



## PERCEPTIONS OF DISTANCE UNDERGRADUATE LEARNING STUDENTS TOWARDS USE H5P INTERACTIVE CONTENT DURING THE TEACHING AND LEARNING PROCESS OF THE ENVIRONMENTAL EDUCATION

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### Abstract

The aim of this study was to verify the perception of 395 distance learning undergraduate students at a Brazilian private university about the use of H5P Moodle interactive content during the teaching and learning process of environmental education (EE). The hypothesis, in line with previous studies, is that most students would report positive experiences after studying through interactive resources. Based on a quantitative, descriptive, and cross-sectional study, these volunteer students carried out the following contributions to this research: (i) They compared the VLE Moodle traditional didactic resources versus H5P Moodle interactive resources. Specifically, the subject studied was “concepts of Ecology”; (ii) They answered an instrument comprised two analysis dimensions (i.e., Feasibility and Motivation) consisting of 14 assertions of the Likert-type. 122 among those 395 students invited, agreed to participate. The study on the reliability of the instrument resulted in a coefficient equal to 0.80. Therefore, it is possible to state that on another occasion, these students would respond to the instrument in the same way. The number of validated assertions was 11/14 (a loss of the 21.40% of the assertions). However, the loss of up to 40% of the total statements is considered adequate when using the Likert scale. Considering only these 11 validated assertions, the overall mean of the instrument was 3.35 points (Standard Deviation = 0.36), which demonstrates a positive student perception of the evaluated object. Ultimately, the tested hypothesis was confirmed, and thus, the most students reported positive experiences after having studied EE through H5P interactive resources.

**Keywords:** Moodle. Plugin H5P. Technology enhanced learning. Active Learning. Playful learning.



## PERCEPÇÕES DE ESTUDANTES DE GRADUAÇÃO A DISTÂNCIA SOBRE O USO DE CONTEÚDOS INTERATIVOS H5P DURANTE O PROCESSO DE ENSINO E APRENDIZAGEM DA EDUCAÇÃO AMBIENTAL

### RESUMO

O objetivo deste estudo foi verificar a percepção de 395 alunos de graduação a distância de uma universidade privada brasileira sobre o uso do conteúdo interativo do H5P Moodle durante o processo de ensino-aprendizagem de educação ambiental (EA). A hipótese, em linha com estudos anteriores, é que a maioria dos alunos relataria experiências positivas após estudar por meio de recursos interativos. A partir de um estudo quantitativo, descritivo e transversal, esses alunos voluntários realizaram as seguintes contribuições para esta pesquisa: (i) Eles compararam os recursos didáticos tradicionais do AVA Moodle versus os recursos interativos do H5P Moodle. Especificamente, o assunto estudado foi “conceitos de Ecologia”; (ii) Eles responderam a um instrumento composto por duas dimensões de análise (ou seja, Viabilidade e Motivação) composto por 14 assertivas do tipo Likert. Dos 395 alunos convidados, 122 concordaram em participar. O estudo da confiabilidade do instrumento resultou em um coeficiente igual a 0,80. Portanto, é possível afirmar que em outra ocasião, esses alunos responderiam ao instrumento da mesma forma. O número de assertivas validadas foi de 11/14 (perda de 21,40% das assertivas). No entanto, a perda de até 40% do total de afirmações é considerada adequada quando se utiliza a escala Likert. Considerando apenas essas 11 assertivas validadas, a média geral do instrumento foi de 3,35 pontos (Desvio Padrão = 0,36), o que demonstra uma percepção positiva dos alunos. Por fim, a hipótese testada foi confirmada e, assim, a maioria dos alunos relatou experiências positivas após ter estudado por meio deste recurso interativo.

**Palavras-chave:** Moodle. *Plugin* H5P. Aprendizagem aprimorada por tecnologia. Aprendizado ativo. Aprendizagem lúdica.



