and pedagogical practices in university programs. Research teams will have a robust tool for studying the links between the development of the different dimensions of professionalization in students and other variables such as teaching practices and individual characteristics. The scope of the scale could be broadened by administering and validating it with students from professionalizing programs in other fields.

Received: 22 December 2022

Final version: 26 April 2023

Accepted: 27 July 2023

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### Appendix A – Initial items of the student professionalization scale and descriptive statistics for E1

Item	Mean	Standard deviation
CO1 I know the competencies targeted by my program.	6.22	1.11
CO2 I develop the competencies targeted by my program.	6.34	0.96
CO3 I acquire useful knowledge for practicing my profession.	6.29	1.16
CO4 I acquire useful attitudes for practicing my profession.	6.3	1.14
CO5 I acquire useful skills for practicing my profession.	6.24	1.14
CO6 I acquire the required autonomy for practicing my profession.	5.77	1.41
CO7 I put into practice useful knowledge for my profession.	6.16	1.13
CO8 I put into practice the attitudes expected in my profession.	6.21	1.15
CO9 I put into practice useful skills for my profession.	6.08	1.25
CO10 I put into practice useful competencies for my profession.	6.02	1.28
CO11 I know the expected level of competence upon completion of my training.	5.78	1.42
CO12 I know my progression in the development of competencies relative to the program' expectations.	5.98	1.20
CU1 I acquire knowledge about my future profession.	6.56	0.93
CU2 I know the attitudes to adopt in my profession.	6.32	1.00
CU3 I know the core values of my profession.	6.36	0.94
CU4 I adhere to the core values of my profession.	6.41	1.03
CU5 I put into practice the core values of my profession.	6.29	1.17
CU6 I know the core values of my program.	6.17	1.17
CU7 I adhere to the core values of my program.	6.28	1.20
CU8 I put into practice the core values of my program.	6.27	1.11
CU9 I acquire the norms/rules of my profession.	6.25	1.03
CU10 I adhere to the norms/rules of my profession.	6.46	0.98
CU11 I put into practice the norms/rules of my profession.	6.28	1.16
CU12 I know about the history of my profession.	5.72	1.35
CU13 I understand the social, political, and institutional context of my profession.	5.78	1.26
CU14 I understand the social, political, and institutional issues, and challenges of my profession.	5.48	1.41
CU15 I know the roles that can be practiced in my profession.	6.02	1.14



<b>Item</b>	<b>Mean</b>	<b>Standard deviation</b>
CU16 I put into practice roles that I will be able to play in my profession.	5.73	1.37
ID1 I have a clear idea about my profession.	6.16	0.96
ID2 I understand the difference between my profession and other professions.	6.28	1.10
ID3 I have a clear idea about what I want to do in my profession.	5.29	1.69
ID4 I know which role I want to play in my profession.	5.52	1.54
ID5 I identify with people who practice my profession.	6.03	1.23
ID6 I identify with training professionals in my program.	5.44	1.58
ID7 I have a clear idea about the approach I intend to adopt in my professional practice.	5.57	1.52
ID8 I know my strengths as a professional.	5.81	1.26
ID9 I know my weaknesses as a professional.	5.76	1.33
ID10 I have a clear idea about what differentiates my profession from other professions in my field.	6.16	1.08
ID11 I have a different image of my profession compared with when I started my training.	5.53	1.71
ID12 I feel that my profession is clearly understood by society.	3.49	1.86
ID13 I feel that my profession is clearly understood by other professional groups I will work with.	4.17	1.91
ID14 I feel that my profession is valued by society.	4.83	1.76
ID15 I feel that my profession is valued by other professional groups I will work with.	4.69	1.77
ID16 I feel capable of practicing my profession.	5.09	1.74
ID17 I feel confident that I can handle situations in my professional practice.	5.47	1.49
ID18 I feel that the program prepares me for practicing my profession.	5.96	1.54
ID19 I feel that the program helps me develop my autonomy.	6	1.41
ID20 I feel that the program provides me with authentic learning experiences, either real or simulated, akin to those encountered by professionals in my field.	5.65	1.59

