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Article abstract

Blended course modalities combine synchronous activities (face-to-face or in virtual classrooms) with asynchronous online activities, and they represent a fertile ground for enhancing student engagement. However, studying student engagement in these environments requires the development of a measurement scale, which is the purpose of this paper. This new measurement scale for student engagement in blended course modalities (EMEECH) provides researchers and instructors with tools for assessing student engagement in blended course modalities (blended, blended online, or blended synchronous) from a multidimensional perspective. This article presents the scale development, along with validity evidence for its internal structure obtained through exploratory factor and internal consistency analyses, based on diversified data from three universities. A first sample (n_1=234) allowed for identifying three dimensions of student engagement: emotional-cognitive, social, and behavioral. A second sample (n_2=231) provided further evidence of the internal structure of the new scale by confirming its factorial structure and its superior internal consistency.

Student engagement: A multidimensional measurement scale applied to blended course modalities at the university level

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Les modalités de cours hybrides, qui combinent des activités synchrones (en classe ou virtuelles) et en ligne asynchrones, représentent un terrain potentiel d'augmentation du niveau d'engagement des étudiants dans leurs cours. L'étude de l'engagement des étudiants dans ces modalités nécessite toutefois l'élaboration d'une échelle de mesure, soit l'objectif de cet article. La nouvelle Échelle multidimensionnelle d'engagement des étudiants dans des modalités de cours hybrides (EMEECH) vient outiller chercheurs et formateurs pour mesurer l'engagement des étudiants dans ces modalités selon une perspective multidimensionnelle. Nous présentons son élaboration ainsi que des preuves de validité pour sa structure interne obtenues par analyses factorielles exploratoires et de cohérence interne sur la base de données diversifiées provenant de trois institutions universitaires. Un premier échantillon ($n_1 = 234$) a permis d'identifier trois dimensions de l'engagement des étudiants: émotionnelle-cognitive, sociale et comportementale. Un second échantillon ($n_2 = 231$) a appuyé la structure interne de la nouvelle échelle en confirmant sa structure factorielle et en présentant une très bonne cohérence interne.

Blended course modalities combine synchronous activities (face-to-face or in virtual classrooms) with asynchronous online activities, and they represent a fertile ground for enhancing student engagement. However, studying student engagement in these environments requires the development of a measurement scale, which is the purpose of this paper. This new measurement scale for student engagement in blended course modalities (EMEECH) provides researchers and instructors with tools for assessing student engagement in blended course modalities (blended, blended online, or blended synchronous) from a multidimensional perspective. This article presents the scale development, along with validity evidence for its internal structure obtained through exploratory factor and internal consistency analyses, based on diversified data from three universities. A first sample (n_1=234) allowed for identifying three dimensions of student engagement: emotional-cognitive, social, and behavioral. A second sample (n_2=231) provided further evidence of the internal structure of the new scale by confirming its factorial structure and its superior internal consistency.

As modalidades de cursos híbridos, que combinam atividades síncronas (em sala de aula ou virtuais) e assíncronas online, representam um campo potencial para aumentar o nível de envolvimento dos estudantes nos seus cursos. O estudo do envolvimento dos estudantes nestas modalidades requer, em todo o caso, o desenvolvimento de uma escala de medição, que é o objetivo deste artigo. A nova Escala Multidimensional para o Envolvimento dos estudantes em modalidades de cursos híbridos (EMEECH) fornece um instrumento para investigadores e formadores medirem o envolvimento dos estudantes nestas modalidades a partir de uma perspetiva multidimensional. Apresentamos a sua elaboração, bem como as provas de validade da sua estrutura interna obtidas por análises fatoriais exploratórias e coerência interna, tendo por base diversos dados de três instituições universitárias. Uma primeira amostra (n_1 = 234) identificou três dimensões do envolvimento dos estudantes: emocional-cognitiva, social e comportamental. Uma segunda amostra (n_2 = 231) apoiou a estrutura interna da nova escala, confirmando a sua estrutura fatorial e apresentando uma coerência interna muito boa.

Introduction

Blended and online course modalities are becoming increasingly popular in higher education, particularly in university institutions (Donovan, 2019). This is partly a result of the democratization of education and the resulting diversification of learners, with many students having academic, personal, and professional responsibilities for which classroom courses are not well suited (Boelens et al., 2018; Conseil supérieur de l'éducation, 2015, 2020). Facilitated by technological advances, new course modalities allow students to complete a varying proportion of teaching and learning activities online. This gives them greater flexibility in terms of time, space, or even learning pace, and thus meets the needs or preferences of a diverse student population (Boelens et al., 2017, 2018).

This study focuses specifically on blended course modalities, which we define as a combination of synchronous classroom or online (virtual classroom) activities and asynchronous online activities (Heilporn et al., 2021a; Lakhal et al., 2020). These course modalities offer greater flexibility than face-to-face courses and preserve real-time interactions between students and with the instructor, therefore minimizing the disadvantages typically associated with asynchronous online courses such as lack of support, a sense of isolation, or low interaction (Berry, 2019; Dumford & Miller, 2018; Watts, 2016). A combination of synchronous and asynchronous activities, in conjunction with technological opportunities, may enrich activities beyond face-to-face or asynchronous online courses (Garrison & Vaughan, 2008; Taylor et al., 2018) in a student-centered approach to teaching and learning. As a result, many authors identify blended course modalities as a potential avenue for increasing student engagement (Drysdale et al., 2013; Halverson et al., 2014; Manwaring et al., 2017; Spring et al., 2016).

Given the many impacts of student engagement, including persistence, deep learning, satisfaction, and academic success (Christenson et al., 2012; Halverson & Graham, 2019; Kahu, 2013; Mandernach, 2015; Manwaring et al., 2017), it generally improves students' educational

experiences (Halverson & Graham, 2019). From a multidimensional perspective, student engagement in a course is manifested in different facets or dimensions, such as their emotional reactions, their participation, their effort, and their use of learning and metacognitive strategies. Measuring student engagement from this perspective yields a great deal of information for researchers and teachers since each dimension offers a potential target (Fredricks et al., 2019). In addition, researchers will be able to put these dimensions into relation, for example, with individual student characteristics or indicators of academic success.

