Universidad de Alcalá
COMISIÓN DE ESTUDIOS OFICIALES DE POSGRADO Y DOCTORADO

UNIVERSIDAD DE ALCALÁ, PATRIMONIO DE LA HUMANIDAD

ACTA DE EVALUACIÓN DE LA TESIS DOCTORAL

Año académico 2018/19

DOCTORANDO: **MORALES CHAN, MIGUEL ANTONIO**
D.N.I./PASAPORTE: ******527860101**

PROGRAMA DE DOCTORADO: **442- INGENIERIA DE LA INFORMACIÓN Y DEL CONOCIMIENTO**
DPTO. COORDINADOR DEL PROGRAMA: **CIENCIAS DE LA COMPUTACIÓN**
TITULACIÓN DE DOCTOR EN: **DOCTOR/A POR LA UNIVERSIDAD DE ALCALÁ**

En el día de hoy 26/06/19, reunido el tribunal de evaluación nombrado por la Comisión de Estudios Oficiales de Posgrado y Doctorado de la Universidad y constituido por los miembros que suscriben la presente Acta, el aspirante defendió su Tesis Doctoral, elaborada bajo la dirección de **ROBERTO BARCHINO PLATA // JOSE AMELIO MEDINA MERODIO.**

Sobre el siguiente tema: *MOOC-CLOUD FRAMEWORK PARA EL DESARROLLO DE ACTIVIDADES DE APRENDIZAJE UTILIZANDO HERRAMIENTAS DE LA NUBE*

Finalizada la defensa y discusión de la tesis, el tribunal acordó otorgar la CALIFICACIÓN GLOBAL[1] de (**no apto, aprobado, notable** y **sobresaliente**): SOBRESALIENTE

Alcalá de Henares, 26 de junio de 2019

EL PRESIDENTE | EL SECRETARIO | EL VOCAL

Fdo.: LLORENÇ HUGUET I ROTGER HEREDERO

Fdo.:JOSE JAVIER MARTÍNEZ HERRÁIZ

Fdo.: CARMEN DE PABLOS Eva Palechano

Con fecha 24 de Julio de 2019 la Comisión Delegada de la Comisión de Estudios Oficiales de Posgrado, a la vista de los votos emitidos de manera anónima por el tribunal que ha juzgado la tesis, resuelve:

- [x] Conceder la Mención de "Cum Laude"
- [ ] No conceder la Mención de "Cum Laude"

La Secretaria de la Comisión Delegada

FIRMA DEL ALUMNO,

Fdo.: MORALES CHAN, MIGUEL ANTONIO

[1] La calificación podrá ser "no apto" "aprobado" "notable" y "sobresaliente". El tribunal podrá otorgar la mención de "cum laude" si la calificación global es de sobresaliente y se emite en tal sentido el voto secreto positivo por unanimidad.

INCIDENCIAS / OBSERVACIONES:

Ante la imposibilidad de actuar como Vocal de la Dra. Carmen de Pablos, actúa como Vocal la Dra. Eva Pelechano.

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Y TRANSFERENCIA

En aplicación del art. 14.7 del RD. 99/2011 y el art. 14 del Reglamento de Elaboración, Autorización y Defensa de la Tesis Doctoral, la Comisión Delegada de la Comisión de Estudios Oficiales de Posgrado y Doctorado, en sesión pública de fecha 24 de julio, procedió al escrutinio de los votos emitidos por los miembros del tribunal de la tesis defendida por ***MORALES CHAN, MIGUEL ANTONIO***, el día 26 de junio de 2019, titulada, *MOOC-CLOUD FRAMEWORK PARA EL DESARROLLO DE ACTIVIDADES DE APRENDIZAJE UTILIZANDO HERRAMIENTAS DE LA NUBE* para determinar, si a la misma, se le concede la mención "cum laude", arrojando como resultado el voto favorable de todos los miembros del tribunal.

Por lo tanto, la Comisión de Estudios Oficiales de Posgrado y Doctorado **resuelve otorgar** a dicha tesis la

MENCIÓN "CUM LAUDE"

EL VICERRECTOR DE INVESTIGACIÓN Y TRANSFERENCIA
F. Javier de la Mata de la Mata
Documento fechado y firmado digitalmente

Copia por e-mail a:
Doctorando: MORALES CHAN, MIGUEL ANTONIO
Secretario del Tribunal: JOSE JAVIER MARTÍNEZ HERRÁIZ
Director/a de Tesis: ROBERTO BARCHINO PLATA // JOSE AMELIO MEDINA MERODIO

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Servicio de Estudios Oficiales de Posgrado

DILIGENCIA DE DEPÓSITO DE TESIS.

Comprobado que el expediente académico de D./Dª MIGUEL ANTONIO MORALES CHAN reúne los requisitos exigidos para la presentación de la Tesis, de acuerdo a la normativa vigente, y habiendo presentado la misma en formato: ☒ soporte electrónico ☐ impreso en papel, para el depósito de la misma, en el Servicio de Estudios Oficiales de Posgrado, con el nº de páginas: 80 se procede, con fecha de hoy a registrar el depósito de la tesis.

Alcalá de Henares a 25 de ABRIL de 2019

PILAR DE LA VEGA

Fdo. El Funcionario

Universidad de Alcalá

Departamento de Ciencias de la Computación

Doctorado en Ingeniería de la Información y del Conocimiento

Título: "MOOC-CLOUD, Framework para el desarrollo de actividades de aprendizaje utilizando herramientas de la nube"

Tesis Doctoral presentada por:
MIGUEL ANTONIO MORALES CHAN

Programa: D442
Nº expediente: 47

Directores:
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HAGO CONSTAR que la Tesis Doctoral titulada "MOOC-CLOUD, Framework para el desarrollo de actividades de aprendizaje utilizando herramientas en la nube" presentada por D. Miguel Antonio Morales Chan, bajo la dirección del Dr. Roberto Barchino Plata y por el Dr. José Amelio Medina Merodio, ha sido realizada por compendio de artículos, reuniendo los requisitos exigidos a este tipo de tesis, así como los requisitos científicos de originalidad y rigor metodológicos para ser defendida ante un tribunal. Esta Comisión ha tenido también en cuenta la evaluación positiva anual del doctorando, habiendo obtenido las correspondientes competencias establecidas en el Programa.

Para que así conste a los efectos del depósito de la tesis, se firma en Alcalá de Henares a 10 de abril de 2019

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Dr. D. José Amelio Medina Merodio, Profesor Doctor del Área de Ciencias de la Computación e Inteligencia Artificial del Departamento de Ciencias de la Computación de la Universidad de Alcalá.

HACEN CONSTAR que la Tesis Doctoral titulada "MOOC-CLOUD, Framework para el desarrollo de actividades de aprendizaje utilizando herramientas en la nube" presentada por D. Miguel Antonio Morales Chan, ha sido realizada por compendio de artículos, reuniendo los requisitos exigidos a este tipo de tesis, así como los requisitos científicos de originalidad y rigor metodológicos para ser defendida ante un tribunal. Por todo ello, consideran que procede su defensa pública

Para que así conste a los efectos del depósito de la tesis, se firma en Alcalá de Henares a 10 de abril de 2019

UNIVERSIDAD DE ALCALÁ · DPTO. DE CIENCIAS DE LA COMPUTACIÓN

Fdo.: Dr. D. Dr. D. Roberto Barchino

Fdo.: Dr. D. José Amelio Medina

AGRADECIMIENTOS

Esta tesis doctoral, si bien ha requerido de mucho esfuerzo y dedicación, no hubiese sido posible sin la fortaleza que Dios me brindo durante todo este proceso. Quiero expresar mi agradecimiento a María Irene, mi esposa y a Marco André mi hijo, que me brindaron en todo momento palabras de aliento y fueron mi motor para lograr este objetivo. Muchas gracias por su apoyo, paciencia y comprensión.

A mis padres Miguel y Beatriz por todo el esfuerzo que siempre realizaron para darme la educación que hoy me ha permitido llegar hasta aquí. A mis hermanas y familia por animarme a seguir adelante con la tesis en todo momento.

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Quiero hacer una mención especial a mis Directores de tesis, el profesor Dr. D. Roberto Barchino y el profesor Dr. D. José Amelio Medina. Agradezco la confianza depositada en mi persona, sin sus orientaciones, ideas y apoyo, no hubiera sido posible la realización de esta tesis. ¡Estaré agradecido por siempre!

A todos ustedes, mi mayor reconocimiento y gratitud.

RESUMEN

Este trabajo de tesis doctoral proporciona un análisis general del uso de herramientas basadas en la nube (CBT, por siglas en inglés) para el diseño de actividades de aprendizaje en un curso en línea masivo y abierto (MOOC, por sus siglas en inglés), proponiendo el desarrollo de un marco de trabajo para la creación y gestión de artefactos de aprendizaje, utilizando estas herramientas asociadas con la taxonomía digital de Bloom para enriquecer el proceso de enseñanza-aprendizaje.

A lo largo de esta tesis doctoral se presentan tres artículos publicados en revistas de impacto, que muestran (1) el estado del arte del uso de CBT para la construcción de actividades de aprendizaje en un ambiente virtual, (2) los principales factores que determinan la adopción de una CBT por parte de los estudiantes de un MOOC, evaluando al mismo tiempo, cuáles son las estrategias de aprendizaje más efectivas y los aspectos que motivan el uso de las mismas y (3) cómo influye el uso de una CBT, para el mejoramiento de la comunicación y colaboración entre maestro-estudiante, estudiante-estudiante y estudiante-maestro, en un entorno MOOC.

El primero de estos artículos describe un modelo de ecuaciones estructurales que explica el uso educativo de las CBT en términos de su adopción y aplicación en el desarrollo de actividades de aprendizaje dentro de un ambiente virtual.

El segundo artículo evalúa la intención conductual de utilizar las CBT en un MOOC y explora los factores que influyen en esta intención de uso, basándose en el modelo de aceptación de tecnología (TAM por sus siglas en inglés).

El último de los artículos, evalúa la motivación de los estudiantes de un MOOC y el nivel de uso de diferentes estrategias cognitivas y metacognitivas relacionadas con el desarrollo de actividades de aprendizaje apoyadas con CBT. Esta evaluación se realizó mediante el uso del Cuestionario de Motivación y Estrategias para el Aprendizaje, por sus siglas en inglés, MSLQ (Motivated Strategies for Learning Questionaire).

El trabajo de tesis finaliza con la presentación de las conclusiones y líneas de acción de trabajo futuro.

ABSTRACT

This doctoral thesis provides a general analysis of the use of cloud-based tools (CBT) for the design of learning activities in a massive open online course (MOOC), it proposes the development of a framework for the creation and management of learning artifacts, associated with Bloom´s digital taxonomy to enrich the teaching-learning process.

This doctoral thesis presents three impact journal papers which demonstrate (1) the state of the art of the use of CBT for the construction of learning activities in a virtual environment, (2) the main factors that determine the adoption of a CBT by MOOC students, evaluating at the same time, which are the most effective learning strategies and the aspects that motivate their use and (3) how the use of a CBT influences the improvement of communication and collaboration between teacher-student, student-student and student-teacher in a MOOC environment.

The first of these articles describes a structural equation modeling to explain the educational usage of CBT in terms of their adoption and application in learning activities within a virtual environment.

The second article evaluate the behavioral intention to use CBT in a MOOC context, and explore the factors that influence this intention, based on extended Technology of Acceptance Model (TAM).

The last of the articles, measures MOOC students' motivational and the level of use of different cognitive and metacognitive strategies related to the development of learning activities supported by CBT. This evaluation was carried out using the Motivation and Strategies for Learning Questionnaire (MSLQ).

Finally, this work closes with the conclusions and future work sections.

ÍNDICE

1. Introducción

En los últimos años, los cursos en línea masivos y abiertos (MOOC, por sus siglas en inglés) han demostrado tener un alto impacto en las instituciones de educación superior, al permitir ofrecer educación abierta, global y de calidad [Pérez y otros, 2016; Hernández y otros, 2014b]. Los MOOCs fueron diseñados para un gran número de participantes, a los que puede acceder cualquier persona, en cualquier lugar, siempre y cuando tengan acceso a internet, ofreciendo una experiencia de aprendizaje completa en línea de forma gratuita [Daniel, 2012]. Actualmente los MOOC han alcanzado la fase de la meseta de productividad en términos del ciclo de sobreexpectación de Gartner [Bozkurt y otros, 2016]. De acuerdo con los datos publicados por [Shah, 2019], para finales del 2018 se habían puesto en marcha 11,400 MOOCs en más de 900 universidades de todo el mundo, registrando a más de 100 millones de estudiantes. Además, se ha evidenciado un aumento en la oferta de programas especializados como Nanodegrees, Specializations, XSeries, Professional Certificates y MicroMasters [De la Roca y otros, 2018]. Estas series de cursos otorgan certificaciones equivalentes a créditos académicos en diferentes universidades alrededor del mundo. Actualmente existen 630 programas de este tipo, gran parte de ellos procedentes de las especializaciones de Coursera y certificados profesionales de edX. Así mismo, durante el 2017 y 2018 se lanzaron en total 37 maestrías virtuales, siendo tecnología y negocios las áreas de mayor oferta. Estos programas basados en MOOCs presentan tarifas más bajas, un horario más flexible y un proceso de admisión menos estricto que los programas tradicionales.

Es evidente que, aunque el escenario actual es diferente al planteado en el 2008, donde Siemens y Downes impulsaron los cursos denominados cMOOC por su enfoque conectivista, donde se buscaba conectar a los participantes para que aprendieran unos de otros a través de la revisión por pares, el debate abierto en los foros y la colaboración en actividades [Shehadeh y otros, 2018]. Así como del 2011, donde Norvig y Thrun realizaron el primer curso en formato xMOOC (basado en un enfoque conductista), que se caracterizaba porque su estructura era muy similar al formato tradicional de un curso virtual, en donde los contenidos eran presentados a través de una serie de videos, apoyados de materiales de estudio, tareas y/o actividades de aprendizaje con plazos de entrega, foros de discusión y evaluaciones de opción múltiple para validar su conocimiento [Morales y otros, 2015].

Las altas tasas de deserción [Guetl y otros, 2014a], los métodos de evaluación (opción múltiple autocalificable y evaluación por pares), los canales de comunicación y el hecho de que la gran mayoría de los participantes de un MOOC no están preparados para controlar su propio ritmo de aprendizaje, representan aún grandes retos al momento de diseñar un MOOC [Guetl y otros, 2014b], esto ha motivado una serie de investigaciones relacionadas al tema, destacando la importancia de la generación de espacios dedicados, que permitan a los usuarios finales practicar y evidenciar de una forma interactiva el conocimiento adquirido.