## Appendix B – Item-item correlation matrices of the final scale for E2

	CO2	CO3	CO5	CO6	CO7	CO9	CO10	CU1	CU16	ID18	ID19	ID20	ID3	ID4	ID7	ID8	ID9	ID12	ID13	ID14	ID15	CU2	CU3	CU4	CU5	CU6	CU7	CU8	CU10	CU11
CO2	1.00	0.52	0.57	0.47	0.50	0.50	0.54	0.50	0.52	0.61	0.60	0.47	0.29	0.31	0.17	0.28	0.28	0.18	0.27	0.33	0.31	0.38	0.36	0.35	0.36	0.53	0.46	0.48	0.36	0.25
CO3	0.52	1.00	0.70	0.47	0.54	0.54	0.58	0.61	0.55	0.62	0.52	0.54	0.28	0.24	0.18	0.24	0.20	0.18	0.25	0.22	0.33	0.29	0.40	0.45	0.39	0.55	0.47	0.51	0.33	0.29
CO5	0.57	0.70	1.00	0.56	0.61	0.67	0.62	0.64	0.59	0.67	0.58	0.57	0.37	0.25	0.20	0.34	0.34	0.22	0.24	0.27	0.36	0.30	0.36	0.42	0.38	0.48	0.43	0.50	0.33	0.30
CO6	0.47	0.47	0.56	1.00	0.53	0.52	0.58	0.50	0.57	0.54	0.65	0.53	0.41	0.30	0.32	0.44	0.38	0.27	0.25	0.25	0.35	0.37	0.35	0.31	0.38	0.40	0.35	0.43	0.27	0.37
CO7	0.50	0.54	0.61	0.53	1.00	0.69	0.74	0.53	0.59	0.48	0.47	0.49	0.42	0.34	0.24	0.40	0.38	0.16	0.20	0.17	0.31	0.32	0.30	0.38	0.45	0.39	0.26	0.39	0.26	0.33
CO9	0.50	0.54	0.67	0.52	0.69	1.00	0.74	0.62	0.66	0.50	0.47	0.51	0.39	0.28	0.23	0.43	0.45	0.22	0.24	0.27	0.33	0.33	0.31	0.43	0.40	0.46	0.33	0.42	0.33	0.35
CO10	0.54	0.58	0.62	0.58	0.74	0.74	1.00	0.55	0.63	0.52	0.53	0.51	0.42	0.35	0.31	0.47	0.44	0.21	0.23	0.21	0.30	0.42	0.41	0.47	0.51	0.49	0.37	0.50	0.33	0.44
CU1	0.50	0.61	0.64	0.50	0.53	0.62	0.55	1.00	0.48	0.54	0.55	0.45	0.31	0.18	0.11	0.37	0.30	0.19	0.19	0.23	0.32	0.28	0.33	0.49	0.29	0.42	0.37	0.42	0.36	0.23
CU16	0.52	0.55	0.59	0.57	0.59	0.66	0.63	0.48	1.00	0.49	0.47	0.54	0.35	0.28	0.25	0.39	0.36	0.19	0.15	0.18	0.28	0.39	0.36	0.32	0.37	0.45	0.37	0.46	0.30	0.36
ID18	0.61	0.62	0.67	0.54	0.48	0.50	0.52	0.54	0.49	1.00	0.68	0.63	0.29	0.20	0.16	0.18	0.21	0.24	0.26	0.32	0.38	0.21	0.27	0.33	0.31	0.44	0.46	0.39	0.28	0.18
ID19	0.60	0.52	0.58	0.65	0.47	0.47	0.53	0.55	0.47	0.68	1.00	0.56	0.30	0.19	0.21	0.32	0.32	0.26	0.26	0.35	0.39	0.29	0.23	0.29	0.22	0.41	0.39	0.39	0.24	0.24
ID20	0.47	0.54	0.57	0.53	0.49	0.51	0.51	0.45	0.54	0.63	0.56	1.00	0.29	0.23	0.11	0.14	0.19	0.22	0.22	0.30	0.40	0.24	0.17	0.29	0.26	0.39	0.39	0.38	0.23	0.16
ID3	0.29	0.28	0.37	0.41	0.42	0.39	0.42	0.31	0.35	0.29	0.30	0.29	1.00	0.75	0.60	0.38	0.35	0.21	0.16	0.07	0.18	0.26	0.28	0.31	0.30	0.24	0.17	0.23	0.27	0.28
ID4	0.31	0.24	0.25	0.30	0.34	0.28	0.35	0.18	0.28	0.20	0.19	0.23	0.75	1.00	0.57	0.31	0.32	0.16	0.15	0.06	0.11	0.30	0.27	0.21	0.34	0.24	0.13	0.23	0.18	0.20