However, to the best of our knowledge, there is no such measurement tool for blended course modalities at the university level in the francophone literature. Therefore, this article relates the development of such a scale, namely the *Échelle multidimensionnelle d'engagement des étudiants dans des modalités de cours hybrides* (EMEECH) (multidimensional scale of student engagement in blended course modalities), and provides evidence of its validity in this context.

Definitions and literature review

Blended course modalities

There are multiple meanings behind the "blended course" label (Hrastinski, 2019). Typically situated on a spectrum between a face-to-face and an online course (Lakhal & Meyer, 2019), a blended course is often defined as a combination of face-to-face and online teaching and learning activities (Bonk & Graham, 2012). Some authors also note the need to reduce classroom time in favour of online activities (Conseil supérieur de l'éducation, 2015; Graham, 2013). However, a broader definition of blended modalities encompasses courses made up of synchronous and asynchronous online teaching and learning activities, in varying proportions (Heilporn et al., 2021a; Lakhal et al., 2017, 2020; Fadde and Vu, 2014; Power, 2008; Raes et al., 2019). Indeed, technological advances and the scope of new course modalities are increasingly challenging the need for face-to-face activities in favour of synchronous online activities. These modalities are generally classified as

i)   Blended courses (combination of face-to-face and asynchronous online activities).

ii) Blended online courses (combination of synchronous and asynchronous online activities).

iii) Blended synchronous courses (combination of asynchronous and synchronous activities, the latter being held simultaneously face-to-face and online so that students can participate in different modes).

To ensure the scale's continued usefulness and its applicability to a large number of courses, we have chosen this broader definition.

Student engagement in a course

Often viewed as a multidimensional psychosocial process, student engagement is rooted in action (Christenson et al., 2012; Kahu, 2013; Lawson & Lawson, 2013). Many authors (Christenson et al., 2012; Fredricks et al., 2019; Kahu, 2013; Lawson & Lawson, 2013; Manwaring et al., 2017) refer to the typology proposed in the literature review by Fredricks et al. (2004, 2016), which involves a three-dimensional perspective: behavioural, emotional, and cognitive.

The *behavioural dimension of student engagement* refers to participation in activities as well as following rules or norms. In a course, this dimension is therefore associated with student effort[1], perseverance, concentration, or attention, as well as asking questions and participating in discussions.

The *emotional dimension of student engagement* has to do with their emotional reactions to activities, peers, or the teacher (e.g., students' interest, enjoyment, joy, boredom, or anxiety), and their sense of belonging in the course.

Finally, the *cognitive dimension of student engagement* concerns psychological investment and the willingness to make the necessary effort to master complex ideas or content. This dimension also encompasses the use of learning, metacognitive, and self-regulation strategies.

This multidimensional perspective on student engagement is the most cited in the literature and offers a rich and relevant characterization of students' psychological and behavioural state (Fredricks et al., 2004; Kahu, 2013).

In developing a new scale of student engagement in blended course modalities, we aimed to distinguish between engagement and its antecedents or outcomes. Engagement should be distinguished from

motivation, which can be seen as an antecedent – an influential but insufficient condition for student engagement (Appleton et al., 2006). Motivation represents an intention, while engagement is rooted in action (Christenson et al., 2012; Lawson & Lawson, 2013). In the literature, student engagement is also often conflated with antecedents such as facilitating instructional strategies (e.g., Martin & Bolliger, 2018) or outcomes such as student academic success (e.g., Handelsman et al., 2005), which can be a source of confusion (Halverson & Graham, 2019). In the proposed scale (EMEECH), the measurement of engagement is based on indicators of the construct itself and is distinct from its antecedents or outcomes.

Synthesis of existing scales at the university level

Most student engagement scales have been developed in English-speaking contexts and identified in recent studies (Henrie et al, 2015; Mandernach, 2015). A portrait of existing scales in the literatures of the English-speaking and French-speaking worlds is presented in the following subsections.

Scales of student engagement in the Anglophone context

In North American Anglophone literature, the best-known scale is the *National Survey of Student Engagement* (NSSE), which assesses very diverse aspects of students' academic experience at their university (Mayer, 2019), extending well beyond their engagement. The main purpose of this scale is to assess the quality of education at institutions, although the scale is also used in research publications (e.g., Vaughan, 2014). There are also equivalents of the NSSE on other continents, such as the *Australasian Survey of Student Engagement* (AUSSE; Coates, 2007; Krause & Coates, 2008). Generally speaking, these scales are intended to assess the quality of students' educational experience at their institution rather than their engagement, and do not distinguish between different dimensions of engagement.

From a multidimensional perspective, the *University Student Engagement Inventory scale* (USEI; Maroco et al., 2016) measures student engagement in an institution in terms of behavioural, emotional, and cognitive dimensions. Exploratory factor analyses (n = 313) have highlighted these three dimensions and good internal consistency indices

were reported (Cronbach's α of respectively 0.74, 0.88, and 0.82 for five items per dimension). Confirmatory factor analyses also produced good fit indices (χ^2/df = 2.26; CFI = 0.97; TLI = 0.97; RMSEA = 0.06). However, student engagement is measured here in the institution and for face-to-face courses[2], and the scale has not been adapted into French.

For the course context, there is a variant of the NSSE called the *Classroom Survey of Student Engagement* (CLASSE; Ouimet & Smallwood, 2005). This survey comes in two versions, one for teachers and one for students, in order to assess their respective perceptions of education quality in a face-to-face course (Mandernach, 2015). Thus, the scale does not include any items specific to online activities, nor does it distinguish between the different dimensions of engagement. Its psychometric properties have not been studied, and it has not been adapted into French.

Several other scales that measure student engagement in a course, including the *Student Course Engagement Questionnaire* (SCEQ; Handelsman et al., 2005) and its variant for an online course, the *Online Student Engagement Scale* (OSE; Dixson, 2010), are mentioned in the literature. An overall internal consistency of 0.91 (19 items; n = 186) was reported for the OSE (Dixson, 2010). However, the OSE was not developed from the multidimensional perspective of Fredricks et al. (2004, 2016), and its items do not fully cover all three dimensions, particularly the cognitive dimension, which is not addressed. This scale has not been adapted into French either.