En este sentido, es importante tomar en cuenta como cada vez más las herramientas basadas en la nube (CBT por sus siglas en ingles), también conocidas como herramientas web 2.0 son utilizadas en el campo de la educación, para apoyar los procesos de enseñanza-aprendizaje [Shehadeh y otros, 2018]. Estas herramientas promueven un cambio en la forma en que las personas aprenden, basado principalmente en la creatividad del profesor que diseña la actividad de aprendizaje, permitiendo de esta forma el intercambio de ideas, comentarios y enlaces a recursos digitales [Shehadeh y otros, 2018]. La mayoría de estas herramientas son de acceso libre y ofrecen una amplia gama de posibilidades de integración en plataformas MOOC, brindando la posibilidad de organizar servicios que anteriormente se consideraban independientes, para dar lugar a entornos de aprendizaje que ofrezcan una experiencia integrada [Hernández y otros, 2014b].

Sin embargo, el proceso de implementación de actividades de aprendizaje que utilicen las CBT como recurso de apoyo, implica varios desafíos [Morales y otros, 2017]. Este proceso requiere una inversión considerable de tiempo y recursos por parte del profesor que, en muchos casos, no tiene los conocimientos básicos necesarios sobre cómo utilizar estas herramientas y cómo aplicarlas en los procesos de enseñanza-aprendizaje; en otras palabras, el profesor no siempre es consciente del impacto que las CBT podrían lograr en términos de motivación, adopción y desarrollo de habilidades en los estudiantes. Además, se hace difícil para los profesores, identificar y seleccionar el tipo de CBT apropiada y a su vez, cómo definir los objetivos didácticos que se desean alcanzar [Morales y otros, 2018].

En este contexto, la aplicación de la Taxonomía de Bloom adquiere un papel importante, debido que está, promueve formas superiores de pensamiento en la educación, como el análisis y la evaluación de conceptos, procesos y principios, en lugar de limitarse únicamente a recordar solo hechos [Anderson y Krathwohl, 2001]. La taxonomía de Bloom proporciona a los profesores, un marco general para enfocarse en lo que espera que los estudiantes aprendan (objetivos de aprendizaje) debido a la instrucción. Por tal motivo, las actividades de aprendizaje que utilizan CBT como recurso de apoyo, pueden asociarse con las habilidades de orden inferior (LOTS) o con las habilidades de orden superior (HOTS) de la Taxonomía de Bloom.

Lo anteriormente expuesto, ha motivado el desarrollo del presente trabajo de tesis, titulado: *"MOOC-CLOUD, Framework para el desarrollo de actividades de aprendizaje utilizando herramientas de la nube"*, que busca proponer un marco de trabajo para la creación y gestión de artefactos de aprendizaje utilizando herramientas basadas en la nube, asociados con la taxonomía digital de Bloom para mejorar la experiencia de aprendizaje de un estudiante en un MOOC.

Esta tesis doctoral muestra el estado del arte del uso de CBT para la construcción de actividades de aprendizaje en un ambiente virtual, los principales factores que determinan la adopción de una CBT por parte de los estudiantes de un MOOC, evaluando al mismo tiempo, cuáles son las estrategias de aprendizaje más efectivas y los aspectos que motivan el uso de las mismas, y cómo influye el uso de una CBT, para el mejoramiento de la comunicación y colaboración entre maestro-estudiante, estudiante-estudiante y estudiante-maestro, en un entorno MOOC.

A continuación, se presenta el estado del arte, objetivo general de esta tesis doctoral, los objetivos específicos, preguntas de investigación y la justificación de la presentación de la tesis como compendio de publicaciones. Posteriormente se muestran los 3 artículos seleccionados, los artículos complementarios y se finaliza con las conclusiones y la descripción del trabajo futuro.

1.1. Estado del arte y trabajos relacionados

En esta sección se analiza el marco normativo general que se ha tomado como referente a la hora de llevar a cabo los diferentes trabajos de investigación que forman parte de esta tesis doctoral. Para ello, se han estructurado los siguientes apartados:

- Aspectos relacionados con el uso de CBT en ambientes virtuales de aprendizaje y MOOCs
- Aspectos relacionados con la interoperabilidad de las CBT

1.1.1 Aspectos relacionados con el uso de CBT en ambientes virtuales de aprendizaje y MOOCs

La integración de CBT en el campo de la educación, como Google Drive[1] para uso de editor de texto, hojas de cálculo, presentaciones, Mindmeister[2] como herramienta para creación de mapas mentales, Prezi[3] o Slideshare[4] para compartir presentaciones; ha transformado la forma en que se enseña y se aprende, facilitando nuevas formas de comunicación, colaboración, interacción y participación entre los participantes de un ambiente de aprendizaje virtual. Estas herramientas al ser gestionadas por servicios en la nube (cloud computing), ofrecen un alto grado de escalabilidad, brindando fácil acceso a través de la web, desde cualquier dispositivo habilitado para internet. [Chang y otros, 2018] indica que estos servicios pueden garantizar la escalabilidad y elasticidad mediante el aprovisionamiento de recursos "bajo demanda". [Bein y otros, 2009] enumeran las principales ventajas y desafíos del uso del cloud computing aplicado en este tipo de herramientas.

Es importante resaltar que, aunque algunas de estas herramientas no estaban destinadas para el uso académico, su aplicación en los procesos de enseñanza-aprendizaje ha vislumbrado resultados interesantes. Según [Usluel y Mazman, 2009] las CBT tienen el potencial de ser utilizadas como recurso de apoyo para el desarrollo de actividades de aprendizaje que fomenten el aprendizaje colaborativo. [Bates, 2011] afirma que estas herramientas facilitan la creación de espacios dedicados de aprendizaje que promueven la construcción del conocimiento. Por su parte, [Washington y Sequera, 2015] sugieren que las CBT favorecen al aprendizaje activo, promoviendo el dialogo, la reflexión y la aplicación de la teoría aprendida a la práctica.

En [Hernández y otros, 2013], se describe la experiencia de utilizar CBT como Mindmeister, Cacco[5], Bubble.us[6], Slideshare, Educaplay[7] y Milaulas[8] como recurso de apoyo para el diseño y desarrollo de actividades de aprendizaje para dos MOOC, "Introducción al e-Learning" y "Desarrollo de aplicaciones para iPhone", implementados en la plataforma Telescopio[9] [Morales y otros, 2014]. El uso de estas herramientas promovió la interacción y colaboración entre los estudiantes, por medio de la creación de recursos digitales que permitían evidenciar su aprendizaje. Los autores manifestaron que las herramientas utilizadas, demostraron una gran escalabilidad y evidenciaron que los estudiantes eran capaces de utilizar estas herramientas y al

[1] https://www.google.com/drive/
[2] https://www.mindmeister.com
[3] https://prezi.com/
[4] https://es.slideshare.net/
[5] https://cacoo.com/es/
[6] https://bubbl.us/
[7] https://es.educaplay.com/
[8] https://www.milaulas.com/
[9] http://telescopio.galileo.edu

mismo tiempo lograr los objetivos didácticos definidos para cada actividad.

Sin embargo, resaltaron que la interoperabilidad entre las CBT, la organización y gestión de las actividades en la plataforma MOOC, así como la selección de la herramienta adecuada a utilizar para lograr los fines didácticos establecidos, eran retos a vencer para próximas ediciones.

[Hernández y otros, 2014a], presentan el diseño e implementación de una serie de actividades de aprendizaje apoyadas con CBT para un MOOC. El estudio evaluó la experiencia de uso de estas actividades de aprendizaje, desde la perspectiva de aspectos emocionales, motivación y percepción de facilidad de uso por parte de los estudiantes. Los primeros hallazgos de esta investigación evidenciaron que los participantes del MOOC que realizaron actividades de aprendizaje apoyadas con CBT, mostraron una alta motivación, percibiendo las mismas, fáciles de utilizar.

Sin embargo, estos resultados no garantizan que los participantes adopten el uso de la herramienta, ni tampoco que se tenga un uso educativo conveniente al momento de implementarlas en los procesos de enseñanza-aprendizaje.

Por su parte, [Hoyos y otros, 2016] describen la experiencia de implementar un conjunto de CBT tales como Blockly[10], Codeboard[11] y Greenfoot[12], como recursos de apoyo para la realización de actividades de aprendizaje destinadas para facilitar el proceso de aprendizaje de lenguajes de programación, a través de la generación de espacios de práctica. Estas herramientas fueron utilizadas en el MOOC "Introducción a la programación con Java" implementado en edX por la Universidad Carlos III de Madrid. Los resultados presentados en este estudio, muestran que los estudiantes obtuvieron una percepción positiva acerca de la utilidad que proporciona la generación de este tipo de espacios de práctica, así como del uso de la CBT.

Los autores concluyeron que el desarrollo de este tipo de actividades de aprendizaje conlleva una alta carga de trabajo para los profesores, sin tomar en cuenta que, en muchas ocasiones no se tiene claro los objetivos didácticos que se desean alcanzar con la puesta en marcha de este tipo de actividades de aprendizaje.

1.1.2 Aspectos relacionados con la interoperabilidad de las CBT

El uso y la combinación de varias CBT en un mismo MOOC, conlleva a que el estudiante cuente con diferentes usuarios (uno diferente para cada CBT, distinto al usuario de la plataforma MOOC) e inicie sesión en varias herramientas al mismo tiempo.

Mientras se combine el uso de varias CBT, se hace necesario contar con un lenguaje común, que permita compartir las diferentes aportaciones y los resultados entre las herramientas, proporcionando al estudiante, por medio de una interfaz amigable, información relevante para lograr los objetivos de aprendizaje. Es por tal motivo que, desde el punto de vista técnico es importante la interoperabilidad.

[Olmedilla y otros, 2006] define la interoperabilidad como "la capacidad de diferentes sistemas para compartir funcionalidades o datos". [Shehadeh, 2016] afirma que la interoperabilidad, permite que la autenticación, comunicación, mantenimiento y la integración con los servicios,

[10] https://blockly-games.appspot.com/
[11] https://codeboard.io/
[12] https://www.greenfoot.org/door

sea más flexible y sostenible.

Por su parte, [Aroyo y otros, 2006], describen los estándares más utilizados para la interoperabilidad en herramientas de aprendizaje, tales como: (a) learning object interoperability framework (LORI), (b) content object repository discovery and resolution architecture (CORDRA), y (c) learning tools interoperability (IMS LTI).

El estándar LTI creado por IMS Global Learning Consortium, es una forma básica y ampliamente adoptada para integrar herramientas externas en plataformas MOOC. Esta especificación admite el intercambio automático de credenciales, facilitando la autenticación y permitiendo que la herramienta del consumidor (TC) y el proveedor de herramientas (TP) intercambien información de manera segura.

Complementariamente, [Hernández y Gütl, 2015] resaltan que, con el fin de permitir la interoperabilidad entre los sistemas, además de considerar los estándares, normas y especificaciones educativas, es indispensable diseñar y desarrollar interfaces personalizadas para cada herramienta que se integre con la plataforma MOOC, brindando una mejor visualización y despliegue en la plataforma, permitiendo un acceso integrado.

La literatura reporta casos de uso del estándar IMS LTI utilizado para integrar herramientas externas en los LMS tradicionales, [Forment y otros, 2012] propone la integración de Google Docs para potencializar las actividades de aprendizaje colaborativo dentro del LMS Moodle. En relación a los MOOC, [Alario y otros, 2017] describe la experiencia de integración de una herramienta externa llamada Codeboard en tres MOOC relacionados a temas de ciencias de la computación implementados en edX[13]. Esta herramienta es un entorno de desarrollo basado en la web que permite editar, compilar y ejecutar código en diferentes lenguajes de programación desde el navegador. Esta CBT está integrada en edX a través del estándar de interoperabilidad IMS LTI, donde edX desempeño el rol de LTI Tool Consumer (TC) y Codeboard como LTI Tool Providers (TP). Esta integración permitió al usuario final, visualizar y acceder a Codebord desde edX, permitiendo la realización de las actividades de aprendizaje y mejorando la experiencia de usuario. Los autores indican que después de ejecutar los tres MOOC, con 112 actividades de Codeboard incluidas, los resultados del estudio evidenciaron un amplio uso de este tipo de actividades y una valoración muy positiva de la utilidad de este tipo de CBT por parte de los estudiantes.

[13] https://www.edx.org

1.2. Objetivo de la tesis

El objetivo general de esta tesis doctoral es **proponer un marco de trabajo para la creación y gestión de artefactos de aprendizaje haciendo uso de CBT también conocidas como herramientas web 2.0, para mejorar la experiencia de aprendizaje de un estudiante en un MOOC.**

Uno de los aspectos importantes a considerar alrededor del objetivo planteado, es la aceptación y adopción de las herramientas basadas en la nube por parte de los principales actores del proceso de enseñanza-aprendizaje. Desde la perspectiva de los estudiantes, la adopción puede medirse en función de la **motivación, de la percepción de su facilidad de uso y utilidad**. Desde la perspectiva de los docentes, puede medirse en función del uso **educativo y la definición de los resultados de aprendizaje asociados a la taxonomía de Bloom.**

Por lo anterior, para alcanzar nuestro principal objetivo se han definido cinco objetivos específicos que permiten alcanzar la meta propuesta.

Los objetivos específicos se enumeran a continuación:

- **ObjEsp1.-** Estudiar y analizar el estado del arte del uso de CBT para la construcción de actividades de aprendizaje en un ambiente virtual.
- **ObjEsp2.-** Identificar y analizar cuáles son los principales factores que determinan la adopción de una CBT para la construcción de actividades de aprendizaje en un ambiente virtual.
- **ObjEsp3.-** Identificar cuál es el impacto de utilizar CBT, en el diseño de actividades de aprendizaje para un MOOC. Evaluando al mismo tiempo, cuales son las estrategias de aprendizaje más efectivas y los aspectos que motivan el uso de las mismas, durante la participación de un MOOC.
- **ObjEsp4.-** Analizar cómo influye el uso de CBT, para el mejoramiento de la comunicación y colaboración entre maestro-estudiante, estudiante-estudiante y estudiante-maestro, en un entorno MOOC.
- **ObjEsp5.-** Proponer un marco de trabajo para la creación y gestión de actividades de aprendizaje, utilizando CBT asociadas con la taxonomía digital de Bloom, facilitando al profesor la elección de la CBT, la definición de los objetivos didácticos para el diseño de la actividad y los métodos de evaluación que permitan evidenciar el aprendizaje del estudiante.