## 1. INTRODUCTION

E-learning (based on information and communication technologies - ICT) is a teaching and learning process that occurs in virtual learning environments (VLE), and where multidirectional communication is possible, i.e., teacher-student and student-student (PEREIRA *et al.*, 2008; AZEITEIRO *et al.*, 2015; AMALI *et al.*, 2019). Moreover, the use of interactive multimedia technology, which combines computer technology, audio, and video, is the main characteristic of this teaching and learning process (AMALI *et al.*, 2019). Currently, more than 550 different kinds of VLEs are available worldwide for educational purposes (SERGIS *et al.*, 2017; OGUGUO *et al.*, 2021; GAMAGE *et al.*, 2022). Among the VLEs that were most widely used during 2015–2020, the Moodle Learning Management System (LMS) is the most popular and preferred open-source LMS (SERGIS *et al.*, 2017; OGUGUO *et al.*, 2021; GAMAGE *et al.*, 2022). Consequently, the number of Moodle users increased from 78 million in 2015 to over 294 million in 2021 (an increase of over 250%) (GAMAGE *et al.*, 2022).

E-learning is an area that has seen considerable growth among worldwide higher education institutions (HEIs), particularly since 2020 with the onset of the COVID-19 pandemic (PAGAN *et al.*, 2021). For instance, in Brazil, the E-learning has become prevalent in HEIs recently. According to data from the National Institute of Educational Studies and Research Anísio Teixeira (INEP), from 3.7 million students entering public and private HEIs in 2020, more than 2 million (53.4%) opted for distance learning pedagogical model (DL) (INEP, 2021). As a result, this movement has increased educational opportunities for students (mainly in developing countries such as Brazil) who were previously unable to access university-level tertiary qualifications (LLERENA-IZQUIERDO AND ZAMORA-GALINDO, 2021; VONTI AND HIDAYATI, 2023).

Although studies have shown that worldwide E-learning in HEIs is growing, online students' dissatisfaction seems to increase at the same rate. A common complaint among these students is that the online learning experience is isolating and demotivating (STONE AND SPRINGER, 2019; MANACEK *et al.*, 2020). Furthermore, studies have shown the lack of interactivity features of VLEs (such as Moodle), is still one of the main dissatisfactions of this students, which has contributed to an increase in school attrition



rates (CAPELETTI, 2014; STONE AND SPRINGER, 2019; MANACEK *et al.*, 2020; DE OLIVEIRA AND NASCIMENTO, 2020). In this context, the ICTs provide an opportunity for HEIs to create course content that is interactive, personalised, and leads to improvements in learning outcomes (WEKERLE *et al.*, 2020; LAI AND BOWER, 2020; JACOB AND CENTOFANTI, 2023). For instance, one tool that allows to increase interactivity resources of Moodle is plugin H5P (HTML 5 Package) (KILLAM *et al.*, 2021; MUNRO, 2021; JACOB AND CENTOFANTI, 2023). Considered a versatile and uncomplicated open-source tool, H5P allows educators and/or instructional designers to create a variety of interactive Moodle-based learning objects (KILLAM *et al.*, 2021; MUNRO, 2021; JACOB AND CENTOFANTI, 2023). Specifically, H5P includes more than 40 editable content applications such as interactive videos, audio recordings, presentations, virtual tours, branching scenarios, games, quizzes, flashcards, among others (see more details in H5P.org) (KILLAM *et al.*, 2021; MUNRO, 2021; JACOB AND CENTOFANTI, 2023).

In this way, due to the wide possibility of applying the H5P in the field of education, there are reports of experiences in different areas of knowledge, namely: in the training of Librarians (SINGH AND SCHOLTZ, 2019), in the teaching of Engineering (CHILUKURI, 2020), in the degree of Chemistry (SCHWEIKER AND LEVONIS, 2020), in Medicine (KILLAM *et al.*, 2021), in Administration (ROSSETTI LÓPEZ *et al.*, 2021), in Nursing (YOUHASAN *et al.*, 2021), and in the degree of English (ADDHINY, 2022). However, to the best of our knowledge, there are no reports of experiences in worldwide HEIs, about the use of H5P during teaching and online-learning process of the environmental education (EE). The EE is an essential tool to implement the 17 United Nations Sustainable Development Goals (SDGs) in the university context (UN, 2015; ESTEBAN IBÁÑEZ *et al.*, 2020; BABALOLA *et al.*, 2021). Specifically, Target 4.7 of SDG4 aims to ensure that worldwide students “acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles” by the year 2030 (UN, 2015). For instance, in Brazilian HEIs, the EE is a cross-cutting theme, and must be offered as an elective to all presential and DL undergraduate courses (BRASIL, 1996; 1999). Corroborating the Target 4.7 of SDG4, the Brazilian Curricular Parameters (BCPs),



establish that an EE is a fundamental tool for teaching people to have social environmental responsibility (BRASIL, 1996; 1999). Therefore, these graduates will be potential change actors with the ability to contribute to a more sustainable society (UN, 2015; ESTEBAN IBÁÑEZ *et al.*, 2020; BABALOLA *et al.*, 2021).