Other questionnaires for measuring student engagement in a course were also presented in more isolated ways in the literature, including by Alvarez-Bell et al. (2017), which draws on items from the NSSE and another scale measuring student engagement at their institution, borrowed from Schreiner and Louis (2011). However, the existing scales applicable to a course context, not adapted in French, do not cover the three dimensions defined by Fredricks et al. (2004), whereas several authors emphasize the importance of considering student engagement from a multidimensional perspective (Brault-Labbé & Dubé, 2010; Krause & Coates, 2008; Maroco et al., 2016).

Scales of student engagement in the Francophone context

In the Francophone context, there are several student engagement scales. A French Canadian version of the NSSE engagement scale, renamed the *Enquête nationale de participation étudiante* (or national survey of student engagement) since it goes well beyond student engagement (Mayer, 2019), is aimed at assessing education in an institution and does not distinguish between the different dimensions of engagement.

Adopting a multidimensional perspective, Brault-Labbé and Dubé (2010) proposed a scale to measure student engagement in their studies. This scale includes dimensions related to students' enthusiasm toward their studies, their perseverance in academic tasks, and their reconciliation of the positive and negative points in their studies – dimensions that were confirmed by exploratory factor analyses (principal component analysis with oblimin rotation, n = 266), with good internal consistency indices (Cronbach's α of respectively 0.88, 0.80, and 0.68 for 6, 3, and 4 items; Brault-Labbé & Dubé, 2010). However, the items on this scale relate to students' studies in general and are much broader than the course level. The dimensions of perseverance and reconciliation of the positive and negative points as defined by Brault-Labbé and Dubé (2010) therefore do not fully cover the different dimensions of student engagement in a course as defined by Fredricks et al. (2004). In addition, there are no items specific to a blended course modality.

Finally, in her doctoral thesis, Parent (2017) recently used her own student engagement scale, broken down into behavioural, emotional, and cognitive dimensions, and developed for face-to-face courses that include a digital component. Inspired by well-known engagement scales such as the NSSE, but also by scales not dealing with student engagement, this scale includes some items that do not fit Fredricks et al.'s definition of engagement (2004). Moreover, the development process for this scale was not reported, nor were its psychometric properties.

Consequently, no existing scale met our needs for an instrument that would i) be applicable to a Francophone context; ii) be applicable to blended course modalities; and iii) highlight the multidimensional nature of student engagement. For these reasons, we proceeded to develop a new student engagement questionnaire inspired by the various existing scales reported in the literature.

Methodology

The *Échelle multidimensionnelle d'engagement des étudiants dans des modalités de cours hybrides* (multidimensional scale of student engagement in blended course modalities) (EMEECH) was developed based on the steps proposed by DeVellis (2016). Throughout the process, evidence was accumulated to support the validity of score interpretation for a given use. This was done adopting a unified perspective of validity as suggested by Messick (1995) and echoed in the most recent *Standards for Educational and Psychological Testing* from the *American Educational Research Association* (AERA, 2014). Evidence of content validity (literature review, determination of the measurement object, item generation, and expert review of the item pool) and answer process (choice of a self-administered questionnaire, selection of measurement format) was collected during the scale development process that will be described in the following pages, while evidence of the internal structure of the scale will be presented at the item evaluation stage. Finally, validity evidence about consequences of using the scale for an intended use will be addressed in the discussion of this paper.

Scale development

Determining the object of measurement

According to DeVellis (2016), it is important to begin the process of developing a measurement scale with a clear and precise delineation of the boundaries of the phenomenon of interest, in this case student engagement in university blended course modalities. We sought to highlight the multidimensional perspective of engagement as presented by Fredricks et al. (2004, 2016, 2019), which includes the behavioural, emotional, and cognitive dimensions presented above.

Additionally, the context, population, and, if applicable, discipline can help determine the desired level of specificity, as these sorts of assessment boundaries help better identify the phenomenon and thus guide the subsequent generation of scale items (DeVellis, 2016). In this case, the study targeted students who had taken a university course in a blended course modality, in a Francophone context and in any discipline. The blended modality also entails that the items measure student engagement in teaching and learning activities in both asynchronous online and synchronous

(classroom or virtual) modes. In addition, the items must remain sufficiently general to be meaningful in any academic discipline, so that caution must be observed regarding their level of specificity.

Generating an initial pool of items

An initial pool of 69 items was developed by the lead author of our study based on the main student engagement scales in the literature and in light of examples of indicators of engagement dimensions put forward by Henrie et al. (2015) and Halverson and Graham (2019). Thus, items from existing engagement scales in the Anglophone context were translated into French and then adapted to blended course modalities where appropriate. Other items were borrowed or adapted from Francophone scales (e.g., Parent, 2017) to reflect indicators of the engagement dimensions that would not have been covered otherwise. Special attention was paid to the specificities of blended course modalities (taking into account online activities) as well as the distinction between the behavioural, emotional, and cognitive dimensions of student engagement.

The items were worded in keeping with the recommendations of the literature on this subject, in terms of, among other things, their neutrality, grammatical structure, level of language and vocabulary, and the formulation of similar items for each indicator (Clark & Watson, 1995; DeVellis, 2016). Negative questions were avoided, in line with DeVellis's (2016) argument that the disadvantages of such questions outweigh their potential benefits.

The initial pool of items consisted of 21, 20, and 28 items respectively for the behavioural, emotional, and cognitive dimensions of student engagement.

Selection of a measurement format

Answer choices were presented in the form of a Likert scale, a format frequently used to measure participants' level of agreement with opinions or attitudes (DeVellis, 2016). In response to items stated in declarative form, the levels of the scale represent varying degrees of agreement with the statements. However, a lack of discrimination and cognitive overload was observed in participants beyond seven levels (Streiner et al., 2015). On the other hand, having fewer than five levels can result in a loss of information and, consequently, a decrease in the scale's reliability (Streiner

et al., 2015). Moreover, an odd number of levels has the disadvantage of allowing participants to choose a middle answer as a non-choice (because they do not know or do not want to express themselves on the issue, out of fatigue or laziness) rather than a completely neutral choice, whereas an even number of levels forces participants to take a positive or negative position on each question (Sturgis et al., 2014). Because we believe that students' position on the items is never completely neutral, we opted for a six-level scale with a high degree of choice variability, in the form of 1) strongly disagree; 2) disagree; 3) somewhat disagree; 4) somewhat agree; 5) agree; and 6) strongly agree.