En base a estos objetivos específicos, es posible plantear las siguientes preguntas de investigación:

RQ1. ¿Cuáles son los principales factores que determinan la adopción de una CBT?

RQ2. ¿Cuál es el impacto de utilizar las CBT en el diseño de actividades de aprendizaje y de aplicar la taxonomía de Bloom para definir los objetivos de aprendizaje?

RQ3. ¿Cómo influye el uso de las CBT en el mejoramiento de la comunicación y colaboración entre maestro-estudiante, estudiante-estudiante y estudiante-maestro?

RQ4. ¿El uso de las CBT para el desarrollo de actividades de aprendizaje en un MOOC, facilita el proceso de aprendizaje del estudiante?

RQ5. ¿Puede la actitud de los estudiantes hacia las CBT, estar influenciada por la facilidad de uso y la utilidad percibida de estás?

RQ6. ¿La identificación de la comunidad, motivación y creación de conocimiento, influyen en la percepción de la utilidad de las CBT?

1.1 Tesis doctoral como compendio de artículos

El Reglamento de Elaboración, Autorización y Defensa de la Tesis Doctoral (Aplicación del RD 99/2011, de 28 de enero. BOE 10 de febrero de 2011. Aprobado por la Comisión de Estudios Oficiales de Posgrado y 17 la Comisión de Doctorado en Sesión de 18 de enero de 2012. Artículo 5d.) [Universidad de Alcalá, (2011)] englobado dentro del programa de Doctorado de Ingeniería de la Información y el Conocimiento, recoge la posibilidad de realizar una tesis doctoral como compendio de artículos de investigación. Para garantizar la calidad del trabajo, la tesis deberá contar con un mínimo de tres publicaciones de reconocido prestigio, entendiéndose por reconocido prestigio las utilizadas para la obtención de complementos de investigación (sexenios) [Ministerio de Educación, Cultura y Deporte (2014)]. Además, se debe argumentar la coherencia del conjunto de la investigación, mostrándose una línea argumental de la misma.

Para la elaboración de esta tesis doctoral, se han seleccionado un total de tres artículos enmarcados bajo la hipótesis de partida:

- Morales Chan, M., Barchino-Plata, R., Medina Merodio, J. A., Alario-Hoyos, C. & Hernández-Rizzardini, R., (2018)**. Modeling educational usage of cloud-based tools in virtual learning environments.** IEEE Access, 7(1), 13347-13354. Factor de impacto: JCR (2017) =3.577; SJR (2017) =0.548

- Morales Chan, M., Barchino-Plata, R., Medina Merodio, J. A., Alario-Hoyos, C., Hernández Rizzardini, R. & De la Roca Marroquín, M., (2018). **Analysis of Behavioral Intention to Use Cloud-Based Tools in a MOOC: A Technology Acceptance Model Approach.** Journal of Universal Computer Science, 24(8), 1072-1089. Factor de impacto: JCR (2017) =1.079; SJR (2017) =0.357

- Morales Chan, M., Barchino-Plata, R., Amelio Medina, J., & Hernández Rizzardini, R., (2015). **MOOC using cloud-based tools: A study of motivation and learning strategies in Latin America.** International Journal of Engineering Education, 31(3), 901-911. Factor de impacto: JCR (2017) =0.575; SJR (2017) =0.799

Además de los artículos seleccionados para el compendio, la investigación realizada ha producido otros artículos con resultados intermedios o relacionados que, a pesar de no haber sido seleccionados para el compendio, son de interés para la comprensión global del trabajo. El detalle de estos artículos complementarios se presenta en la sección 3.

1.2 Estructura de la memoria de tesis doctoral

El contenido de la presente tesis doctoral está dividido en 4 secciones:

En la primera sección, se presenta una visión general de la tesis, incluyendo una introducción al problema que da pie a la investigación. Así mismo, se presenta el objetivo general de la tesis, objetivos específicos, preguntas de investigación y la justificación de la presentación de la tesis como compendio de publicaciones.

En la segunda sección se presenta de manera detallada cada una de las tres publicaciones seleccionadas para la presentación de la tesis como compendio de publicaciones. Para justificar la presencia de cada uno de estos artículos, se presenta un resumen del artículo, así como un análisis del impacto de la publicación.

En la tercera sección se presenta una lista de artículos adicionales publicados en congresos, que han sido resultado de investigaciones complementarias, que han servido para brindar una perspectiva integral a la resolución del problema. Es importante resaltar que este trabajo de tesis fue realizado en el marco del proyecto "MOOC-Maker" (Co-financiado por la Unión Europea a través del programa Erasmus+) donde participe como coordinador para la Universidad Galileo, miembro del consorcio. Por tal motivo, un número de publicaciones fueron desarrollados con otros autores diferentes a los co-directores de la tesis doctoral, permitiendo de esta forma complementar los resultados del presente estudio.

En la última sección, se presentan las conclusiones y los trabajos futuros derivados de esta tesis doctoral.

Al final de este documento se presentan la bibliografía general y los anexos.

2. Compendio de artículos de la Tesis

El objetivo de esta tesis es proponer un **marco de trabajo para la creación y gestión de artefactos de aprendizaje, utilizando herramientas basadas en la nube asociadas con la taxonomía digital de Bloom para mejorar la experiencia de aprendizaje de un estudiante en un MOOC.**

Para reflejar el trabajo realizado se han elaborado tres artículos, publicados en revistas científicas de reconocido prestigio, que reflejan las etapas necesarias para la elaboración del marco de trabajo propuesto.

Dentro de esta recopilación de artículos, el primero de ellos propone un modelo de ecuaciones estructurales que explica el uso educativo de las herramientas basadas en la nube en términos de su adopción y aplicación en el desarrollo de actividades de aprendizaje dentro de un ambiente virtual de aprendizaje.

El segundo artículo evalúa la intención conductual de utilizar herramientas basadas en la nube en el contexto de un MOOC, y explora los factores que influyen en esta intención de uso, basándose en el modelo de aceptación de tecnología (TAM por sus siglas en ingles).

El tercer artículo evalúa a través del cuestionario Motivated Strategies for Learning Questionnaire (MSLQ) la motivación y las estrategias de aprendizaje autorregulado que un estudiante emplea al momento de utilizar herramientas basadas como recurso para el desarrollo de actividades de aprendizaje en un MOOC.

A continuación, se muestra una tabla en la que se reflejan las publicaciones y qué objetivo cubren cada una de ellas, donde una X en la intersección entre la publicación y el objetivo indica que este ha sido alcanzado o parcialmente alcanzado con dicha publicación:

Artículo	Objetivo 1	Objetivo 2	Objetivo 3	Objetivo 4	Objetivo 5
Modeling educational usage of cloud-based tools in virtual learning environments	x	x			
Analysis of Behavioral Intention to Use Cloud-Based Tools in a MOOC: A Technology Acceptance Model Approach		x	x	x	
MOOC Using Cloud-based Tools: A Study of Motivation and Learning Strategies in Latin America			x	x	x

Tabla 1 - Trazabilidad entre los objetivos de la tesis y las publicaciones presentadas

2.1 Artículo I – Modeling educational usage of cloud-based tools in virtual learning environments

2.1.1 Descripción de aportes al objetivo de la tesis

El primer artículo que forma parte de este trabajo de tesis propone un modelo de ecuaciones estructurales que explica el uso educativo de las herramientas basadas en la nube (CBTs) en términos de su adopción y aplicación en actividades de aprendizaje dentro de un curso virtual. El análisis de datos se basó en una encuesta en línea, que evaluó una serie de actividades de aprendizaje apoyadas con CBTs, aplicadas en un entorno de aprendizaje virtual propuesto para el programa de innovación educativa implementado en la Universidad Galileo. La segunda sección de este artículo, presenta una revisión de literatura acerca de la aplicación de las CBT en la educación superior, explorando los factores que podrían afectar su aceptación y adopción por parte de los principales actores del proceso de enseñanza-aprendizaje y el resultado que podrían tener al asociarse con la taxonomía digital de Bloom.

En este trabajo de investigación se analiza la relación de dependencia entre la adopción y el uso educativo de las CBT utilizando un modelo de ecuaciones estructurales (SEM) para estimar las relaciones multivariadas y los efectos directos e indirectos de las variables bajo estudio. Para dicho propósito, se propuso un modelo que consta de 4 variables latentes (η) y 13 variables observables (y), donde la variable latente $\eta 1$ =Adopción es influenciada por 5 variables observables que son: y1 = utilidad, y2=usabilidad, y3=facilidad de condiciones, y4=identificación con la comunidad, y y5=motivación. Así mismo, consideramos que el uso educativo está determinado por tres variables latentes, $\eta 2$ = Habilidades de Pensamiento de Orden Superior (Bloom_B), $\eta 3$ = Habilidades de Pensamiento de Orden Inferior (Bloom_A), y $\eta 4$ = Coordinación Relacional (RC). Estas tres variables latentes se explican por ocho variables observables: y6=Recordar, y7=Comprender y y8=Aplicar (para $\eta 3$), y9=Analizar, y10=Evaluar y 11=Crear (para $\eta 2$) y y12=comunicación, y13=colaboración (para $\eta 4$). Nuestro modelo estructural permite combinar el análisis factorial con el análisis de regresión, explicando así la correlación y varianza entre las variables observables y las variables latentes.

El artículo presenta en su sección V, el análisis de datos y los resultados del modelo. Estos resultados, revelaron que la utilidad es una de las principales razones de la rápida adopción de las CBT. La adopción también puede explicarse en términos de facilidad de condiciones, usabilidad e identificación con la comunidad. Las CBT demostraron ser de fácil acceso, al ser web, no requieren de la instalación de software, muchas de ellas son gratuitas y permiten el trabajo colaborativo e interacción con el usuario generador de los recursos. El artículo también mostró que, en términos de uso educativo, hay una mayor correlación con las habilidades de pensamiento de orden inferior (LOTS) que con las habilidades de pensamiento de orden superior (HOTS) de la taxonomía de Bloom. El estudio sugiere que, a partir de la percepción del estudiante, la comunicación y colaboración entre pares puede ser una fuerte motivación para utilizar las CBT en actividades de aprendizaje en entornos virtuales.

De esta forma, los resultados presentados en este artículo cumplen con el Objetivo Especifico 1 y 2 (Sección 1.1) de este trabajo de tesis, analizando el estado del arte del uso de las CBT para la construcción de actividades de aprendizaje e identificando y analizando cuáles son los principales factores que determinan la adopción de una CBT para la construcción de actividades de aprendizaje en un ambiente virtual.

Así mismo, se responde a las preguntas de investigación RQ1, RQ2 y RQ3, mismas que cuestionan el impacto que se tiene al utilizar estas herramientas asociadas a la Taxonomía digital de Bloom en el diseño de actividades y cómo influyen en el mejoramiento de la comunicación y colaboración entre maestro-estudiante, estudiante-estudiante y estudiante-maestro. Resulta importante resaltar que las CBT tienen el potencial de apoyar, mejorar y transformar la experiencia de aprendizaje a través del intercambio de ideas, comentarios, recursos y reutilización de contenidos en entornos de aprendizaje que son gestionados por los propios profesores y estudiantes.

2.1.2 Indicios de calidad

Morales Chan, M., Barchino-Plata, R., Medina Merodio, J. A., Alario-Hoyos, C. &

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2.1.3 Artículo

El nombre del artículo publicado en la Revista IEEE Access es**: Modeling educational usage of cloud-based tools in virtual learning environments**

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Modeling Educational Usage of Cloud-Based Tools in Virtual Learning Environments

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ABSTRACT In recent years, cloud computing has motivated new learning tools based on the cloud to collaborate and share content with a large number of students. Thus, the main objective of this paper is to propose structural equation modeling explaining the educational usage of cloud-based tools (CBTs) in terms of their adoption and application in learning activities within a virtual course. The data analysis used a representative sample from Galileo University, Guatemala. The results of the study revealed that usefulness is one of the main reasons for the rapid adoption of CBTs. The study also showed that in terms of educational usage, there is a greater correlation with lower order thinking skills than that with higher order thinking skills of Bloom's taxonomy. Finally, the evidence from this study suggests that from a student perception, peer-to-peer communication and collaboration can be a strong motivation to use CBTs on learning activities.

INDEX TERMS Educational technology, structural equation model, virtual learning environment, e-learning technologies.

I. INTRODUCTION

Nowadays, cloud computing is one of the new technological trends with an important impact on teaching and learning environments [1]. Cloud computing promotes a change in the way of learning, both inside and outside the classroom, revolutionizing the teacher's role and his attributions, providing new resources and tools for the development of enhanced learning situations, and significantly transforming the way we communicate, collaborate, and build knowledge. Cloud-based tools (CBTs), such as Google Drive,[1] Genial.ly,[2] Educaplay[3] and Mindmeister,[4] are highly interactive tools with sharing, collaborating, and producing content characteristics that use cloud computing, and can reach a large number of students [2]. These tools are accessible through the web, from any Internet-enabled device, without having to worry about their maintenance or hosting [3]. Many of these tools are free and offer a diversity of features that can be used for education.

[1]https://gsuite.google.com/
[2] https://www.genial.ly/
[3]https://www.educaplay.com/
[4]https://www.mindmeister.com/

CBTs have the potential to support, enhance and transform the learning experience through the exchange of ideas, comments, resources and content reuse in learning environments that are managed by teachers and students themselves [4]. The added value of CBTs to the teaching process (through the design of learning activities that make appropriate use of them) can be meaningful [5]. CBTs can improve learners' communication and motivation, promote team work, increase positive interactions between group members and enrich the overall learning experience [6]. Another important aspect to note of CBTs is that they can be typically integrated into learning environments through their application programming interfaces, facilitating their tailoring to different learning situations.

However, the implementation process of learning activities that include CBTs involves several challenges. For example, this process requires a considerable investment of time and resources by the teacher who, in many cases, does not have the necessary basic knowledge about how to use these tools, and how to apply them to the teaching-learning process; in other words, the teacher is not always aware of the impact

CBTs could achieve in terms of motivation, adoption, and skill development in students, and how to reach this impact. Moreover, the choice of the CBTs, and the definition of didactic objectives in the design of the learning activity, become a difficult task to tackle. The teacher, in order to face all these challenges in an effective way, needs to understand the Learning Orchestration (LO) process. LO is defined [7] as the process in charge of productively coordinating interventions from learners across multiple learning activities. LO is mainly based on teacher's responsibilities, such as defining activities, workload and evaluation rubrics, among others [8]. The success of implementing activities that make use of CBTs depends on a clear definition of learning objectives that take into account the potential and purposes of the CBTs chosen.