Taking into consideration the previous research gaps, the aim of this study is to verify the perception of 395 DL undergraduate students (from 19 different undergraduate courses) at a private Brazilian HEI about the use of H5P Moodle interactive content during the teaching and learning process of the EE. The hypothesis, in line with previous studies (e.g., CARR AND BARRY, 2020; CARR., 2021; LÓPEZ *et al.*, 2021; SINNAYAH *et al.*, 2021; PLOETZNER, 2022; JACOB AND CENTOFANTI, 2023; VONTI AND HIDAYATI, 2023), is that the most students would report positive and/or motivating experiences after studying EE through H5P interactive resources.

## 2. METHODS

### 2.1 ETHICAL ASPECTS

This study was approved by the Ethics Research Committee of the Metropolitan University of Santos (UNIMES) - opinion n. 5.788.781, and by the system CEP/CONEP - CAAE n. 63995822.7.0000.5509. At the commencement of the research, all students were informed about the study casuistry. The students that agreed to voluntarily participate, were informed that they would have access to the H5P Moodle interactive resources and undertake a questionnaire as part of the research. Moreover, the students were informed that they would be free to opt out at any time if they did not want their questionnaire results to be included in analyses. They were also informed that opting out would not detrimentally impact them, their research results, or their relationship with teaching staff in any way.

### 2.2 STUDY CHARACTERISTICS



This is a quantitative, descriptive cross-sectional survey conducted among 395 DL undergraduate students at UNIMES, and regularly enrolled in the EE discipline. In UNIMES, the EE is a cross-cutting theme, and offered as an elective discipline to all DL undergraduate courses (BRASIL, 1996; 1999). These students come from 19 undergraduate courses, namely: Accounting Sciences, Administration, Architecture, Biological Sciences, Chemistry, Commercial Management, Environmental Management, Gastronomy, Geography, Information Technology, Letters, Logistics, Management Processes, Mathematics, Physical Education, Physics, Public Management, Pedagogy, and Social Work. In summary, these volunteer students carried out the following contributions to this research: (i) Firstly, they compared the VLE Moodle traditional didactic resources versus H5P Moodle interactive resources; (ii) Ultimately, they answered the questionnaire about the “perceptions of distance undergraduate learning students towards use H5P interactive content during the teaching and learning process of the environmental education”. Both research steps were accessed via the Moodle LMS, and they were conducted during December 02, 2022, to February 02, 2023. There were no exclusion criteria. Besides, each student was allowed to complete the questionnaire once.

### **2.3 COMPARISON BETWEEN VLE MOODLE TRADITIONAL DIDACTIC RESOURCES AND H5P MOODLE INTERACTIVE RESOURCES**

It is important to highlight that these 395 students studied EE during the 2nd semester of 2022 (i.e., from August to November 2022). However, this study was developed in VLE Moodle through the following traditional didactic resources, namely: (i) reading a handout; and (ii) video lessons (both prepared by the professor). Specifically, the subject studied was “concepts of Ecology”. From this experience, these students were allocated in another VLE Moodle virtual classroom, which was prepared with H5P interactive resources. In this way (from December 2022 to February 2023), these students carried out interactive activities with the same theme addressed in the traditional didactic





resources. After both experiences, it was possible to establish a comparison between both teaching methodologies (i.e., use of Moodle traditional didactic resources versus use of H5P Moodle interactive resources).

## 2.4 ANALYSIS INSTRUMENT

The analysis followed the methodology of Caivano and Domene (2020). The response to the instrument was conducted in two phases; the first phase, the instrument was pre-tested by a group of five professors from UNIMES, to analyse the statements' clarity and phraseology, objectivity, and assertiveness. In phase II, the instrument was answered by DL undergraduate volunteer students at UNIMES. The instrument comprised two analysis dimensions consisting of 14 assertions of the Likert-type (Table 1) (WAKITA *et al.*, 2012).