Expert review of the initial pool of items

At this stage, the initial pool of items was reviewed by seven university professors, i.e., researchers in measurement and evaluation, with respect to student engagement or blended course modalities. To this end, they were presented with the selected definitions of blended modalities and student engagement. The experts were then asked to rate the clarity and relevance of each item on a scale of 1 (low) to 3 (high) and to provide feedback and suggestions for improvement.

This step of the process allowed for clarifying the items and avoiding an over- or under-representation of the construct (AERA, 2014). Following this consultation, 13 items were reworded as they were not sufficiently clear according to the experts. A discussion among the co-authors of this study then led to the elimination of 30 items that were insufficiently relevant3 (AERA, 2014). No additional items were suggested.

Finally, the items were double-checked according to student engagement indicators suggested in the literature (Halverson &Graham, 2019; Henrie et al., 2015). Prior to data collection, the item pool consisted of 13, 10, and 16 items respectively for the behavioural, emotional, and cognitive dimensions of student engagement. To avoid any bias in the results, all 39 items were presented in random order to each participant in the questionnaire, without reference to any dimension of engagement.

The inclusion of validation items

For conciseness purposes, we decided not to include any scales or items related to participants' social desirability bias since we did not consider the student engagement scale to be a sensitive topic.

Administration to a sample

Participants and recruitment

To ensure that the target population was representative, i.e., students who have taken a university course in a blended modality in a Francophone context, we targeted students who took such a course in the fall 2019 semester at three universities (in the Canadian provinces of Quebec and Ontario) that offer numerous courses in blended modalities (blended, blended online, and/or blended synchronous). Once the project was approved by the various research ethics boards, these students were invited to participate in the project through generic email lists in January 2020. This was therefore a convenience sample, as only voluntary students answered the online questionnaire (announced length of 10 minutes) distributed on the SurveyMonkey platform (questionnaire closed on January 31, 2020). In addition, given the broad definition of blended course modalities adopted in this project, as well as to ensure proper development of the scale, the proportions of participants in the different course modalities (blended, blended online, and blended synchronous) were collected to confirm the sample's diversity across these course modalities.

DeVellis (2016) suggests that a scale under development should be submitted to at least 300 participants, although he mentions that in practice, scales have often been developed with smaller samples. The risks of having too small a sample have to do with the residual variance between participants as well as the covariances between items, which, when more unstable, can lead to interpretation errors and, consequently, to errors in the scale development. However, the minimal size of a sample depends on the robustness of the obtained measures (e.g., communalities) following factor analysis (Maccallum et al., 1999). As a result, several authors (Costello & Osborne, 2005; DeVellis, 2016; Yong & Pearce, 2013) recommend targeting a sufficiently high ratio of 5 to 10 participants per item. Since our preliminary pool contained 39 items in total, we aimed for a sample size of at least 195 participants in order to achieve a minimum ratio of 5:1.

After cleaning up the collected sample and deleting data for 22 participants suggesting risks of univariate or multivariate outliers based on Mahalanobis and Cook's distance analysis (Tabachnick & Fidell, 2007), the sample size stood at 465 participants. These participants came from a variety of courses and programs at all university levels and in the various

blended course modalities. Some descriptive statistics on the socio-demographic characteristics of the participants are presented in Table 1 and demonstrate the diversity of the sample collected.

Table 1
Participants' socio-demographic characteristics (n=465)

Characteristics		Frequencies in %
Gender	73.1% female	26% male; 0.9% prefer not to answer
Age	53.3% ≤25 years	19.3% [26–35 years]; 16.8% [36–45 years]; 10.6% [>45 years]
University level	66.5% undergraduate	33.5% graduate
Course modality	46.2% blended	32.7% blended online; 21.1% blended synchronous

Evaluation of items

Given the ratio of more than 10 participants per item obtained, the dataset was randomly divided into two similar sample sizes (n_1 = 234 and n_2 = 231). Chi-square tests of independence (α = 5%) showed no significant difference between the two samples for the characteristics of Gender ($p = 0.72$); Age ($p = 0.76$); University level ($p = 0.09$); and Course modality ($p = 0.96$).

The first sample (S1) was used to run exploratory tests on items aimed at developing a scale of student engagement in blended course modalities. An initial examination of item performance (difficulty, discrimination, skewness, item-scale correlations, and item-item correlations) was performed first, followed by exploratory factor analyses (EFA). Indeed, when developing a new scale, EFAs are recommended in order to explore its internal structure (Worthington & Whittaker, 2006). These EFAs are especially relevant to our study given that the multi-dimensionality of student engagement has been little studied either in higher education or, to our knowledge, in blended course modalities. Items showing low communalities (<0.32) that did not significantly load on any factor (<0.32), or that significantly loaded on several factors (>0.32), were withdrawn (Tabachnick & Fidell, 2007; Worthington & Whittaker, 2006). After obtaining a simple structure, items with low loading (<0.40) on their factor were also removed (Pituch & Stevens, 2016). It should be noted that the entire process of cleaning up the items was carried out while placing significant importance on the conceptual meaning of the items and the underlying latent factors. Internal consistency analyses were then performed on each of the identified factors.

Next, the final scale was tested on the second sample (S2) by EFA and internal consistency analyses to gather additional validity evidence of its internal structure. Analyses were conducted with SPSS software version 25.0.

Results

Initial examination of item performance

An item analysis was first conducted to guide the subsequent selection process (Laveault & Grégoire, 2014). Variances and skewness coefficients were also calculated, as were item-item and item-scale correlations (DeVellis, 2016). Difficulty and discrimination indices, variances, and skewness and item coefficients are presented in Table 2, along with the item-scale correlation and the number of item-item correlations higher than 0.30 for each item.

Following the initial examination of these measures, four items were removed as they had high asymmetries, high difficulty (>0.90), and low discrimination (<0.20) indices (Laveault & Gregoire, 2014): Eng1: "I participated in the synchronous (in-class or virtual) sessions of the course;" Eng2: "I visited the online course platform every week;" Eng10: "I handed in the course assignments on time;" and Eng11: "I followed the proposed timeline for the different course activities." Some of them had low item-scale correlations (<0.30) or a large number of item-item correlations below 0.30 (DeVellis, 2016; Pituch & Stevens, 2016).

After deletion, the average difficulty of the remaining items stands at 0.78 (SD = 0.08) and the average discrimination is 0.33 (SD = 0.09). The items discriminate well (>0.30 on average) but are considered of low difficulty (Laveault & Grégoire, 2014).