In this context, the application of Bloom's taxonomy takes a leading role. Bloom's taxonomy was developed by Dr. Benjamin Bloom [9] to promote higher forms of thinking in education, such as analyzing and evaluating concepts, processes and principles, rather than just remembering facts. Bloom's taxonomy provides a framework to focus on what we expect students to learn because of instruction.

Considering the above-mentioned context, the central research questions (RQs) of this work are:

- (RQ1) What are the main factors that determine the adoption of a CBT?
- (RQ2) What is the impact of using CBTs in the design of learning activities and applying Bloom's taxonomy to define learning objectives?
- (RQ3) How does the use of CBTs influence the improvement of communication and collaboration between teacher-student, student-student and student-teacher?

This paper presents and analyzes a structural equation modeling (SEM) that explains the educational usage of CBTs in terms of their adoption and application for learning activities development. This SEM is associated with lower-order thinking skills (LOTS) and higher-order thinking skills (HOTS) from Bloom's taxonomy, and the relational coordination affected by communication and collaboration. The study is organized as follows: Section 2 is a review of the literature on CBTs, and the main aspects to consider in their implementation in educational scenarios, such as adoption and educational usage. Section 3 defines the SEM and hypotheses on which it is based. Section 4 presents the research method, and the data collection instruments and techniques. Section 5 analyzes the data and discusses the results. Finally, conclusions and future work are presented in the last section.

II. LITERATURE REVIEW

According to [5], the potential of CBTs in teaching and learning environments has caught the attention in higher education. Universities are increasingly using a wide range of useful CBTs to support teaching, learning and assessment methods [10]. The study by ECAR [6] on the use of technology by university students at the beginning of this decade showed that 25% of students in all types of institutions were already using CBTs, such as wikis, blogs, and social bookmarking tools, among others. Some students had decided to use these tools by themselves, whereas others used them upon request of their teachers. The study showed that some students were using this kind of tools for entertainment or for socializing, but a growing number of students were applying these tools for educational activities, especially those students who were in favor of collaborating among peers.

A. ADOPTION OF CLOUD BASED TOOLS IN HIGHER EDUCATION

An important aspect to consider of CBTs is their acceptance and adoption by the main stakeholders of the teaching-learning processes, such as universities and educational institutions of middle and higher levels [11]. From the students' perspective, the adoption of CBTs can be measured in accordance with the following factors: motivation, usage, utility and compatibility [12]–[14]. Students use CBTs because these technologies are perceived as a positive factor, which adds value to their teaching and learning activities [15]. According to Ibrahim and Huang, other factors that affect the use of this type of technology are: the expectation of effort, social influence, conditions of use, perceived learning, collaboration and commitment [16], [17].

Usluel and Mazman [13] and Mazman and Usluel [18] examined different theories and models that explain the acceptance, adoption, and use of a technology. Some of these theories and models were focused on the internal decision-making processes of individuals, such as the theories of reasoned action and planned behavior. Other authors emphasized on the main characteristics of innovation, such as the unified theory of acceptance and usage theory [18] and also on models such as the Technology Acceptance Models I and II (TAM) [19], [20] which predict the acceptance and future use of a technology through the perception of its easiness of use and utility.

B. EDUCATIONAL USAGE OF CLOUD BASED TOOLS

For this study, we evaluate the educational usage of CBTs and their impact in learning and teaching environments, when these tools are part of the learning activities; CBTs, and the definition of learning outcomes based on Bloom's taxonomy, become the core of the learning activity. Bloom classifies the cognitive knowledge operations into six levels through a hierarchy and assumes that students must master the lower levels of the hierarchy before advancing to a higher level. Anderson and Krathwohl made two changes in the original taxonomy [9], [21]: the use of verbs, rather than nouns, for each category; and the sequence of verbs within the taxonomy. The new terms in the revised taxonomy, according to Anderson & Krathwohl are enumerated from 1 (LOTS) to 6 (HOTS). 1) *Remembering* is defined as retrieving, recalling, and recognizing knowledge from memory; it is used to produce definitions, facts, or lists, or to recite or retrieve material. 2) *Understanding* builds relationships and links knowledge;

students understand the processes and concepts and are able to explain or describe these. 3) *Applying* is defined as carrying out or using a procedure through implementing it; applying is related and refers to situations where learned material is used through products, such as models, presentations, interviews, and simulations. 4) *Analyzing* is defined as breaking material or concepts into parts, determining how the parts interrelate to one another; it also includes making inferences and finding evidence to an overall structure. 5) *Evaluating* means making judgments based on criteria and standards through checking and reviewing; it entails that students must be able to present and defend opinions based on a set of criteria. Finally, 6) *Creating* is defined as putting the elements together to form a coherent or functional whole; it includes reorganizing elements into a new pattern or structure through generating, planning, or producing. For our research, the educational use of CBTs was associated with the development of learning activities designed for instructional purposes that may be associated with LOTS or HOTS in Bloom's taxonomy [9].

Moreover, we consider the theory of relational coordination which states that the relationship between peers is more effective if carried out through frequent, high quality communication. From an educational perspective, we propose that communication between students and teachers, when using CBTs during the learning process, should be frequent, timely and accurate. Additionally, the collaboration between people is influenced by the quality of their relationships, in particular of shared goals, shared knowledge and mutual respect coordination [5], [6].

III. RESEARCH MODEL AND HYPOTHESES

This paper investigates the relationship of dependencies between the adoption and the educational usage of CBTs using a structural equation modeling (SEM) to estimate multivariate relations and direct and indirect effects of the variables under study. SEM encourages confirmatory rather than exploratory modeling; it usually starts with a hypothesis, represents it as a model, operationalizes the constructs of interest with a measurement instrument, and tests the model [22].

For this purpose, we propose a model (see Fig. 1), which consists of 4 latent variable (η) and 13 observable variables (**y**). We consider that the latent variable $\eta\mathbf{1} = \textbf{\textit{Adoption}}$ is influenced by five observable variables, which are: $y1 = usefulness$, $y2 = usability$, $y3 = facilitating\ conditions$, $y4 = community\ identification$, and $y5 = motivation$.

Moreover, we consider that the **educational usage** is determined by three latent variables: $\eta\mathbf{2} = Higher-Order\ Thinking\ Skills\ (Bloom\_B)$, $\eta\mathbf{3} = Lower-Order\ Thinking\ Skills\ (Bloom\_A)$, and $\eta\mathbf{4} = Relational\ Coordination\ (RC)$. These three latent variables are explained by eight observable variables: $y6 = remembering$, $y7 = understanding$ and $y8 = applying$ (for $\eta3$), $y9 = analyzing$, $y10 = evaluating$ and $y11 = creating$ (for $\eta2$) and $y12 = communication$ and $y13 = collaboration$ (for $\eta4$). The first six observable variables are related with Bloom's taxonomy and represent the different thinking skills that can be promoted with the use of CBTs for learning. The last two observable variables are related with relational coordination [23] and represent the fact that CBTs can contribute to have more effective relationships between peers through high quality communication and collaboration. The proposed model is represented in Fig. 1.

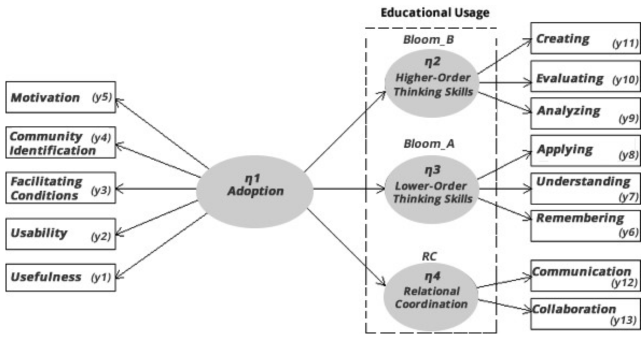

FIGURE 1. Proposed model.

According to the aim of this study, the following hypotheses are proposed and will be tested:

- H1: Observable variables y1-y5 have a significant influence on students' adoption of CBTs ($\eta1$).
- H2: Latent variable "Bloom_A" ($\eta3$) is influenced by observable variables y6-y8, which have a significant influence on educational usage of CBTs.
- H3: Latent variable "Bloom_B" ($\eta2$) is influenced by observable variables y9-y11, which have a significant influence on educational usage of CBTs.
- H4: Latent variable "RC" ($\eta4$) is influenced by observable variables y12-y13, which have a significant influence on educational usage of CBTs.
- H5: Latent variable "Bloom_B" ($\eta2$) is influenced by latent variable "Adoption" ($\eta1$).
- H6: Latent variable "Bloom_A" ($\eta3$) is influenced by latent variable "Adoption" ($\eta1$).
- H7: Latent variable "RC" ($\eta4$) is influenced by latent variable "Adoption" ($\eta1$).
- H8: Latent variable "Bloom_B" ($\eta2$) is influenced by latent variable "Bloom_A" ($\eta3$).
- H9: Observable variable "Motivation" (y5) has a significant influence on latent variable "Bloom_B" ($\eta2$).
- H10: Observable variable "Motivation" (y5) has a significant influence on latent variable "RC" ($\eta4$).

All hypotheses are depicted in Fig. 2.

IV. RESEARCH METHOD

A. INSTRUMENT

Our data analysis is based on an online survey, which evaluated the different learning activities supported with CBTs into virtual learning environment proposed for the educational innovation program implemented at the Galileo University (for the collaboration, information exchange and knowledge construction we used CBTs such as Xtranormal, Goanimate,

TABLE 1. The web-based questionnaire structure.

Section	*Purpose*	*Number of items/questions*	*Scale*
1	The first section evaluated several of learning activities where CBTs are used, such as: Xtranormal[5], GoAnimate[6], MindMeister[7], Issuu[8], etc.	10 items	-
2	The second section collected students' views on the adoption of CBTs in an educational context and related them to Bloom's revised taxonomy.	14 questions	5-point Likert scale
3	The third section consisted of measuring motivational aspects	5 questions	5-point Likert scale
4	The fourth section evaluated communication and collaboration aspects	6 questions	10-point Likert scale
5	The fifth section consisted of measuring usability aspects	5 questions	5-point Likert scale
6	The sixth section consisted of measuring usefulness, facilitating conditions, and community identification	9 questions	5-point Likert scale
7	The last section consisted of demographic questions	4 questions	Closed-ended question (Multiple Choice)

[5] www.xtranormal.com
[6] www.goanimate.com
[7] www.mindmeister.com
[8] www.issuu.com

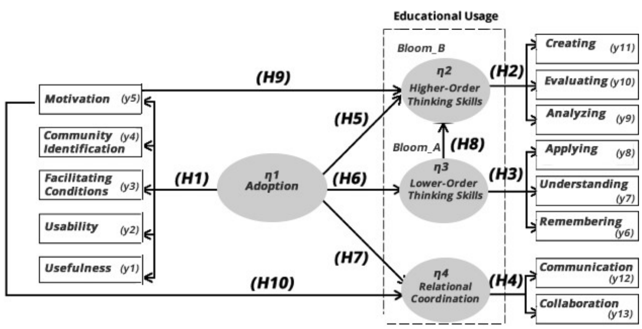

FIGURE 2. Hypotheses model.

MindMeister and Issuu, among others). The survey consisted of 7 sections (see Table 1).

The first section included a personal evaluation of the learning effort required to use the CBTs for the assigned learning activities, the time spent to perform the activity (to learn to use the CBT and the collaborative work with peers), personal opinions about CBTs implemented, and open questions about the learning experience.

The second section contained a set of 14 statements related to Bloom's revised taxonomy to be assessed using a 5-point Likert scale (from strongly disagree to strongly agree).

The third section focused on measuring motivational aspects, these depending on many personal factors

(personality, education, etc.), family, and social context in which the learning process is conducted (teaching methods, teachers, etc.). Motivation is essential for learning, and progress is inherent in the possibility of giving meaning and significance to knowledge. This section contained 5 statements to be assessed on a 5-point Likert scale from very unmotivated to very motivated.

The fourth sections focused on communication and collaboration, and contained 6 statements to be assessed with a 10-point Likert scale. These section aimed to measure the relevance of these resources in the teaching-learning processes. Students in courses that include CBTs usually tend to work more in collaboration, exchanging ideas, sharing information and working with people who have common interests.

The fifth section had 5 questions and a 5-point Likert scale for usability measures. Usability is a relevant factor in the adoption of CBTs, as the user may need some technical skills.

The sixth section focused on usefulness, facilitating conditions, and community identification. This section had 9 statements to be assessed with a 5-point Likert scale (from strongly disagree to strongly agree). These statements examined the main factors that influence student intentions to utilize CBTs in their courses. The seventh section collected demographic data from the users.

To validate the instrument, we used three parameters. (1) Content Validity reflects whether the items on the instrument adequately cover the entire topics should be covered. Therefore, professional e-Learning instructional designers' opinions were obtained to verify if the questions were appropriate and understandable. (2) Criterion Validity reflects how well an instrument is related to other instruments that measure similar variables. Experts were consulted to validate whether there were previous studies where a similar instrument had already been used. (3) Construct Validity is concerned about whether the instrument measures properly construct. Also, experts were consulted on whether these questions could be used to measure the research questions.

The web-based questionnaire was also tested with a focus group of 15 randomly selected students; this focus group included a visual verification of students' performance (there was no interaction or support with the students), and a written report of the experience, by the surveyor. Based on the feedback received from the experts, the online survey was modified, considering standardized instruments to

TABLE 2. Demographic and descriptive statistics of the surveyors.

Item		*Frequency*	*Percentage*
Gender	Female	157	48.5%
	Male	167	51.5%
Age	10–18	13	4.01%
	19–27	169	52.16%
	28–36	95	29.32%
	37–45	31	9.57%
	46–54	13	4.01%
	55+	3	0.93%
Educational Level	Graduate Student	286	86.27%
	Post-graduate Student	38	11.73%
Internet Access	No	114	35.19%
	Yes	210	64.81%

measure this experience: perceived usefulness, attitude, intention and behavior [13], [18], [20], the System Usability Scale (SUS) [8], and the motivational aspects [12]''.