**Table 1.** Instrument applied to evaluate the “perceptions of distance undergraduate learning students towards use H5P interactive content during the teaching and learning process of the environmental education”. The instrument comprised two analysis dimensions consisting of 14 assertions of the Likert-type. The analysis dimensions (D) were: (D1) Feasibility in the use of H5P Moodle interactive resources to promote the EE teaching-learning process in DL [assertions (A): A1,A2,A3,A4,A5,A6 and A7]; and (D2): Motivation of students to study with the support of the H5P plugin [assertions (A): A8, A9, A10, A11, A12,A13 and A14]. To ensure the legitimacy and consistency of the responses, similar assertions were used, in addition to interspersing positive (e.g., A1, A3, A4, A6, A8, A10, A11 and A14), and negative assertions (e.g., A2, A5, A7, A9, A12 and A13). Note: Numerical values that indicates the answer possibilities: **\*a\*=positive:** (4) Completely agree, (3) Agree in most cases, (2) Disagree in most cases, (1) Completely disagree; **\*b\*=negative:** (1) Completely disagree, (2) Disagree in most cases, (3) Agree in most cases, (4) Completely agree

(D)	(A)		types
D1	A1	The gamification (I) proposed by some activities transforms written content into more accessible materials and therefore facilitates learning. (I) Gamification: activity that refers to a game/simulation <b>*a*</b> .	Positive
D1	A2	Some interactive contents (II) are highly complex and, therefore, make learning difficult. (II) Interactive content: examples are: (a) interactive video; (b) interactive museum; (c) interactive slides; (d) evaluative questions (drag-and-drop; fill-in-the-blank; multiple choice; true or false); (e) memory game, among other contents <b>*b*</b> .	Negative
D1	A3	With the use of different interactive resources, merely expository contents (such as a handout) were transformed into something dynamic and interesting <b>*a*</b> .	Positive
D1	A4	Compared to traditional study (that is, through a booklet and video lessons), studying through interactive resources makes it easier for students to absorb the content and their learning becomes efficient and accelerated <b>*a*</b> .	Positive
D1	A5	After using different interactive resources, the virtual learning environment became visually polluted (excess images), making learning difficult <b>*b*</b> .	Negative
D1	A6	The different knowledge tests (e.g., multiple choice or true and false questions), combined with different interactive features, facilitate learning <b>*a*</b> .	Positive
D1	A7	Although the “memory game” works on concentration and the development of students' quick thinking, this ludic didactic resource (iii) is not suitable for higher education. (iii) Ludic: Way to develop creativity, knowledge, through games. The aim is to educate, teach, having fun <b>*b*</b> .	Negative





<b>D2</b>	A8	Studying with the support of different interactive contents is more motivating than studying through traditional material (example, handout + video lesson) <b>*a*</b> .	Positive
<b>D2</b>	A9	Carrying out studies, through interactive video, has become less intuitive and interesting <b>*b*</b> .	Negative
<b>D2</b>	A10	The interactive contents are very attractive and, therefore, increase the students' attention <b>*a*</b> .	Positive
<b>D2</b>	A11	The study, carried out with the support of different interactive resources [e.g., interactive video and virtual tour (360)], makes the student more active and engaged in the teaching and learning process <b>*a*</b> .	Positive
<b>D2</b>	A12	The gamification proposed by some activities reduces attention to the studied content <b>*b*</b> .	Negative
<b>D2</b>	A13	Studying with the support of different interactive resources makes studying more boring <b>*b*</b> .	Negative
<b>D2</b>	A14	Studying with the support of an “interactive video” is more stimulating than watching a video lesson recorded by the teacher, because it helps to maintain attention on certain subjects considered monotonous <b>*a*</b> .	Positive