In addition, item Eng18: "I felt enthusiastic about this course" was eliminated because it correlated very strongly with the items Eng19: "I had fun in this course" (r = .83) and Eng25: "I looked forward to the activities in this course" (r = .82), in order to avoid any risk of collinearity (Bourque et al., 2007; Tabachnick & Fidell, 2007). The mean item-scale correlation is 0.60 (SD = 0.12). All items also show a negative asymmetry, a sign of non-normality of the variables, which was confirmed by the significance of the Shapiro-Wilk test (*p* = 0.000).

Table 2
Initial examination of item performance (S1)

	Eng1	Eng2	Eng3	Eng4	Eng5	Eng6	Eng7	Eng8	Eng9	Eng10
Difficulty	0.89	**0.92**	0.83	0.84	0.84	0.90	0.87	0.88	0.90	**0.97**
Discrimination	**0.17**	**0.15**	0.22	0.31	0.26	**0.18**	0.24	**0.17**	**0.16**	**-0.01**
Variance	1.32	1.10	1.36	1.09	1.46	0.72	1.50	1.18	0.78	**0.32**
Asymmetry	**-2.27**	**-2.65**	-1.17	-1.21	-1.43	-1.70	-1.84	-2.00	-1.96	**-4.12**
r(item-scale)	0.32	0.47	0.46	0.72	0.54	0.51	0.49	0.39	0.45	**0.01**
N^{umber}.r ≥0.30	**3**	15	21	34	25	22	21	9	20	**2**
	Eng11	**Eng12**	**Eng13**	**Eng14**	**Eng15**	**Eng16**	**Eng17**	**Eng18**	**Eng19**	**Eng20**
Difficulty	**0.93**	0.75	0.69	0.81	0.74	0.81	0.80	0.75	0.75	0.74
Discrimination	**0.08**	0.26	0.41	0.35	0.41	0.43	0.31	0.47	0.46	0.32
Variance	0.73	2.24	2.28	1.57	1.83	1.80	1.39	1.95	1.86	2.03
Asymmetry	**-2.69**	-0.99	-0.53	-1.09	-0.68	-1.25	-1.08	-0.88	-0.91	-0.89
r(item-scale)	**0.26**	0.34	0.58	0.72	0.67	0.79	0.55	0.76	0.76	0.54
N^{umber}.r ≥0.30	7	7	27	33	30	33	23	30	31	18
	Eng21	**Eng22**	**Eng23**	**Eng24**	**Eng25**	**Eng26**	**Eng27**	**Eng28**	**Eng29**	**Eng30**
Difficulty	0.74	0.60	0.60	0.88	0.70	0.79	0.82	0.75	0.72	0.82
Discrimination	0.32	0.39	0.46	0.23	0.50	0.42	0.29	0.41	0.39	0.25
Variance	1.71	2.23	2.37	0.92	2.12	1.53	1.49	1.56	1.85	0.98
Asymmetry	-0.82	-0.25	-0.19	-1.80	-0.51	-0.96	-1.05	-0.93	-0.63	-1.06
r(item-scale)	0.55	0.50	0.63	0.61	0.76	0.78	0.57	0.77	0.67	0.65
N^{umber}.r ≥ 0.30	22	22	26	27	29	34	24	33	24	30

	Eng31	Eng32	Eng33	Eng34	Eng35	Eng36	Eng37	Eng38	Eng39
Difficulty	0.83	0.77	0.86	0.71	0.77	0.78	0.65	0.85	0.70
Discrimination	0.26	0.37	0.29	0.36	0.32	0.28	0.38	0.23	0.48
Variance	1.15	1.44	1.10	2.58	1.34	1.49	2.16	1.00	1.81
Asymmetry	-1.21	-0.84	-1.37	-0.67	-0.78	-0.88	-0.19	-1.19	-0.42
r(item-scale)	0.53	0.71	0.69	0.43	0.62	0.53	0.52	0.51	0.77
N[umber].r ≥ 0.30	25	29	30	10	29	21	23	23	31

Note. r(item-scale) = item-scale correlation; n[umber].r = number of item-item correlations ≥0.30. The values shown in bold are those identified as problematic.

Exploratory factor analysis

At this stage, the internal structure of the scale was analyzed. The adequacy of the dataset with EFAs depends on the possibility of breaking down the correlation matrix into factors, which can be checked with Bartlett's test of sphericity ($p < 0.05$) and the Kaiser-Meyer-Olkin index (KMO ≥ 0.7). For the S1 dataset, the significance of Bartlett's test ($p = 0.000$) indicates that the correlation matrix is not an identity matrix and that there are therefore correlations between items, while the KMO index of 0.94 suggests a very good fit of the items to the underlying latent factors (Bourque et al., 2007). An extraction by principal axis factoring with oblique rotation (oblimin) was then performed, as recommended in the literature when the factors relating to the theoretical construct (here, engagement dimensions) are intercorrelated (Costello & Osborne, 2005; Worthington & Whittaker, 2006).

Following the recommendations of Yong and Pearce (2013), the number of factors selected was based on the eigenvalue analysis (>1), the scree plot, and the interpretability of the resulting factor matrix from a conceptual perspective. Although an initial EFA uncovered five factors with eigenvalue higher than 1 (13,82; 3.14; 1.99; 1.32; and 1.21), the matrix after rotation did not allow for a clear factor interpretation and the scree plot instead suggested a three-factor structure. These three main factors explained 39.34%, 7.91%, and 4.46% of the shared variance in the dataset, for a total of 51.71%.

Next, the post-rotation factor matrix was analyzed and the EFAs were continued by eliminating items until a simple and conceptually interpretable structure was obtained (Pituch & Stevens, 2016; Tabachnick & Fidell, 2007; Worthington & Whittaker, 2006). Items Eng8: "I completed the activities offered in the synchronous (in-class or virtual) sessions of the course;" Eng9: "I completed the activities offered online in this course;" Eng31: "I thought critically in this course;" and Eng37: "I explored some of the topics in the course in more depth than required" were removed because of low communalities h^2 under 0.32 (Tabachnick & Fidell, 2007), respectively 0.25, 0.29, 0.31, and 0.31. Item Eng35: "I assessed the strengths and weaknesses of my own ideas regarding a course topic" was also eliminated, as it did not significantly (≥0.32) load on any factor (Tabachnick & Fidell, 2007). In addition, items Eng23: "I felt a sense of community in this course;"

Eng26: "I was psychologically invested in this course;" and Eng28: "I explored the course topics in depth" were deleted because they significantly loaded on several factors. Upon obtaining a simple structure, items Eng30: "I took into account multiple perspectives in course assignments and activities;" and Eng36: "I reflected on how I learned in this course" showed loadings of .39 and .36 below .40, and thus were also removed (Pituch & Stevens, 2016; Worthington & Whittaker, 2006).