Afterward, an explanatory and confirmatory analysis was conducted to identify the relation between factors and factor loads. A preliminary scale of 19 items was prepared to investigate the adoption of CBTs; the Cronbach's alpha coefficient of this scale was 0.945, which guarantees the internal consistency of the instrument. Second order confirmatory factor analyses were conducted on the remaining 18 items. The Factor loads of confirmatory factor analyzed results are presented in the Appendix.

B. PROCEDURE AND DATA COLLECTION

The study was conducted at the participants of the educational innovation program offered by the Galileo University in online format. This program is composed of 5 modules (4 weeks duration each module) designed in learning units that usually last for one week each unit having a diversity of learning resources such as videos, podcasts, animations, interactive contents, and a wide diversity of learning activities specially designed with CTBs supported. 324 students completed the questionnaire. Table 2 summarizes the demographic profile of the participants, including their age, gender, educational level, and internet access (this refers only to internet access from home). As can be observed in Table 2, the numbers of females and males were nearly equal, the age range with more participants in the study was between 19 and 27 years old, and most individuals were graduate students.

V. DATA ANALYSIS

A. STRUCTURAL EQUATION MODELING

The aim of this model is to analyze the educational usage of CBTs depending on their adoption and educational usage, considering Bloom's revised taxonomy and the Relational Coordination (RC).

Our structural model allows combining a factor analysis with regression analysis, thus explaining the correlation and variance between observable variables and latent

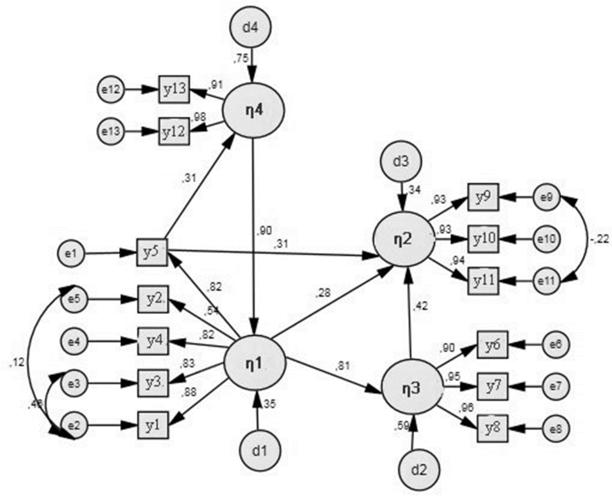

FIGURE 3. The result of SEM (standardized coefficients).

TABLE 3. Model fit indexes for the measurement model [24].

Fit indexes	Good fit	Accepted values	Model results
RMSEA	0 < RMSEA < 0.05	0.05 < RMSEA < 0.08	0.078
IFI	0.95 < IFI < 1	0.90 < IFI < 0.95	0.972
NNFI	0.97 < NNFI < 1	0.95 < NNFI < 0.97	0.961
CFI	0.97 < CFI < 1	0.95 < CFI < 0.97	0.971
GFI	0.95 < GFI < 1	0.90 < GFI < 0.95	0.913
AGFI	0.0 < AGFI < 1	0.85 < AGFI < 0.90	0.858
X^2/df	$X^2/df < 3$	$3 < X^2/df < 5$	3.69

TABLE 4. Covariance matrix of latent variables.

	Bloom_A	*Bloom_B*	*CR*	*Adoption*
Bloom_A	1.00			
Bloom_B	0.42	1.00		
RC	0	0	1.00	
Adoption	0.81	0.28	0.90	1.00

variables (unobservable). To create the model, IBM ©SPSS AMOS 21.0 and SPSS Statistics 21.0 program was used. Fig. 3 explains how CBTs for learning would be used.

For testing the structural model the fit indices for the measurement model are the Root Mean Square Error of Approximation (RMSEA), Incremental Fit Index (IFI), Non-Normed Fit Index (NNFI), Comparative Fit Index (CFI), Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), and X^2/df (chi-square)/df (degree of freedom) [24].

Table 3 shows the values for these indexes.

As shown in Table 3, all the fit indexes are satisfactory, demonstrating that the measurement model exhibited a good fit. Standard path coefficients of structural equation model are given in Fig. 3. Covariance matrix of latent variables is presented in Table 4.

B. MODEL RESULTS

All the coefficients between ''Adoption'' ($\eta 1$) and its observable variables are found to be significant ($p < .005$ or

$t > 1.96$). Results show that the five observed variables, namely usefulness (y1), usability (y2), facilitating conditions (y3), community identity (y4), and motivation (y5), have significant positive influences on adoption ($\eta 1$) ($\beta = 0.88$, $\beta = 0.54$, $\beta = 0.83$, $\beta = 0.82$, $\beta = 0.82$); this allows accepting hypothesis H1.

All the coefficients between educational usage of CBTs, "Bloom_A" ($\eta 3$), "Bloom_B" ($\eta 2$), "RC" ($\eta 4$) and its observable variables are also significant ($p < .005$ or $t > 1.96$). This result supported that the three observable variables namely remembering (y6), understanding (y7), and applying (y8), have a significant positive effect on "Bloom_A" ($\eta 3$) ($\beta = 0.90$, $\beta = 0.95$, $\beta = 0.96$); this allows accepting hypothesis H2. In addition to this, it is found that latent variable "Bloom_A" ($\eta 3$) is also correlated with the latent variable "Adoption" ($\eta 1$) ($\gamma = 0.81$); this allows accepting hypothesis H6.

Regarding latent variable "Bloom_B" ($\eta 2$), the three observable variables namely analyzing (y9), evaluating (y10) and creating (y11), have a significant positive effect ($\beta = 0.93$, $\beta = 0.93$, $\beta = 0.94$). Although with a lower correlation index there is a relationship between latent variable "Bloom_B" ($\eta 2$), and latent variable "Adoption" ($\eta 1$) ($\gamma = 0.28$); all this allows accepting hypotheses H3 and H5. In addition, the study evidenced that latent variable "Bloom_A" ($\eta 3$) has a significant positive effect on "Bloom_B" ($\eta 2$) ($\beta = 0.42$), which allows accepting hypothesis H8.

This model has also found that two observable variables related with latent variable "RC" ($\eta 4$) namely communication (y12), and collaboration (y13), have a significant positive effect on "RC" ($\eta 4$) ($\beta = 0.98$, $\beta = 0.91$); this allows accepting hypothesis H4. The latent variable "RC" ($\eta 4$) is related to the "Adoption" ($\eta 1$) ($\gamma = 0.90$), however, it is in opposite direction, and that is because the "Adoption" ($\eta 1$) does not explain the collaboration or communication when using a CBTs. Hence, "RC" ($\eta 4$) is an independent variable, due the fact that the adoption of a CBTs ($\eta 1$) does not have influence on the type of communication and collaboration that the student will have. This allows accepting hypothesis H7.

Analyzing the behavior of the observable variable "motivation" (y5), a significant influence on latent variable "Bloom_B" ($\eta 2$) is found ($\beta = 0.31$), which allows accepting hypothesis H9. Nevertheless, there is no evidence that observable variable "motivation" (y5) has an influence on latent variable "RC" ($\eta 4$) ($\beta = 0.31$) (because it is not significant for the model), which leads to the rejection of hypothesis H10.

C. FINDINGS AND DISCUSSION

In this study, the SEM explains the educational usage of CBTs directly from the student's adoption perspective. The results show that the latent variable "Adoption" ($\eta 1$) has a significant positive relationship with usefulness (y1), usability (y2), facilitating conditions (y3), community identification (y4), and motivation (y5), with the usefulness (y1) variable being the highest of the observable variables (see Table 5). Therefore, from the users' perception, usefulness (y1) is one of the main reasons for the rapid adoption of CBTs.

TABLE 5. Path coefficients.

Variables	*Observed Variable*	*Path Coefficients*
Adoption (η1)	Usefulness (y1) Usability (y2) Facilitating Conditions (y3) Community Identification (y4) Motivation (y5)	0.88 0.54 0.83 0.82 0.82
Bloom_A (η3)	Remembering (y6) Understanding (y7) Applying (y8)	0.90 0.95 0.96
Bloom_B (η2)	Analyzing (y9) Evaluating (y10) Creating (y11)	0.93 0.93 0.94
RC (η4)	Communication (y12) Collaboration (y13)	0.98 0.91

Adoption can also be explained in terms of facilitating conditions; CBTs are of easy access, can be found online, do not require installing software, and many of them are free or have free versions under some circumstances. Community identification and motivation also present high values indicating that both are relevant for the adoption of a CBT. It is important to be aware that 81.48% of participants are between the ages of 19 and 36 years old (Table 1). Extrapolating this result, one could argue that this is a new generation of students, which is more used to virtual environments and social networks. It is relevant to mention that, the variable of usability received the lowest score in the adoption test, although it still has an acceptable rate; this could be explained by the fact that many of these CBTs were new to the students surveyed.

With the help of this SEM, the educational use of CBTs is examined according to two dimensions of Bloom's revised taxonomy (remembering, understanding, applying, analyzing, evaluating and creating) and the Relational Coordination (communication and collaboration). In Bloom's revised taxonomy case, we found that students more closely associate the use of these tools to "Bloom_A" ($\eta 3$) ($\gamma = 0.81$), which explains Lower-Order Thinking Skills. This finding shows that students who were surveyed are conditioned to an educational environment which normally promotes Lower-Order Thinking Skills, because professors' purposes when creating learning activities (using CBTs) have a powerful relation with memorization of concepts and do not focus on activities that allow students learning by doing. In addition, it is found that "Bloom_B" ($\eta 2$), which explains Higher-Order Thinking Skills (analyzing, evaluating and creating), has a lower correlation to the latent variable "Adoption" ($\eta 1$) (0.28). For our research this value is still acceptable due the fact that the educational environment of the students is known to lack of enough learning activities that promote Higher-Order Thinking Skills, such as design, planning, production, experimentation, critical thinking, problem solving

TABLE 6. Factor loads.

Constructs	Items	Factor loads
Usefulness	UTI1	.714
	UTI2	.702
	UTI3	.665
Ease of Use /Usability	USA1	.460
	USA2	.385
	USA3	.373
	USA4	.659
	USA5	.537
Facilitating Conditions	FAC1	.702
	FAC2	.668
	FAC3	.630
Community Identification	COMI1	.786
	COMI2	.769
	COMI3	.759
Motivation	MOT1	.819
	MOT2	.795
	MOT3	.746
	MOT4	.751
	MOT5	.604
Remembering	REM1	.849
	REM2	.857
Understanding	UND1	.827
	UND2	.878
Applying	APP1	.883
	APP2	.862
Analyzing	ANA1	.805
	ANA2	.787
Evaluating	EVA1	.813
	EVA2	.716
Creating	CRE1	.786
	CRE2	.800
Communication	COM1	.641
	COM2	.619
	COM3	.650
	COM4	.633
Collaboration	COL1	.664
	COL2	.636

and others. This opens an opportunity to use CBTs for such educational purpose.

Finally, it is also found that "RC" ($\eta 4$) is influenced by latent variable "Adoption". This finding shows that from student perception, peer-to-peer communication and collaboration could be an educational use for CBTs. After reviewing and analyzing data collected from the fourth section of our web questionnaire, using a 10-point Likert scale, from totally disagree to totally agree, the responses for "Do you consider that the CBTs presented contribute to establishing communication among classmates?" returned a M = 7.93 SD = 2.45 for the statement. The responses for "Do you consider these tools contribute to better teacher-student communication? Returned a M = 4.52 SD = 3.31. It can be suggested that the perception of students regarding this type of tools does not represent a benefit to improve communication between teacher and student.

VI. CONCLUSIONS

The "Adoption" of CBTs for educational usage is demonstrated in this SEM. The evidence from this study suggests that people use CBTs to apply knowledge and to develop skills in different learning environments. The inclusion of these types of tools in the teaching-learning process is of benefit to both, the student and the teacher. It can be suggested that a large amount of the population is interested in using innovative, multimedia, highly visual, and attractive tools for learning especially the ones they can manipulate as part of their learning activities. Further work on a unified educational environment is required, to create an environment where all these cloud services can be orchestrated and managed to create learning activities that are innovative and simple to use at the same time. Also, studies on cognitive learning strategies, further motivation insights, emotions and usability need to be evaluated whereas performing any learning process using such CBTs. Finally, how to best interoperate such tools in a way that the legacy systems can incorporate these tools seamlessly, without large maintenance costs, is a concern to the technical short and large term viability of this new educational environment.

APPENDIX

See Table 6.

REFERENCES

[1] T. Ercan, "Effective use of cloud computing in educational institutions," *Procedia-Social Behav. Sci.*, vol. 2, no. 2, pp. 938–942, Jan. 2010.

[2] A. Shehadeh and C. Gütl, "The application of cloud-based tools in MOOCs: Experiences and findings," MOOC-Maker Project, Tech. Rep. WDP1.10, Oct. 2016. [Online]. Available: http://www.mooc-maker.org/wp-content/files/WDP1.10_OpenContentLicense.pdf

[3] M. Saraswathi and T. Bhuvaneswari, "Multitenancy in cloud software as a service application," *Int. J. Adv. Res. Comput. Sci. Softw. Eng.*, vol. 3, no. 11, pp. 159–162, 2013.

[4] G. Kiryakova, "Cloud computing—A necessary reality in modern education," *Int. J. Sci. Res. Publications*, vol. 7, no. 4, pp. 158–164, Apr. 2017.

[5] S. Tyagi, "Adoption of Web 2.0 technology in higher education: A case study of universities in the National Capital Region, India," *Int. J. Edu. Develop. ICT*, vol. 8, no. 2, pp. 28–43, Aug. 2012.

[6] S. D. Smith and J. B. Caruso. (Oct. 2010). The ECAR Study of Undergraduate Students and Information Technology, 2010. EDUCAUSE Center for Applied Research. [Online]. Available: https://www.educause.edu/ir/library/pdf/EKF/EKF1006.pdf

[7] H. K. Mohamed and E. Sumitha, "Perception and use of social networking sites by the students of Calicut University," *DESIDOC J. Library Inf. Technol.*, vol. 31, no. 4, pp. 295–301, Jul. 2011, doi: 10.14429/djlit.31.4.1109.

[8] R. Hernández, "Cloud interoperability service architecture for education environments," *J. Universal Comput. Sci.*, vol. 21, no. 5, pp. 656–678, Jul. 2015.

[9] L. W. Anderson and D. R. Krathwohl, Eds., "*A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*. New York, NY, USA: Longman, 2001.