The analysis dimensions (D) were: (D1) Feasibility in the use of H5P Moodle interactive resources to promote the EE teaching-learning process in DL; assertions (A): A1, A2, A3, A4, A5, A6 and A7; and (D2): Motivation of students to study with the support of the H5P plugin (A8, A9, A10, A11, A12, A13 and A14). To ensure the legitimacy and consistency of the responses, similar assertions were used, in addition to interspersing positive (e.g., A1, A3, A4, A6, A8, A10, A11 and A14), and negative assertions (e.g., A2, A5, A7, A9, A12 and A13) (Table 1) (MORAES *et al.*, 2012; WAKITA *et al.*, 2012). The questionnaire was organized with four possible answers, since a "neutral" position of the students was not intended, i.e.: (i) totally disagree; (ii) partially disagree; (iii) partially agree; and (iv) totally agree. The numerical order could be whether descending (4, 3, 2, 1) or ascending (1, 2, 3, 4) depending on the statement being favourable or unfavourable, thus enabling the calculation of mean values and standard deviation (MORAES *et al.*, 2012; WAKITA *et al.*, 2012). The mean value was used for verification of data behaviour and its dispersion based on the following definitions: (i) From 1.00 to 1.99 points: Poor perception of the evaluated object, which implied the necessity for changes or substitutions; (ii) From 2.00 to 2.99 points: The perception indicates the need for adjustments in the assessed object, but an overall positive perception of its implementation; (iii) From 3.00 to 4.00 points: Positive perception of the evaluated object; and (iv) Standard Deviation acceptable (SD): <1.5 points. Moreover, to measure the internal consistency of the instrument (i.e., reliability), Spearman-Brown coefficient was applied with acceptance criteria  $r > 0.80$ . Firstly, the "r" was calculated for the 14 assertions, aiming at their eliminating assertions with a linear correlation lower than 0.30. Afterwards, the "r" was calculated again, considering only the assertions validated in the first step. In this last step, only assertions with a linear correlation of less than 0.20, were eliminated. All statistical analysis was conducted from data processing using Statistical Package for Social Sciences – SPSS software version 18 for Windows.

### 3. RESULTS AND DISCUSSION



Considering the lack of reports of experiences in worldwide HEIs about the use of H5P during teaching and online-learning process of the EE, this study verified, for the first time, the perception of 395 Brazilian students from 19 DL different undergraduate courses from UNIMES (a private Brazilian HEI) about the use of H5P Moodle interactive content during the teaching and learning process of the cross-cutting theme EE. Among 395 students selected and invited, 30.9% agreed to participate (i.e., 122 students), being 87.7% women (107 students) and 12.3% men (15 students). Most of the participating students were from the Pedagogy course (81 students), followed by the Public Management course (18 students). Together, the other 17 courses added 23 participations.

The study on the reliability of the instrument resulted in a coefficient equal to 0.80. Therefore, it is possible to state that on another occasion, these students would respond to the instrument in the same way. The number of validated assertions was 11 (Tables 2a and 2b). For that reason, the loss of this study was only 21.40% of the assertions, i.e., A1, A10 and A14 showed linear correlation lower than 0.30. According to Wakita et al (2012), the loss of up to 40% of the total statements is considered adequate when using the Likert scale. Moreover, the results indicate the quality of content validation, considering aspects such as adequacy of phraseology, objectivity and assertiveness in the propositions presented. Considering only these 11 validated assertions, the overall mean of the instrument was 3.35 points (SD = 0.36) (Table 2c), which demonstrates a positive student perception of the evaluated object.

The tested hypothesis was confirmed, and thus, in line with previous studies (e.g., CARR AND BARRY, 2020; CARR., 2021; LÓPEZ et al., 2021; SINNAYAH *et al.*, 2021; PLOETZNER, 2022; JACOB AND CENTOFANTI, 2023; VONTI AND HIDAYATI, 2023), the most students reported positive and motivating experiences after having studied EE through H5P interactive resources. For instance, several and recent studies have demonstrated that active learning through high quality interactive content has a more significant positive impact on learning outcomes than just reading and/or watching videos (both considered non-interactive learning contents) (CARR AND BARRY, 2020; FORONDA *et al.*, 2020; CARR., 2021; PLOETZNER, 2022; JACOB AND CENTOFANTI, 2023). Corroborating with these authors, the assertions A3 (3.69



points; DV: 0.60) and A4 (3.63 points; DV=0.61), both from dimension (D1) (Tables 1 and 2a), demonstrate that most students agreed that compared to traditional study (that is, through a booklet and video lessons), studying through H5P interactive resources makes it easier for students to absorb the content and their learning becomes efficient, dynamic, interesting, and accelerated.