Upon obtaining a simple structure, Worthington and Whittaker (2004) emphasize the importance of the conceptual interpretability of the selected factors beyond any empirical considerations. In this scale, the first factor (F1) corresponds to the *emotional and cognitive* dimensions of student engagement. It describes their interest and enthusiasm, which leads to cognitive investment and deeper exploration in the course.

The second factor (F2) relates to a social dimension of engagement, as it concerns interactions as well as trust or relational ties between students. This is a new dimension which, from the multidimensional engagement perspective of Fredricks et al. (2004), showed more within the emotional (affective reactions to peers and sense of belonging) and behavioural (participation in discussions) dimensions.

The third factor (F3) has to do with the *behavioural dimension* of student engagement in the course. Beyond the completion of activities, it includes items related to students' efforts to understand complex concepts and their performance (doing their best) in the course, both of which were originally developed for the cognitive dimension of engagement as defined by Fredricks et al. (2004).

Internal consistency analyses

Internal consistency analyses were conducted for each factor from the EFAs. Four items were removed because they showed multiple correlation squares (R^2) of less than 0.40, indicating a low proportion of common variance with the other items in the corresponding factor (DeVellis, 2016; Worthington & Whittaker, 2006). Thus, item Eng17: "I felt confident in this course" was removed ($R^2 = 0.38$) from the F1 factor; Item Eng13: "I actively participated in discussions in this course" was removed ($R^2 = 0.35$) from the F2 factor; and items Eng3: "I completed the suggested readings in this course" and Eng7: "I completed the weekly work for this course" were removed ($R^2 = 0.33$ and 0.37) from the F3 factor.

For each factor, new internal consistency analyses presented satisfactory results, with Cronbach's α coefficients of 0.94 (F1), 0.86 (F2), and 0.86 (F3) demonstrating their superior internal consistency. The final scale is presented in Table 3, with 9 items for F1, 5 items for F2, and 6 items for F3.

Finally, the emotional-cognitive factor of student engagement (F1) showed a strong correlation of 0.61 with the behavioural factor (F3) and a medium correlation of 0.40 with the social factor (F2). In contrast, the behavioural and social factors of student engagement were only weakly correlated with each other at 0.25.

Validation of the final structure

To validate the results obtained with the first data sample (S1), the final factor structure was tested on the second sample (S2) by EFA and internal consistency analyses, providing additional evidence of the scale structure.

Based on the 20 items retained from the previous tests, the scree plot of an EFA (KMO = 0.94) on S2 clearly suggested a three-factor structure explaining 60.48% of the shared variance in the data. The resulting factor structure is identical to the one obtained for S1, which confirms the dimensions previously identified.

Internal consistency analyses also confirmed the very good internal consistency of the factors, with Cronbach's α coefficients of 0.93 (F1), 0.85 (F2), and 0.89 (F3) as well as R2 greater than or equal to 0.40, a sign of a good proportion of common variance between items in each factor.

The final results for S2 are presented in Table 4. The emotional-cognitive factor of student engagement (F1) showed a strong correlation of 0.60 with the behavioural factor (F3) and an average correlation of 0.39 with the social factor (F2).

Table 3
Final scale loadings and multiple correlation squares (S1)

Item no.	Statement	F1	F2	F3	R^2
Eng14	I found ways to make the course relevant to me	0.67			0.59
Eng15	I felt intrigued by the activities in this course	0.73			0.56
Eng16	I was interested in this course	0.79			0.75
Eng19	I had fun in this course	0.92			0.74
Eng25	I looked forward to the activities in this course	0.91			0.70
Eng27	I tried to apply the content of this course to other professional or personal situations	0.53			0.41
Eng29	I wanted to explore topics related to the course	0.73			0.52
Eng32	I developed better judgment skills in this course	0.68			0.55
Eng39	I felt completely absorbed in the course activities	0.73			0.67
Eng12	I talked to other students about the course		0.86		0.54
Eng20	I felt comfortable talking to the other students in the course		0.77		0.56
Eng21	I felt that my point of view was taken into account by the other students in the course		0.68		0.51
Eng22	I felt connected to the group of students in this course		0.65		0.48
Eng34	I discussed the course with other students outside of class and online activities		0.65		0.46
Eng4	I paid attention in this course			0.52	0.51
Eng5	I reviewed my course notes to make sure I mastered the content			0.60	0.40
Eng6	I spent time on this course			0.73	0.44
Eng24	I made an effort to understand the complex concepts in this course			0.74	0.50
Eng33	I really wanted to master the content of this course			0.67	0.57
Eng38	I did my best in this course			0.64	0.42
	Explained variance (%)	*43.04*	*10.44*	*5.71*	

Table 4
Final scale loadings and multiple correlation squares (S2)

Item no.	Statement	F1	F2	F3	R^2
Eng14	I found ways to make the course relevant to me	0.67			0.63
Eng15	I felt intrigued by the activities in this course	0.72			0.51
Eng16	I was interested in this course	0.89			0.77
Eng19	I had fun in this course	0.89			0.76
Eng25	I looked forward to the activities in this course	0.88			0.71
Eng27	I tried to apply the content of this course to other professional or personal situations	0.49			0.46
Eng29	I wanted to explore topics related to the course	0.69			0.52
Eng32	I developed better judgment skills in this course	0.62			0.53
Eng39	I felt completely absorbed in the course activities	0.70			0.56
Eng12	I talked to other students about the course		0.86		0.62
Eng20	I felt comfortable talking to the other students in the course		0.69		0.52
Eng21	I felt that my point of view was taken into account by the other students in the course		0.54		0.41
Eng22	I felt connected to the group of students in this course		0.68		0.48
Eng34	I discussed the course with other students outside of class and online activities		0.76		0.53
Eng4	I paid attention in this course			0.69	0.61
Eng5	I reviewed my course notes to make sure I mastered the content			0.56	0.40
Eng6	I spent time on this course			0.79	0.50
Eng24	I made an effort to understand the complex concepts in this course			0.78	0.53
Eng33	I really wanted to master the content of this course			0.61	0.54
Eng38	I did my best in this course			0.77	0.57
	Explained variance (%)	*44.02*	*9.79*	*6.67*	

The social and behavioural factors of student engagement showed a medium correlation of 0.30, slightly higher than in the first sample. The item-item correlation matrix for the final scale is also presented in the Appendix.