[10] PDST Technology in Education. (Mar. 2015). *Cloud based Tools & Applications for Learning*. Accessed: Jan. 2, 2018. [Online]. Available: http://www.pdsttechnologyineducation.ie/en/Technology/Advice-Sheets/Cloud-based-Tools-and-Applications.pdf

[11] J. Kimbrell, "The Impacts of Web 2.0, Web 3.0, and Web 4.0 technologies used in distance education," M.S. thesis, East Carolina Univ., Greenville, NC, USA, Jan. 2013. [Online]. Available: http://hdl.handle.net/10342/1821

[12] M. Morales, R. Hernández, R. P. Barchino, and J. A. Medina, "MOOC using cloud-based tools: A study of motivation and learning strategies in Latin America," *Int. J. Eng. Edu.*, vol. 31, no. 3, pp. 901–911, May 2015.

[13] Y. K. Usluel and S. G. Mazman, "Adoption of Web 2.0 tools in distance education," *Int. J. Hum. Sci.*, vol. 1, no. 1, pp. 818–823, Jan. 2009.

[14] G. Conole and A. Panagiota, "A literature review of the use of Web 2.0 tools in higher education," in *A Report Commissioned by the Higher Education Academy*. Milton Keynes, U.K.: The Open Univ., 2010. [Online]. Available: http://oro.open.ac.uk/id/eprint/23154

[15] R. S. Campión, F. N. Nalda, and A. M. Rivilla, "Web 2.0 and higher education: Its educational use in the university environment," *Eur. J. Open, Distance e-Learn.*, vol. 15, no. 2, pp. 1–18, Dec. 2012. [Online]. Available: https://files.eric.ed.gov/fulltext/EJ992491.pdf

[16] R. Ibrahim, K. Khalili, and J. Azizah, "Towards educational games acceptance model (EGAM): A revised unified theory of acceptance and use of technology (UTAUT)," *Int. J. Res. Rev. Comput. Sci.*, vol. 2, no. 3, pp. 839–846, Jun. 2011. [Online]. Available: https://goo.gl/YCuGtj

[17] W.-H. D. Huang, D. W. Hood, and S. J. Yoo, "Gender divide and acceptance of collaborative Web 2.0 applications for learning in higher education," *Internet Higher Edu.*, vol. 16, pp. 57–65, Jan. 2013, doi: 10.1016/j.iheduc.2012.02.001.

[18] S. G. Mazman and Y. K. Usluel, "Modeling educational usage of Facebook," *Comput. Edu.*, vol. 55, no. 2, pp. 444–453, Sep. 2010.

[19] I. Ajzen, "The theory of planned behavior," *Org. Behav. Hum. Decis. Process.*, vol. 50, no. 2, pp. 179–211, 1991.

[20] V. Venkatesh and F. D. Davis, "A theoretical extension of the technology acceptance model: Four longitudinal field studies," *Manage. Sci.*, vol. 46, no. 2, pp. 186–204, Feb. 2000, doi: 10.1287/mnsc.46.2.186.1192.

[21] B. S. Bloom, *Taxonomy of Educational Objectives, Handbook 1: Cognitive Domain*. New York, NY, USA: David McKay Company, 1956.

[22] Z. Guo, W. Wang, X. Song, and Q. Jiang, "Path analysis of international dry bulk carriers based on structural equation modeling," *J. Eastern Asia Soc. Transp. Stud.*, vol. 8, pp. 2214–2224, Jan. 2019, doi: 10.11175/easts.8.2214.

[23] J. Gittell. (Aug. 2011). *Relational Coordination: Guidelines for Theory, Measurement and Analysis*. [Online]. Available: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.468.6354&rep=rep1&type=pdf

[24] K. Schermelleh-Engel and H. Moosbrugger, "Evaluating the fit of structural equation models: Tests of significance and descriptive goodness-of-fit measures," *Methods Psychol. Res. Online*, vol. 8, no. 2, pp. 23–74, May 2003.

2.2 Artículo II: Analysis of Behavioral Intention to Use Cloud-Based Tools in a MOOC: A Technology Acceptance Model Approach

2.2.1 Descripción de aportes al objetivo de la tesis

Considerando los resultados obtenidos en el artículo 1 de este compendio (sección 2.1) que describen los factores relacionados a la adopción de las CBT y el uso educativo asociado a la taxonomía de Bloom que un docente puede darle en un entorno virtual para enriquecer el proceso de aprendizaje y mejorar la gestión del conocimiento. El articulo 2 evalúa la intención conductual de utilizar una CBT llamada "Codeboard" como recurso de apoyo, en el desarrollo de una serie de actividades de aprendizaje, orientadas a alcanzar los niveles de orden inferior y superior de Bloom, facilitando un espacio interactivo de práctica, que a su vez le permita generar un portafolio digital. Este IDE (Integrated Development Environment) basado en la Web, fue utilizado para enriquecer las actividades de aprendizaje de nuestro MOOC: "Java Fundamentals for Android Development" implementado durante el 2017 en la plataforma edX (www.edx.org), como parte del MicroMasters: "Professional Android Developer", explorando los factores que influyen en esta intención, basándose en el modelo de aceptación de tecnología (TAM). Este MOOC contó con la participación de 34,967 estudiantes de 193 países. El MOOC estaba estructurado en 5 lecciones, y cada una de ellas presentaba un promedio de 8 a 10 video-contenidos con una duración promedio de 6 minutos. Para enriquecer el proceso de aprendizaje del lenguaje de programación Java, propusimos el uso de Codeboard para practicar y obtener retroalimentación inmediata de su progreso relacionado con el contenido. Esta herramienta funciona como editor de código fuente, compilador y depurador. Además, Codeboard soporta el estándar IMS LTI, facilitando la interoperabilidad con la plataforma edX. Además, se llevó a cabo un cuestionario al final de cada lección y se contó con el apoyo académico a través de diferentes medios, tales como sesiones de tutoría, foros y correo electrónico. Estos recursos de aprendizaje en su conjunto (artefactos de aprendizaje), proporcionan el andamiaje que el alumno necesita para entender y ampliar sus conocimientos del lenguaje de programación Java.

Este estudio propone en la sección III, una extensión del TAM original al incluir un enfoque especial en la validación de las relaciones involucradas entre, la utilidad percibida, la facilidad de uso, la actitud hacia el uso y la intención conductual de utilizar una CBT. Además, se definieron cuatro variables externas relacionadas con los aspectos sociales -identificación de la comunidad, motivación, facilidad de condiciones y creación de conocimiento para utilizar- y se examinó su validez. En este sentido, se utilizó un modelo de ecuación estructural (SEM) para probar la relación causal entre los diferentes constructores.

Como resultado de la investigación se encontró que la facilidad de uso y la utilidad percibida influyen positivamente en la actitud del alumno hacia el uso de la herramienta basada en la nube "Codeboard" utilizada en el entorno MOOC. También demuestra una influencia positiva entre la actitud y la intensión de uso. Por otra parte, no se encontró ninguna influencia significativa entre la facilidad de uso y la utilidad percibida. Este hallazgo sugiere que, si una herramienta basada en la nube es fácil de usar para un estudiante, esto no garantiza que será útil para su proceso de aprendizaje. Lo anterior, permite reflexionar sobre los criterios que deben utilizarse para integrar herramientas basadas en la nube en un MOOC.

De esta forma, los resultados presentados en este artículo cumplen con el Objetivo Especifico 2, 3 y 4 (Sección 1.1) de este trabajo de tesis, identificando el impacto que se obtiene al utilizar las CBT en el diseño de actividades de aprendizaje en un MOOC, los principales factores que determinan la adopción de una CBT y analizando cómo el uso de una CBT podría mejorar la comunicación y colaboración entre maestro-estudiante, estudiante-estudiante y estudiante-maestro, en un MOOC.

Finalmente, el trabajo publicado en la revista "Journal of Universal Computer Sciences", da respuesta a las peguntas de investigación RQ5, identificando si la actitud de los estudiantes hacia el uso de CBT, está influenciado por la facilidad de uso y la utilidad percibida de estás. Y también la RQ6, analizando cómo influye la identificación de la comunidad, motivación y creación del conocimiento con la percepción de la utilidad de las CBT.

Resulta importante resaltar que, aunque este tipo de CBT es prometedor desde el punto de vista pedagógico, se necesitan estrategias didácticas para promover aún más la intención conductual de uso de estas tecnologías emergentes como recurso para mejorar el aprendizaje en un MOOC.

2.2.2 Índices de calidad

Morales Chan, M., Barchino-Plata, R., Medina Merodio, J. A., Alario-Hoyos, C., Hernández Rizzardini, R. & De la Roca Marroquín, M.

Analysis of Behavioral Intention to Use Cloud-Based Tools in a MOOC: A Technology Acceptance Model Approach.

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La revista JUCS (Journal of Universal Computer Science) está referenciada en el ISI Journal Citation Reports (JCR) de Thomson Reuters/Web of Science con un índice de impacto de 0.466. En los últimos 5 años, su índice general de impacto es de 0.566. La revista tiene la característica de ser de acceso libre, garantizando su mayor difusión. La revista se publica desde el año 1994 con una publicación promedio de 12 ediciones al año incluyendo ediciones especiales (Special Issues). La revista se encuentra indexada en el Scimago Journal & Country Rank (SJR) con un índice H de 39, con un factor de impacto de SJR (0.429). El volumen 24, No. 8 presento las nuevas tendencias en el campo de los MOOCs, en el marco del proyecto MOOCMaker que contó con el apoyo y la cofinanciación de la Comisión Europea a través del programa Erasmus+.

2.2.3 Artículo

El nombre del artículo publicado en la Revista JUCs es: **Analysis of Behavioral Intention to Use Cloud-Based Tools in a MOOC: A Technology Acceptance Model Approach**

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Analysis of Behavioral Intention to Use Cloud-Based Tools in a MOOC: A Technology Acceptance Model Approach

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Abstract: MOOC students' adoption of cloud-based tools has the potential to enrich the learning process and enhance the management of knowledge. The aims of this study are to evaluate the behavioral intention to use cloud-based tools in MOOC context, and to explore the factors that influence this intention, based on extended technology of acceptance model (TAM). This paper reports the findings of a case study conducted on the edX platform. Survey data collected from 133 end-users were analyzed by using structured equation modeling (SEM) to validate the causal relationship among the various constructs of the research model proposed. The findings suggested that the perceived ease of use and the perceived usefulness influence the attitude toward the cloud-based tools used in a MOOC.

Keywords: Cloud-based tools, MOOC, Codeboard, technology acceptance model and structural equation modeling
Categories: L.3.0, L.3.3, L.3.5, L.3.6

1 Introduction

Massive open online courses (MOOCs) are transforming teaching-learning processes in higher education institutions worldwide [Perez, et al., 16]. In recent years, MOOCs have been spreading and receiving a great deal of attention among the academic community, mainly because this type of methodology provide learners with an unprecedented level of autonomy in the learning process and offer free access to high quality content [Hernández, et al., 14a]. According to a report by Class Central, during 2016, more than 6,850 MOOCs were developed at 700 universities, registering more than 58 million students. Computer science and programming courses represented 17.4% of the courses announced and were the second most demanded courses behind business courses (19.3%) [Shah, 16].

Coding and programming are subjects on the rise; more industries are demanding these types of skills in their employees' profiles. In addition, rapid technological development, the popularity of MOOCs, and collaboration between technology companies such as Google[1], AT&T[2] and GitHub[3], and MOOC providers such as Udacity,[4] which have dedicated themselves to creating specialized academic programs tailored to a particular career skill set (e.g., nanodegree programs), has brought with it new approaches to learning programming [Spyropoulou, et al., 15]. However, we cannot lose sight of the fact that learning programming is considered a difficult goal to achieve, and programming courses have high dropout rates [Law, et al., 10].

The typical format used for the development of a MOOC is the xMOOC approach, which is remarkably similar to the traditional classroom format, offering video lectures, supporting learning materials (such as reading materials from textbooks or websites, lecture slides and lecture notes, etc.), assignments along with deadlines, discussion forums, and quizzes to validate the knowledge [Morales, et al., 15]. However, to teach programming languages, this type of learning resources may not be a sufficient in some cases. In this sense, the incorporation of cloud-based tools (CBTs), also known as Web 2.0 tools, could enrich the learning process, offering new opportunities in the educational domain.

Today, the universities are increasingly using a wide range of CBTs to support teaching, learning, and assessment process [PDST Technology in Education, 15]. These tools have the potential to be used in a wide range of learning activities. In the case of programming courses, students are able, for example, to interact with one another, analyze and inspect the program code, and produce bug reports. CBTs allow for the exchange of ideas, comments, links to resources, and the reuse of study content in learning environments that can be are managed by the professors and students themselves [Geser, 12]. Most of these tools are freely accessible and provide a diverse and evolving range of possibilities to support and enhance the learning experience. According to Chang, [Chang, et al., 07] the CBTs can interoperate with other systems as virtual learning environment (VLE) or learning management system

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[1] www.google.com
[2] www.att.com
[3] www.github.com
[4] www.udacity.com

(LMS), offering the possibility to orchestrate services that were previously seen as standalone CBTs, making it easier to use them in education.

Taking into account the above context, the aims of this study is to evaluate the behavioral intention to use CTBs in a MOOC related to computer science and programming, and to explore the factors that influence this intention, based on the technology acceptance model (TAM) [Davis, 89]. TAM explains and predicts user acceptance and the future use of a technology or system [Walker, et al., 12]. This theory was selected because it is widely recognized in research on technology usage in many different contexts [Venkatesh, et al., 00].

This study proposes an extension of the original TAM by including a special focus on the validation of the relationships involved, perceived usefulness, ease of use, attitude toward use, and behavioral intention to use. In addition, four external variables related to social aspects were defined - community identification, motivation, facilitating conditions and knowledge creation to use - and their validity was examined. In this sense, we used a structural equation modeling (SEM) to test the causal relationship between the different constructs. The following research questions guided our study:

- **(RQ1)** Can learners' attitude toward CBTs used in MOOCs be influenced by Perceived ease of use and Perceived usefulness?
- **(RQ2)** Do external variables community identification, motivation and knowledge creation influence the Perception of the usefulness of CBTs?

To investigate the above, the study is based on the use of a CBT as Codeboard, this Web-based IDE (Integrated Development Environment), it was used to enrich the learning activities of our MOOC, "Java Fundamentals for Android Development" [Morales, et al., 17].