**Table 2.** Results of the means values (MV) and Standard Deviations (SD), used for the verification of data behaviour and its dispersion based on the following definitions: (i) From 1.00 to 1.99 points: Poor perception of the evaluated object; (ii) From 2.00 to 2.99 points: Overall positive perception of its implementation; (iii) From 3.00 to 4.00 points: Positive perception of the evaluated object; and (iv) SD acceptable: <1.5 points. Moreover, to measure the reliability of the instrument, Spearman-Brown coefficient was applied. Firstly, the "r" was calculated in **Table 2a**: Dimension: D1 (Assertions: A1-A7) and in **Table 2b**: D2 (A8-A14), aiming at their eliminating assertions with a linear correlation lower than 0.30. Afterwards, the "r" was calculated again, considering only the assertions validated in the first administration. In this last step, only assertions with a linear correlation of less than 0.20, were eliminated. Only assertion A1 (D1) and assertions A10 and A14 (D2), were not validated. **Table 2c** presents the results of the overall mean and the overall standard deviation (A1-A14). Note: (\*) does not accord the criterion  $r \geq 0.30$ .

Dimensions (D)	Assertions (A)	First administration			Second administration (Final result)		
		MV	SD	r	MV	SD	r
D1	A1	3.88	1.26	0.28*	<b>Not validated</b>		
D1	A2	2.74	0.60	0.74	2.74	0.60	0.78
D1	A3	3.69	0.61	0.42	3.69	0.61	0.40
D1	A4	3.63	1.03	0.35	3.63	1.03	0.31
D1	A5	3.07	0.53	0.77	3.07	0.53	0.80
D1	A6	3.73	1.19	0.42	3.73	1.19	0.38
D1	A7	2.96	3.62	0.70	2.96	3.62	0.74

Dimensions (D)	Assertions (A)	First administration			Second administration (Final result)		
		MV	SD	r	MV	SD	r
D2	A8	3.79	0.49	0.51	3.79	0.49	0.49
D2	A9	3.09	1.13	0.75	3.09	1.13	0.75
D2	A10	3.46	0.76	0.21*	<b>Not validated</b>		
D2	A11	3.65	0.63	0.46	3.65	0.63	0.40
D2	A12	3.25	1.02	0.74	3.25	1.02	0.75
D2	A13	3.29	1.10	0.70	3.29	1.10	0.73
D2	A14	3.32	1.01	0.22*	<b>Not validated</b>		

Dimensions (D)	Assertions (A)	First administration	Second administration (Final result)
D1 + D2	Overall mean (A1-A14)	3.40	3.35
	Overall SD (A1-A14)	0.35	0.36



Regarding assertion A6 (Tables 1 and 2a) (3.73 points; and DV: 0.53), most students agreed that the different interactive questionnaires (e.g., “multiple choice”, “true or false”, “fill in the blanks”, “drag the words”, “mark the words” and “drag and drop”, combined with other interactive features facilitate learning. Spontaneous testimonial from “N.A.O” a student of Biological Sciences (sent by email) confirms the results of assertion A6. She wrote: “[...] *I liked the exercises [...]. [...] The exercises help us to check our understanding and fixing the content [...].* These results are in conformity to study from Sinnayah *et al.* (2021), who investigated the use of H5P interactive resources during physiology education and found that 90% of the students who attempted the interactive questionnaires (e.g., fill-in-the-blank, and multiple-choice questions) indicated that their level of content knowledge was significantly improved.

Regarding assertions A2 and A5 (both negative assertions) (Tables 1 and 2a), it was believed that total disagreement would be prevalent. In fact, the students tended to disagree most of the time, with (i) 2.74 points; SD=1.26; and (ii) 3.07 points; SD =1.03, respectively. Therefore, corroborating the study by Jacob and Centofanti (2023), the results of assertive A2 indicate that students found that different H5P interactive resources, are not complex, and thus had helped them to understand the content better. Specifically, about assertion A5 (which discusses the benefits of using images), spontaneous testimonial from “E.P.S”, a Pedagogy student (sent by email) confirms the results of this assertion. She wrote: “[...] *I'm really enjoying it [...]. [...] The content is VERY GOOD [...]. [...] I must praise the use of figures, photos, illustrations (e.g., pictures of animals, plants, rivers, landscapes of the biome). They make the text lighter, more pleasant, enlightening, and didactic [...].* In this context, Lin and Wang (2012) and Cheng (2020) explains that when student satisfaction regarding course content and design is high, they are in turn more likely to engage further within the virtual learning environments (VLE).