Discussion and conclusion

In this study, we developed a multidimensional scale of student engagement in blended course modalities (*Échelle multidimensionnelle d'engagement des étudiants dans des modalités de cours hybrides* or EMEECH) in accordance with the guidelines suggested by DeVellis (2016), blended course modalities combining synchronous (in-class or virtual) and asynchronous teaching and learning activities. Various pieces of validity evidence were collected throughout the development process to ensure the robustness of the interpretation of the scale scores for the intended use (AERA, 2014; DeVellis, 2016).

Based on a review of recent studies on the assessment of student engagement in higher education, items were formulated for the behavioural, emotional, and cognitive dimensions of student engagement (Fredricks et al., 2004, 2016) based on existing scales and examples of indicators in the literature. Their clarity and relevance were verified by an expert panel of seven professors and researchers.

Therefore, the scale development process provided various evidence as to its content validity. The internal structure of the scale was also investigated through EFAs and internal consistency analyses on two diversified data samples (blended course modality, university level, discipline, etc.) from three universities in the provinces of Quebec and Ontario. The first sample suggested a structure of three main factors showing superior internal consistency, while the second sample provided further evidence of the validity of this structure.

The first factor relates to the emotional and cognitive dimensions of student engagement. The results suggest that these two theoretical dimensions are intrinsically linked in practice, according to the students. This factor also accounts for the largest percentage (43%) of the shared variance in the data, reflecting its importance in student engagement and its preponderance over other factors in blended course modalities.

The second factor highlights a social dimension of student engagement that specifically concerns their interactions and sense of connectedness with other students in the course. However, the corresponding items were initially distributed in the behavioural, emotional, and cognitive dimensions defined by Fredricks et al. (2004), whether according to the examples of indicators in the literature (Bond & Bedenlier, 2019; Henrie et al., 2015) or when they were generated for this scale. The new social factor of student engagement, to be considered as a dimension in itself (10% explained variance), echoes the social and collaborative dimensions of the conceptual framework presented by Redmond et al. (2018) about online student engagement at the university level, which has not yet been empirically tested. It also reflects the findings of very recent studies (Hoi & Le Hang, 2021; Zhoc et al., 2019) confirming the appropriateness of including a social dimension to student engagement in higher education.

Finally, a third, smaller factor (6% explained variance) relates to the behavioural dimension of student engagement. It also includes items related to student effort, associated in the literature with either the behavioural or cognitive dimension, depending on the author (Halverson & Graham, 2019).

These three factors do not exactly correspond to the Fredricks et al. dimensions of student engagement (2004). This could be because they have been conceptually defined but little tested empirically in higher education and never applied to blended modalities (Halverson & Graham, 2019). Therefore, our study also provides evidence for the preponderance of an emotional-cognitive factor of engagement as well as the presence of a new social factor. With respect to existing studies including scales of student engagement in courses in both English and French contexts, our study sets itself apart by the diversity of validity evidence provided throughout the scale development.

In terms of the internal structure of the scale, exploring it through exploratory factor analyses has helped to highlight the students' perspective on their engagement in blended course modalities.[4] Furthermore, additional evidence of the internal structure of the scale was collected in a subsequent data collection conducted in blended online courses,[5] with the aim of interrelating dimensions of student engagement with categories of influential instructional strategies (Heilporn, 2021a; Heilporn et

al., 2021b). The analyses of the corresponding measurement model confirmed the unicity of an emotional-cognitive dimension as well as the social dimension of student engagement.

The final 20-item scale is concise and requires no additional optimization in terms of length[6] (DeVellis, 2016). It should also be noted that questions specific to only one mode of a blended course (either synchronous sessions only or online activities only) were eliminated during the item evaluation process. This means that student engagement is measured through items related to a course as a whole, which highlights the importance of considering the combination of synchronous and asynchronous teaching and learning activities altogether when studying student engagement in blended course mode.

In terms of the implications of using the scale and interpreting its results, it is quick for students to complete (due to the small number of items), while providing detailed information to teachers on various dimensions of student engagement. Therefore, teachers can easily obtain a picture of their students' engagement and implement improvements if needed. However, teachers should refrain from assessing student engagement based solely on the overall score on the scale. Indeed, some students who are very shy or are embarrassed by a disability may score lower on items related to the social engagement dimension, which is why it is important for teachers to interpret each of the scale dimensions while taking into account the students' personal characteristics.

In conclusion, the measurement scale developed in this article is intended to help Francophone researchers and teachers study student engagement in blended course modalities from a multidimensional perspective. The benefits of using this new scale and interpreting the results are significant as it provides detailed information on different dimensions of student engagement as targets for teachers to use in their courses. The scale can also be used by researchers to measure student engagement based on individual characteristics, the activities or strategies implemented by teachers, or indicators of student academic success in higher education. Moreover, beyond blended modalities, the final scale can easily be adapted for any course in higher education, although it has not been empirically tested in such contexts.

Limitations and future research avenues

This study has several limitations. First, the sample was a convenience sample. Although its size meets the recommended standards for scale development in social science (Boateng et al., 2018; DeVellis, 2016), it is possible that only the most engaged students answered the questionnaire. The results should therefore be interpreted with caution.

Second, a one-time data collection was conducted shortly after the end of an academic term, whereas engagement can vary over time, depending on the context and activities. The items proposed were also very general so that they would be independent of specific disciplines, situations, and/or activities. As a result, participants had to recall and provide an overall measure of their engagement throughout the course, in different situations and activities, which poses risks for the accuracy of the results. This being said, we did make it easy for students to evaluate each of the items by wording them simply and concisely. Multiple data collections (multiple times in the course of an academic term) could be conducted in future research to better capture changes in student engagement over time or depending on the teaching and learning activities at hand.