ID7	0.17	0.18	0.20	0.32	0.24	0.23	0.31	0.11	0.25	0.16	0.21	0.11	0.60	0.57	1.00	0.43	0.36	0.17	0.19	0.01	0.08	0.34	0.30	0.22	0.27	0.27	0.21	0.24	0.26	0.34
ID8	0.28	0.24	0.34	0.44	0.40	0.43	0.47	0.37	0.39	0.18	0.32	0.14	0.38	0.31	0.43	1.00	0.68	0.16	0.14	0.11	0.16	0.49	0.35	0.30	0.40	0.34	0.18	0.34	0.24	0.44
ID9	0.28	0.20	0.34	0.38	0.38	0.45	0.44	0.30	0.36	0.21	0.32	0.19	0.35	0.32	0.36	0.68	1.00	0.15	0.16	0.13	0.20	0.39	0.34	0.26	0.42	0.35	0.22	0.34	0.18	0.36
ID12	0.18	0.18	0.22	0.27	0.16	0.22	0.21	0.19	0.19	0.24	0.26	0.22	0.21	0.16	0.17	0.16	0.15	1.00	0.64	0.57	0.52	0.15	0.10	0.18	0.11	0.24	0.28	0.20	0.24	0.07
ID13	0.27	0.25	0.24	0.25	0.20	0.24	0.23	0.19	0.15	0.26	0.26	0.22	0.16	0.15	0.19	0.14	0.16	0.64	1.00	0.56	0.69	0.21	0.22	0.20	0.21	0.30	0.30	0.26	0.24	0.12
ID14	0.33	0.22	0.27	0.25	0.17	0.27	0.21	0.23	0.18	0.32	0.35	0.30	0.07	0.06	0.01	0.11	0.13	0.57	0.56	1.00	0.70	0.24	0.17	0.20	0.17	0.32	0.37	0.27	0.24	0.01
ID15	0.31	0.33	0.36	0.35	0.31	0.33	0.30	0.32	0.28	0.38	0.39	0.40	0.18	0.11	0.08	0.16	0.20	0.52	0.69	0.70	1.00	0.23	0.16	0.33	0.17	0.28	0.38	0.24	0.24	0.03
CU2	0.38	0.29	0.30	0.37	0.32	0.33	0.42	0.28	0.39	0.21	0.29	0.24	0.26	0.30	0.34	0.49	0.39	0.15	0.21	0.24	0.23	1.00	0.53	0.38	0.43	0.51	0.36	0.47	0.38	0.47
CU3	0.36	0.40	0.36	0.35	0.30	0.31	0.41	0.33	0.36	0.27	0.23	0.17	0.28	0.27	0.30	0.35	0.34	0.10	0.22	0.17	0.16	0.53	1.00	0.37	0.56	0.63	0.46	0.60	0.37	0.51
CU4	0.35	0.45	0.42	0.31	0.38	0.43	0.47	0.49	0.32	0.33	0.29	0.29	0.31	0.21	0.22	0.30	0.26	0.18	0.20	0.20	0.33	0.38	0.37	1.00	0.43	0.46	0.58	0.51	0.38	0.26
CU5	0.36	0.39	0.38	0.38	0.45	0.40	0.51	0.29	0.37	0.31	0.22	0.26	0.30	0.34	0.27	0.40	0.42	0.11	0.21	0.17	0.17	0.43	0.56	0.43	1.00	0.59	0.41	0.68	0.30	0.54
CU6	0.53	0.55	0.48	0.40	0.39	0.46	0.49	0.42	0.45	0.44	0.41	0.39	0.24	0.24	0.27	0.34	0.35	0.24	0.30	0.32	0.28	0.51	0.63	0.46	0.59	1.00	0.60	0.71	0.41	0.45
CU7	0.46	0.47	0.43	0.35	0.26	0.33	0.37	0.37	0.37	0.46	0.39	0.39	0.17	0.13	0.21	0.18	0.22	0.28	0.30	0.37	0.38	0.36	0.46	0.58	0.41	0.60	1.00	0.67	0.43	0.24
CU8	0.48	0.51	0.50	0.43	0.39	0.42	0.50	0.42	0.46	0.39	0.39	0.38	0.23	0.23	0.24	0.34	0.34	0.20	0.26	0.27	0.24	0.47	0.60	0.51	0.68	0.71	0.67	1.00	0.45	0.47
CU10	0.36	0.33	0.33	0.27	0.26	0.33	0.35	0.36	0.30	0.28	0.24	0.23	0.27	0.18	0.26	0.24	0.18	0.24	0.24	0.24	0.24	0.38	0.37	0.38	0.30	0.41	0.43	0.45	1.00	0.50
CU11	0.25	0.29	0.30	0.37	0.33	0.35	0.44	0.23	0.36	0.18	0.24	0.16	0.28	0.20	0.34	0.44	0.36	0.07	0.12	0.01	0.03	0.47	0.51	0.26	0.54	0.45	0.24	0.47	0.50	1.00