The rest of the paper is structured as follows. [Section 2] describes the theoretical framework for this study. [Section 3] presents the research model and hypotheses proposed. [Section 4] presents the case study used. In [Section 5] the results of the collected data and the proposed model, which were analyzed using SEM, are reported. Finally, this work concludes with the discussion and conclusions sections [Section 6, 7].

2 Study Background

Technology acceptance model (TAM) is derived from the general theory of reasoned action (TRA) [Fishbein, et al., 75]. According to Davis [Davis, 89], TAM suggests that when new users are introduced with a new technology, its usage or adoption can be predicted by three significant factors: Perceived usefulness (PU) of the technology to the user, the Perceived ease of use (PEU), and the Attitudes towards usage (ATU) of the system [Davis, 89]. PU is defined as "*the degree to which an individual thinks a system would increase his job performance and productivity*". PEU refers to "*the sense of lack of effort an individual requires in order to adopt a given technology*" [Venkatesh, et al., 00].

TAM models how users come to accept and use a particular technology. Individuals who perceive technology as being easy to use and useful to their workplace will accept it more easily than those who do not [Walker, et al., 12].

In addition, TAM postulates that PU and PEU are affected by external variables. Thus, PU and PEU mediate the effect of external variables on a user's attitude and behavioral intention, and therefore the actual system use [Alharbi, et al., 14] (See Figure 1).

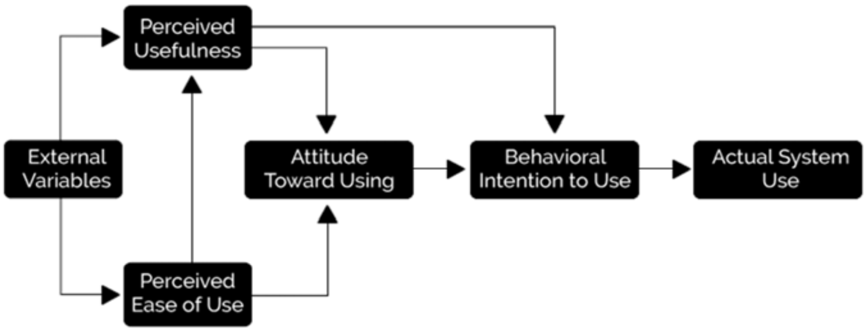

Figure 1: Original Technology Acceptance Model (TAM)

3 Research model and hypotheses

In accordance with the research objective, the research model proposed is an extension of the conventional TAM. Our model consists of the TAM core constructs defined as - PU, PEU, ATU, and BIU - and four external variables defined as knowledge creation (KC), community identification (CI), facilitation of conditions (FC) and motivation (MO). [see Figure 2].

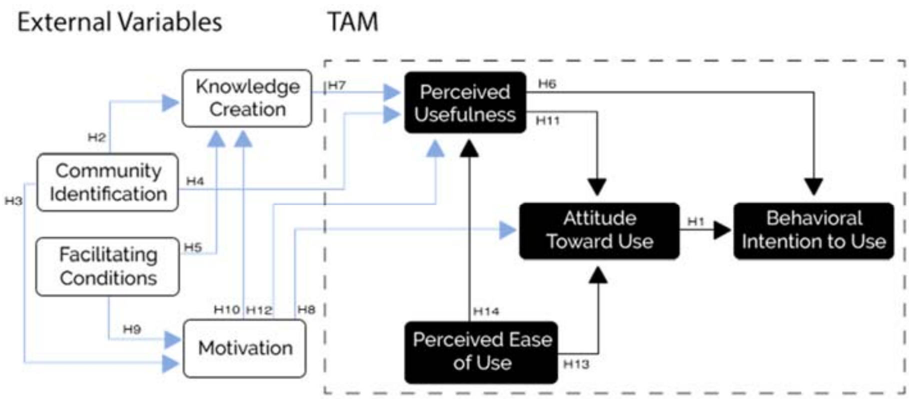

Figure 2: Research model proposed

Thus, the hypotheses of this work are presented in and described below: According to [Davis, 89] and [Taylor, et al., 95]; attitude toward use has a positive and significant influence on behavioural intention. Therefore, this study proposes the following hypothesis:

- (H1) Attitude toward using (ATU) CBTs in MOOCs positively influences behavioral intention to use them (BIU).

Community identification is the individual's sense of group belonging as a community member, and the commitment by the individual to a sense of values, beliefs, and conventions shared with other community members [Kay, et al., 08]. Using CBTs during the learning process of a programming language usually allowed for the building collaboration between peers, given users the ability to create groups and share features and related resources.

The present study defines community identity as the individual's level of commitment to the group of peers using CBTs as learning resource.

- (H2) Community identification (CI) positively influences Knowledge creation (KC).
- (H3) Community identification (CI) positively influences Motivation (MO).
- (H4) Community identification (CI) positively influences Perceived usefulness (PU).

Facilitating conditions are defined as the degree to which an individual believes that an organizational and technical infrastructure exists to support the use of the system [Deci, et al., 91]. For example, the tutorials are provided to explain how use a given tool, and the help menu or other services are crucial to the adoption of the CBTs. The previous definition allows use to infer that this type of resources facilitates and supports learning activities related to the use of CBTs.

- (H5) Facilitating condition (FC) positively influences Knowledge creation (KC).
- (H9) Facilitating condition (FC) positively influences Motivation (MO).

According to Mitchell [Mitchell, et al., 00], Knowledge creation as a process refers to the initiatives and activities undertaken to generate new ideas or objects. Styhre [Styhre, et al., 02] describes knowledge creation as "*the utilization of complex and discontinuous events and phenomena to deal with collectively defined problems.*" On the other hand, as an output, Mitchell [Mitchell, et al., 00], defined the knowledge creation process as "*the representation of an idea", and argued that it "can be differentiated from its impact on the organizational system, or outcome.*" This means that new knowledge is diffused, adopted, and embedded in the form of new products, services, and systems. Therefore, this could have a positive effect on Perceived usefulness (PU).

- (H7) Knowledge creation (KC) positively influences Perceived usefulness (PU).

Motivation is an important factor in the adoption of CBTs. According to [Deci, et al., 91], an important aspect of student engagement in the learning process, without the necessity of rewards or constraints, is the instinct motivation. Extrinsic motivation, on the other hand, provides students with engagement in the learning process as a means to an end, such as grades, recognition, or feedback. Motivation depends on many personal factors (personality, education, etc.), family, and the social context in which the learning process is conducted (teaching methods, teachers, etc.). Motivation is essential for learning, and progress is inherent in the possibility of giving meaning and significance to knowledge. Without motivation, the student is unable to do a proper job, not only in terms of learning a concept but also in terms of establishing strategies that allow for solving problems similar to those learned.

- (H8) Motivation (MO) positively influences Attitude toward use (ATU).
- (H10) Motivation (MO) positively influences Knowledge creation (KC).
- (H12) Motivation (MO) positively influences Perceived usefulness (PU).

Finally, considering the model proposed by Davis [Davis, 89], the next hypotheses seek to revalidate such relationships in the context of CBTs in a MOOC.

- (H13) Perceived ease of use (PEU) positively influences attitude toward use (ATU).
- (H14) Perceived ease of use (PEU) positively influences perceived usefulness (PU) of the system.
- (H11) Perceived usefulness (PU) positively influences Attitude toward use (ATU).
- (H6) Perceived usefulness (PU) positively influences Behavioral intention to use (BIU).

4 MOOC learning environment settings: Case Study

This research is developed according to the MOOC "Java Fundamentals for Android Development" which is part of the Professional Android Developer MicroMasters Program into edX, was implemented during January 2017 with 34,967 learners from 193 countries registered in the course. This program was created to developers familiar with object-oriented programming languages and interested in building Android applications. This MOOC is not only about Java; it is about how you use Java on the development of Android applications, and about the basic knowledge learners need to begin programming with Android [Morales, et al., 17].

The structure and sequencing of the MOOC supports the learning objectives of each topic that is covered in the course syllabus. This MOOC has 5 lessons, and each lesson combines several video lectures, learning activities for practice and get immediate feedback of his progress related to content, a questionnaire at the end of the lesson, and academic support through different means, such as tutoring sessions, forums, and email.

These learning resources all together provide the scaffolding the learner needs to understand and expand his knowledge of java programming language. The alignment of these main lesson components on edX platform ensures an internally consistent structure to help learners accomplish the learning goals. In general, the course content builds towards greater complexity, starting with basic topics and moving towards complex ones.

To enrich the learning process of java programming language, we proposed the use of a CBT such as Codeboard. It consists of a source code editor, a compiler, built in automation tools, and a debugger. In addition, Codeboard supports the IMS LTI standard, facilitating the interoperability with the edX platform [Morales, et al., 17]. Below are the types of activities created using Codeboard.

a) *Activities that enable students to practice, to integrate concepts, and to learn new ones:* In each lesson, there are activities that involve the use of Codeboard to solve java exercises with the aim to improve learners programming skills and understanding. Codeboard facilitate the delivery of the assigned exercises and is easy to use [Morales, et al., 17]. A learner can understand how a programming exercise works. Simple changes can be implemented and deployed immediately without affecting the original program, or other learners. The learner can compile and run the new code with the changes and verify if the code is having the expected behavior. With this type of activities, it is possible to practice the concepts in an interactive way.

b) *Special activities to share and learn from peers:* Throughout the MOOC content, there are special activities that were designed to lead students in the process of collaborating with one another. The approach use in this type of activities involves examining the role students may play in their learning process, their attitudes, engagement and the responsibility they have on shaping their own learning experience. To share and learn from each other is one of the great advantages of Codeboard. Students were asked to share their solutions with their peers by posting the link at a special forum. This way, anyone could review a solution and learn from it; even better, students could give each other advices of better programming practices.

c) *More efficient and effective feedback:* It is important to realize that in something as complex and ever changing as programming, there are always many ways to do something correctly. One of the main problems that a tutor has to face is how to review and grade an assignment; students' submissions are just lines of code. With Codeboard the submission process of an exercise to be reviewed by a tutor or a peer becomes easier and efficient. The student only needs to share a link, and the tutor or peer just needs to compile and run the program to test that it works. Finding errors in case the program does not work correctly is also simple, and the tutor gives a better feedback to the student´s work.

5 Methodology

5.1 Participants and data collection

The full sample obtained comprised 133 questionnaires, from which those with incomplete or unclear responses were omitted, thus yielding a final sample of 131 questionnaires. 20% were pre-university students, 50% had a bachelor's degree and 30% had a postgraduate degree and 83.33% of the sample was male.

To test our hypotheses, data were collected from a web-based questionnaire, which consisted of two sections. The first section it's about student´s Demographic data (DD), such as age, gender, or educational level.

The second section is the main component of the questionnaire and consists of 30 questions to investigate the 8 factors introduced in research model and hypotheses section. [Table 1] shows questionnaire structure and question types.

Section	Number of questions	Survey question types
DD	5 questions	Closed-ended question (Multiple Choice)
ATU	1 questions	Set of questions using a 5-point Likert scale (from strongly disagree to strongly agree)
BIU	2 questions	Set of questions using a 5-point Likert scale (from strongly disagree to strongly agree)
CI	3 questions	Set of questions using a 5-point Likert scale (from strongly disagree to strongly agree)
FC	3 questions	Set of questions using a 5-point Likert scale (from strongly disagree to strongly agree)
KC	4 questions	Set of questions using a 5-point Likert scale (from strongly disagree to strongly agree)
MO	5 questions	Set of questions using a 4-point Likert scale (from absolutely unmotivated to absolutely motivated
PEU	3 questions	Closed-ended question (Multiple Choice) & Set of questions using a 5-point Likert scale (from strongly disagree to strongly agree)
PU	4 questions	Closed-ended question (Multiple Choice) & Set of questions using a 5-point Likert scale (from strongly disagree to strongly agree)

Table 1: Questionnaire structure and question types

5.2 Data Analysis

This study employed a regression analysis of latent variables, based on the optimization technique of partial least squares (PLS) to elaborate the model. This study draws on SmartPLS 3.2.6. PLS is a multivariate technique for testing structural models and estimates the model parameters that minimize the residual variance of the dependent variables of the whole model [Hair, et al., 13]. It does not require any parametric conditions and is recommended for small samples [Hulland, 99] .

5.3 Justification of numbers of cases

Roldán [Roldán, et al., 12] indicated that the sample size issue has been one of the main characteristics of PLS. The segmentation process used by the PLS algorithm allows the dividing of complex models into subsets. It permits to calculate sample size, in terms of largest number of structural paths directed at a particular dependent latent variable.

Although there are different, much less restrictive criteria, Reinartz [Reinartz, et al., 09] advise increasing the sample size to 100 cases in order to reach acceptable levels. Although this criterion has been a highly used, Roldán [Roldán, et al., 2016] advise not to use the old heuristic rule of 10 cases per predictor which was suggested by Barclay [Barclay, et al., 95], so they suggest for a more precise valuation, to specify the size effect for each regression existing, while consulting the power tables developed by Cohen [Cohen, 92]. On the other hand, Hair [Hair et al., 14] suggest using programs such as G*Power 3.0 (Institut für experimentelle psychologie, 2007) for specific power analysis according to model specifications. [Borenstein, et al., 01] [Faul, et al., 07]

To determine the sample size, it is necessary to specify the effect size (ES), the value of the alpha significance level (α) and the power (1-β). In general terms, an alpha level of 0.05 and a power of 80% are accepted. It is necessary to specify the size of the expected effect and from these three data calculate the sample size. In this case, the multiple regression study was conducted with four predictors, an average effect size (ES) of 0.15, an alpha of 0.05, and a power of 0.95 (according [Cohen, 92]). Applying the analysis, it is observed that the result is N=129 subjects.

Hence, the sample available for our analysis (131 valid cases) surpasses any requirement demanded, to carry out the analysis of the measurement models and the structural model.

6 Results

6.1 Analysis of validity and reliability

The reliability analysis ensures the validity and consistency of the items used for each variable. Chin [Chin, 98] recommends the convergent validity of all construct measurement items should meet the following three conditions: (a) the factor loading (λ) > 0.5; (b) the composite reliability (CR) > 0.6; and (c) average variance extracted (AVE) > 0.5. [Table 2] shows results for reliability and validity of all constructs.

For this study, the factor loadings **(λ)** of all items was higher than 0.5. All the values of CR exceed 0.87 [Werts, et al., 1974], [Chin, 98] and the analysis of variance, all the values for the AVE were above 0.50, and range between 0.66 – 0.80, [Fornell, et al., 81], exceeding the minimum acceptable values for validity.