Finally, although it would have been advantageous to provide evidence of relationships of the new scale scores with other variables of student engagement in a course (AERA, 2014), it was not possible to identify any scales with studied psychometric properties in the Francophone context. However, the detailed development process for the new scale presented in this article already provides ample evidence of validity. In order to confirm the robustness of the obtained factors and to provide further evidence of the validity of the interpretation of the scale scores for the intended use, further studies on new samples should make it possible to verify the stability of its internal structure, including by means of confirmatory factor analysis. The scale can also be easily tested in parallel with items connected to antecedents (e.g., facilitating conditions) or to consequences of student engagement, including indicators of student success.

NOTES

1. According to Fredricks et al. (2004), "A distinction needs to be made between effort that is primarily behavioral, a matter of simply doing the work, and effort that is focused on learning and mastering the material" (p. 64), which comes under the cognitive dimension.

2. For example, "I don't feel very accomplished at this school" or "When I have doubts I ask questions and participate in debates in the classroom" (Maroco et al., 2016, p. 8).

3. The decision rule used is that an item is deleted when at least three experts assign it a moderate relevance or when two experts assign it a low or moderate relevance.

4. In contrast to recent studies such as Hoi and Le Hang (2021) or Zhoc et al. (2019), who imposed four items per factor without discussing the choice of items or their number and verified the appropriateness of their scale for student engagement through confirmatory factor analyses with, in some cases, mixed results on some dimensions (e.g., very low item loadings on the behavioural dimension in the 2021 Hoi and Le Hang study, with higher cross-loadings of these items on other dimensions).

5. In the context of the pandemic, at the end of the 2020 summer academic term (n = 482); this is why data pertaining to other blended course modalities could not be collected.

6. Although the first emotional-cognitive factor of student engagement consists of nine items, it seemed premature to eliminate some of these from the first data collection.

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Table 5
Item-item correlations for the final scale

	Eng14	Eng15	Eng16	Eng19	Eng25	Eng27	Eng29	Eng32	Eng39	Eng12	Eng20	Eng21	Eng22	Eng34	Eng4	Eng5	Eng6	Eng24	Eng33	Eng38
Eng14	1	0.55	0.72	0.68	0.67	0.61	0.61	0.62	0.62	0.21	0.37	0.35	0.34	0.09	0.64	0.45	0.45	0.48	0.59	0.52
Eng15	0.55	1	0.65	0.66	0.61	0.42	0.50	0.51	0.59	0.21	0.36	0.27	0.39	0.19	0.43	0.29	0.30	0.29	0.41	0.40
Eng16	0.72	0.65	1	0.82	076	0.60	0.67	0.64	0.65	0.22	0.37	0.30	0.40	0.19	0.59	0.45	0.39	0.41	0.55	0.45
Eng19	0.68	0.66	0.82	1	0.80	0.51	0.61	0.57	0.64	0.26	0.46	0.36	0.43	0.17	0.56	0.42	0.35	0.34	0.49	0.39
Eng25	0.67	0.61	0.76	0.80	1	0.47	0.60	0.62	0.67	0.17	0.30	0.28	0.39	0.13	0.56	0.44	0.35	0.36	0.50	0.41
Eng27	0.61	0.42	0.60	0.51	0.47	1	0.52	0.55	0.45	0.28	0.37	0.28	0.33	0.23	0.46	0.39	0.29	0.42	0.45	0.37
Eng29	0.61	0.50	0.67	0.61	0.60	0.52	1	0.55	0.57	0.20	0.31	0.27	0.40	0.21	0.50	0.39	0.25	0.39	0.55	0.36
Eng32	0.62	0.51	0.64	0.57	0.62	0.55	0.55	1	0.58	0.27	0.38	0.37	0.49	0.24	0.54	0.45	0.32	0.43	0.49	0.39
Eng39	0.62	0.59	0.65	0.64	0.67	0.45	0.57	0.58	1	0.18	0.28	0.23	0.31	0.10	0.52	0.41	0.38	0.42	0.49	0.47
Eng12	0.21	0.21	0.22	0.26	0.17	0.28	0.20	0.27	0.18	1	0.61	0.44	0.56	0.72	0.25	0.22	0.20	0.23	0.21	0.28
Eng20	0.37	0.36	0.37	0.46	0.30	0.37	0.31	0.38	0.28	0.61	1	0.57	0.59	0.50	0.38	0.30	0.26	0.29	0.29	0.34
Eng21	0.35	0.27	0.30	0.36	0.28	0.28	0.27	0.37	0.23	0.44	0.57	1	0.57	0.34	0.31	0.23	0.23	0.24	0.28	0.34
Eng22	0.34	0.39	0.40	0.43	0.39	0.33	0.40	0.49	0.31	0.56	0.59	0.57	1	0.49	0.23	0.21	0.11	0.17	0.24	0.27
Eng34	0.09	0.19	0.19	0.17	0.13	0.23	0.21	0.24	0.10	0.72	0.50	0.34	0.49	1	0.16	0.15	0.07	0.21	0.15	0.18
Eng4	0.64	0.43	0.59	0.56	0.56	0.46	0.50	0.54	0.52	0.25	0.38	0.31	0.23	0.16	1	0.55	0.63	0.61	0.66	0.67
Eng5	0.45	0.29	0.45	0.42	0.44	0.39	0.39	0.45	0.41	0.22	0.30	0.23	0.21	0.15	0.55	1	0.48	0.55	0.49	0.53
Eng6	0.45	0.30	0.39	0.35	0.35	0.29	0.25	0.32	0.38	0.20	0.26	0.23	0.11	0.07	0.63	0.48	1	0.55	0.54	0.64
Eng24	0.48	0.29	0.41	0.34	0.36	0.42	0.39	0.43	0.42	0.23	0.29	0.24	0.17	0.21	0.61	0.55	0.55	1	0.63	0.60
Eng33	0.59	0.41	0.55	0.49	0.50	0.45	0.55	0.49	0.49	0.21	0.29	0.28	0.24	0.15	0.66	0.49	0.54	0.63	1	0.60
Eng38	0.52	0.40	0.45	0.39	0.41	0.37	0.36	0.39	0.47	0.28	0.34	0.34	0.27	0.18	0.67	0.53	0.64	0.60	0.60	1