Regarding D2 (subject: motivation), the use of interactive video during the teaching and learning process deserves to be highlighted. The assertions A8 (3.79 points; DV=0.49); A9 (3.09 points; DV= 1.13), and A11 (3.65 points; DV= 0.63) (Tables 1 and 2b), demonstrate students' satisfaction when using this interactive resource. Interactive videos they are innovating engagement tools, able to stimulate students' critical thinking, besides encourage autonomous learning (SPANJERS *et al.*, 2010; WILKIE *et al.*, 2018; JACOB AND CENTOFANTI, 2023). One of the advantages of interactive content video, is that it can be





paused to incorporate interactive questionnaires (e.g., “multiple choice”, “true or false”, “fill in the blanks”, “drag the words”, “mark the words” and “drag and drop”), which allows students to apply their understanding of presented concepts in a logical, meaningful manner (SPANJERS *et al.*, 2010; JACOB and CENTOFANTI, 2023). Corroborating the results of assertion A8, Wilkie *et al.* (2018), Zeller *et al.* (2021) and Ploetzner (2022) found that interactive videos, are more effective for didactic content retention and comprehension than videos without interactions. Again, spontaneous testimonial from “N.A.O”, a student of Biological Sciences confirms the results of those three assertions. She wrote: [...] *I found the videos very didactic [...] The short duration (up to 5 minutes) is an incentive to watch them [...].*

The volunteer students also made some spontaneous criticisms about this research (sent by email). It is important to mention that many of criticisms are related to failures in the configuration of activities by professors (which demonstrates that students actually carried out the H5P simulations), e.g.,: (i) “E.P.S” - Pedagogy student: [...] *the activity about Brazilian Biomes is incorrectly configured [...];* (ii) “E.A.C” - Pedagogy student: [...] *In some cases, the font size was too small. I had trouble viewing some activity. There should be some question in the questionnaire to assess this aspect [...];* (iii) “N.A.O” - Biological Sciences student - [...] *So far, I've only had difficulty dragging and fixing the names of Humboldt and Odum on the Ecologists' Questionnaire [...].*

#### 4. CONCLUSION

Based on a quantitative, descriptive, and cross-sectional study, an evaluation of the perception of 122 volunteer DL undergraduate students from a private Brazilian HEI, about the use of H5P Moodle interactive content during the teaching and learning process of the EE was carried out. Firstly, these students compared the VLE Moodle traditional didactic resources (i.e., booklet plus non-interactive video lessons) versus several H5P Moodle interactive resources (e.g., interactive videos, presentations, virtual tours 360, games, quizzes, flashcards, among others). Specifically, the subject studied was “concepts of Ecology”. Soon after, they answered an instrument comprised two analysis dimensions (i.e., Feasibility and Motivation) consisting of 14 assertions of the Likert-type. The results obtained are summarised below:

(i) The most part of participating students (i.e., 99 among those 122) were from Pedagogy



and Public Management courses.

(iii) The study on the reliability of the instrument resulted in a coefficient equal to 0.80. Therefore, it is possible to state that on another occasion, these students would respond to the instrument in the same way.

(iii) The number of validated assertions was 11/14 (a loss of the 21.40% of the assertions). However, the loss of up to 40% of the total statements is considered adequate when using the Likert scale.

(iv) The overall mean of the 11 assertive instrument was 3.35 points ( $SD = 0.36$ ), which demonstrates a positive student perception of the evaluated object.

(v) In line with previous studies, majority part of students reported positive and motivating experiences after having studied EE through H5P interactive resources.

H5P technology proved to be a cost-effective way to embed interactive activities in the VLE Moodle. For instance, in Brazil (which have strong budget constraints for education) there are more than 3.0 million students enrolled in DL courses. Therefore, this study can encourage Brazilian educators and/or instructional designers to create a variety of interactive H5P Moodle-based learning objects.

Moreover, H5P Moodle technology proved as an efficient method for the teaching and learning process of the cross-cutting theme EE. Since there are over 290 million Moodle users worldwide, the use of that plugin at private and public HEIs, can contribute worldwide students to acquire the knowledge and skills needed to promote sustainable development (according to Target 4.7 of SDG4 by UN).

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