Thus, all the items exhibited convergent validity (Chin, 98). In addition, the Cronbach's (α) of all items were higher than 0.75, indicating a high confidence level [Nunnally, et al., 94].

		(λ)	Composite Reliability (CR)	Average Variance Extracted (AVE)	Cronbach's Alpha
ATU	ATU1	1,00	1,00	1,00	1.00
BIU	BIU 1	0,90	0,89	0,80	0,75
	BIU 2	0,89			
CI	CI 1	0,90	0,91	0,78	0,86
	CI 2	0,85			
	CI 3	0,90			
FC	FC 1	0,83	0,89	0,73	0,82
	FC 2	0,81			
	FC 3	0,90			
KC	KC 1	0,86	0,92	0,73	0,88
	KC 2	0,82			
	KC 3	0,87			
	KC 4	0,88			
MO	MO 1	0,82	0,91	0,66	0,87
	MO 2	0,79			
	MO 3	0,81			
	MO 4	0,88			
	MO 5	0,78			
PEU	PEU 1	0,88	0,87	0,68	0,77
	PEU 2	0,87			
	PEU 3	0,71			
PU	PU 1	0,91	0,92	0,74	0,88
	PU 2	0,74			
	PU 3	0,89			
	PU 4	0,89			

Table 2: Factor loading (λ), construct reliability (CR), average variance extracted AVE and Cronbach's alpha coefficients.

Additionally, [Fornell, et al., 81] suggest that the square root of AVE in each latent variable can be used to establish discriminant validity so for confirm discriminant validity among the constructs, the square root of the AVE must be superior to the correlation between the constructs. [Table 3] presents the square roots of the AVE on the diagonal and the correlations among the constructs. This value is larger than other correlation values among the latent variables, so that the values indicate adequate discriminant validity of the measurements.

	ATU	BIU	CI	FC	KC	MO	PEU	PU
ATU	1,00							
BIU	0,50	0,89						
CI	0,12	0,41	0,88					
FC	0,21	0,05	0,03	0,85				
KC	0,57	0,56	0,29	0,13	0,86			
MO	0,39	0,38	0,28	0,21	0,47	0,81		
PEU	-0,20	0,10	0,20	0,08	0,10	0,10	0,82	
PU	0,60	0,43	0,19	0,33	0,64	0,54	-0,03	0,86

Table 3: Discriminant validity matrix [Fornell, et al., 81]

On the other hand, as we can show in [Table 4] the discriminant validity measures using the heterotrait-multitrait (HTMT) method [Henseler, et al., 14] which indicated the mean of the heterotrait-heteromethod correlations relative to the geometric mean of the average monotrait-heteromethod correlation of both variables.

We used a conservative criterion of 0.85, which is associated with sensitivity levels of 95% or better. With construct correlations of 0.70, the specificity rates for HTMT 0.85 are near to 100%. We found that the HTMT ratio for group-focused and individual focused transformational leadership, at 0.83, was below the 0.85 cutoff, and substantially below the 0.95 cutoff recommended for conceptually close constructs [Henseler, et al., 14]. This provides good support for our claims of discriminant validity between our measures of group - and individual level transformational leadership measures [Henseler, et al., 14]

	ATU	BIU	CI	FC	KC	MO	PEU	PU
ATU								
BIU	0,58							
CI	0,12	0,53						
FC	0,16	0,07	0,07					
KC	0,61	0,69	0,33	0,13				
MO	0,41	0,46	0,32	0,21	0,53			
PEU	0,22	0,16	0,24	0,15	0,15	0,16		
PU	0,61	0,51	0,22	0,38	0,72	0,62	0,13	

Table 4: Discriminant validity matrix (Heterotrait-Monotrait Ratio Criterion)

6.2 Structural model analysis

The model proposed for this study [see Figure 2] has been prepared from PLS-SEM for structural model analysis, exploring the intensity and direction of the relationships among variables. PLS program can generate T-statistics for significance testing of both the inner and outer model, using a procedure called bootstrapping [Chin, 98].

In this procedure, a large number of subsamples (5000) are taken from the original sample with replacement to give bootstrap standard errors, which in turn gives approximate T-values for significance testing of the structural path. After the bootstrapping procedure is completed. Results can get as the following: All the R^2 values range from 0 to 1. The higher the value, the more predictive capacity the model has for that variable.

Where R^2 should be high enough for the model to reach a minimum level of explanatory power. The R^2 values are greater than 0.10 with a significance of t > 1.64 [Frank, et al., 92].

[Figure 3] and [Table 5] shown the variance explained (R^2) in the dependent constructs and the path coefficients for the model. They are not less than 0.10, indicating that the independent explanatory variables are adequate.

	R^2	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	Q^2
ATU	0,40	0,42	0,06	6,32	0,00	0,37
BIU	0,28	0,31	0,09	2,99	0,00	0,20
KC	0,25	0,27	0,06	4,01	0,00	0,16
MO	0,12	0,15	0,06	2,09	0,02	0,05
PU	0,50	0,27	0,06	4,01	0,00	0,33

Table 5: Structural model results

The standardized of the regression coefficients show the estimates of the relationships of the structural model, that is, the hypothesized relationships between constructs. In addition, it will analyze the algebraic sign if there is change of sign, the magnitude and statistical significance is greater T-statistic of (t (4999), one-tailed test) 1.64.

Furthermore, the hypotheses were checked and validated, and the relationships were positive, mostly with high significance [Table 6]. (Note: Result = R, Accepted = A, and Sign Change = SC).

			SPC	Sample	Standard	T	P	SC
H1	A	ATU ->	0,38	0,38	0,13	**2,83**	**0,00**	No
H2	A	CI ->KC	0,17	0,17	0,08	**2,15**	**0,02**	No
H3	A	CI ->MO	0,28	0,28	0,08	**3,29**	**0,00**	No
H4		CI ->PU	-0,02	-0,01	0,10	0,22	0,41	Si
H5		FC ->KC	0,04	0,04	0,10	0,40	0,34	Si
H6		PU ->	0,21	0,22	0,13	1,64	0,05	No
H7	A	KC ->	0,51	0,51	0,08	**6,15**	**0,00**	No
H8		MO ->	0,12	0,13	0,09	1,32	0,09	Si
H9		FC ->	0,20	0,21	0,12	1,64	0,05	Si
H10	A	MO ->	0,41	0,41	0,08	**4,89**	**0,00**	No
H11	A	PU ->	0,53	0,53	0,08	**6,76**	**0,00**	No
H12	A	MO ->	0,32	0,31	0,12	**2,65**	**0,00**	No
H13	A	PEU ->	-0,19	-0,19	0,08	**2,33**	**0,01**	No
H14		PEU ->	-0,11	-0,12	0,10	1,11	0,13	Si

Table 6: Structural model results. Path significance using percentile bootstrap 95% confidence interval (n = 5.000 subsamples)

However, when it is applied percentile bootstrap to generate a 95% confidence interval using 5.000 resamples, H1, H2, H3, H7, H10, H11, H12, H13, is supported because its confidence interval not includes zero [See Table 5]. Thus, all hypotheses are adopted.

All of these results complete a basic analysis of PLS-SEM in our research. PLS-SEM result is shown in [Figure 3].

Finally, [Table 7] shows the amount of variance that each antecedent variable explains on each endogenous construct. R^2 figures are outstanding for almost all values, greater than 0.24. Thus, cross-validated redundancy measures show that the theoretical structural model has a predictive relevance.

7 Discussion

This research found that perceived ease of use and perceived usefulness positively influence a learner's attitude toward CBT (codeboard) used in a MOOC environment (H11 and H13 were accepted). It also demonstrates a positive influence between ATU and BIU (H1 was accepted), providing support for our research question (RQ1), which estimated a strong relationship among these three variables (PU, PEU, ATU). This finding is consistent with those of previous research on adoption or acceptance of an innovation in a system, as reported by [Walker, et al., 12, Alharbi, et al., 14].

On the other hand, no significant influence was found between the perceived ease of use of a CBT and perceived usefulness (H14 was not accepted). This finding suggests that if a CBT is easy for a student to use, this does not guarantee that it will be useful for his or her learning process. This should allow us to reflect on the criteria to be used when integrating CTBs into a MOOC.

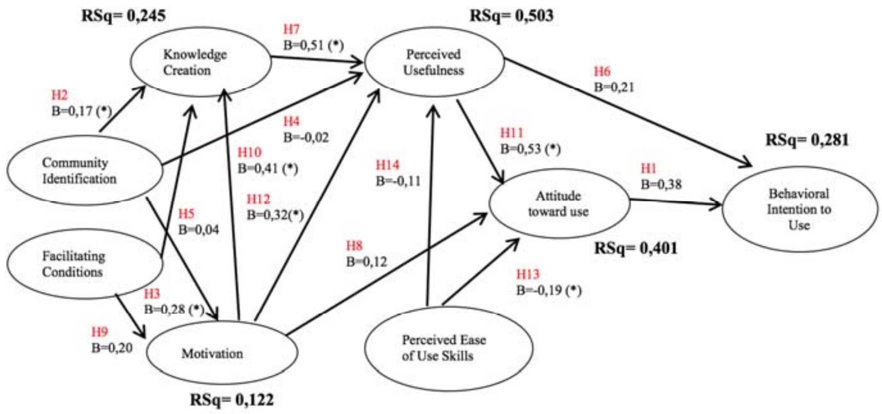

*Figure 3: Results of testing the model significance *p < 0.05*

In relation to the second research question (RQ2) examined, the three external variables analyzed (KC, CI, MO) with regard to the student's perception of usefulness and attitude toward use CBTs in a MOOC, we found that the knowledge creation and motivation have a positive influence (H7 and H12 were accepted). However, no exist evidence that the perception of usefulness was influenced by community identification (H4 was not accepted). This suggests that the learners don't perceive useful the individual's sense of group belonging as a community member, at the moment of the learning process.

This study has also found that the identification with the community of students influences and conditions both knowledge creation and motivation (H2 and H3 were accepted). In addition, it is found that the motivation has a positive influence in the knowledge creation (H10 was accepted). In this sense, the motivation could be influenced by the implementation of learning activities using a new tool.

Contrary to expectations, if learners have the facilitating conditions from using a new tool (for example: manuals, guides and tutorials), no implies that they are motivated to use it or will generate knowledge through it (H5 and H9 were not accepted).

	R^2	Q^2	Antecedent	Path Coefficient	Correla-tion	Explained variance (%)
ATU	**0,40**	**0,37**				**40**
			H11: Perceived Usefulness	0,53	0,60	31,8
			H8: Motivation	-0,12	0,39	4,68
			H13: Perceived Ease of Use	-0,19	-0,20	3,61
BIU	**0,28**	**0,20**				**28**
			H6: Perceived Usefulness	0,21	0,43	8,85
			H1: Attitude toward use	0,38	0,50	19,00
KC	**0,24**	**0,16**				**24**
			H2: Community Identification	0,17	0,29	4,93
			H5: Facilitating Conditions	0,04	0,13	0,5
			H10: Motivation	0,41	0,47	19,2
MO	**0,12**	**0,07**				**12**
			H3: Community Identification	0,28	0,32	8,9
			H9: Facilitating Conditions	0,20	0,21	4,2
PU	**0,50**	**0,33**				**50**
			H7: Knowledge Creation	0,51	0,64	32,64
			H4: Community Identification	-0,02	0,19	0,3
			H14: Motivation	0,32	0,54	17,2
			H13: Perceived Ease of Use	-0,11	-0,03	0,03

Table 7: Effects on endogenous variables (extended model)

8 Conclusions

This study has investigated the correlation between the core constructs of the TAM (PU, PEU, ATU, BIU) and the four external variables defined in our research model proposed (KC, CI, FC, MO) through a structural equation modeling (SEM) to explain the causal relationships existing's. Most of the causal relationships between the constructs postulated by the structural model are well supported.

In view of the results, we can conclude that research model proposed affirm that the attitudes toward use of Codeboard such as resource to support the development of learning activities is significantly associated with the behavioral intention to use it. This implies that TAM is an appropriate model for analyzing the behavioral intention of using CBTs into a MOOC.

This study has a few limitations. First, the sample size is limited (note that, this study only analyzes Codeboard as a CBT), a larger sample size of different types CBTs is required to further generalize. Second, the prior knowledge and experience of the learners about use this CBT, may have an effect direct on the outcomes of the study. In a future study, an analysis that differentiates the participants with regards to their prior knowledge and experience with CBT may lead to improved insights.

Additionally, while this type of CBTs shows pedagogical promise, didactic strategies are needed to further promote the behavioral intention to use of these emerging technologies as resource for improving learning in a MOOC.

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References

[Alharbi et al., 14] Alharbi, S. and Drew, S. Using the Technology Acceptance Model in Understanding Academics' Behavioural Intention to Use Learning Management Systems. International Journal of Advanced Computer Science and Applications (IJACSA), (2014).

[Barclay, et al., 95] Barclay, D.; Higgins, C. & Thompson, R. The partial least squares (PLS) approach to causal modeling: Personal computer adoption and use as an illustration. Special Issue on Research Methodology. Technology Studies, 2(2): 285- 309, (1995).

[Borenstein, et al., 01] Borenstein, M., Rothstein, H. y Cohen, J., (2001). Power and precision. Available online: http://power-analysis.com.

[Chang et al., 07] Chang, V., & Guetl, C. E-Learning Ecosystem (ELES) - A Holistic Approach for the Development of more Effective Learning Environment for Small-and-Medium Sized Enterprises (SMEs). In 2007 Inaugural IEEE-IES Digital EcoSystems and Technologies Conference (pp.420 – 425) http://doi.org/10.1109/DEST.2007.372010

[Chin, 98] Chin, W. W. (1998). The partial least squares approach to structural equation modelling. In Marcoulides, G. A. (Ed.), Modern methods for business research (pp. 295–336). Mahwah, NJ: Lawrence Erlbaum.

[Cohen, 92] Cohen, J. A power primer. Psychological Bulletin, 112, 1, 155-159. Cohen, J. (1994). The earth is round (p< .05). American Psychologist, 49, 997-1003, (1992).

[Davis, 89] Davis, F. D. Perceived Usefulness, Perceived Ease of Use, and Use Acceptance of Information Technology. MIS Quarterly, 13(3), 319-340, (1989).

[Deci, et al., 91] Deci, L., Vallerand, R., Pelletier, L. & Ryan, R. Motivation and Education: The Self-Determination Perspective, EDUCATIONAL PSYCHOLOGIST, 26(3 & 4), 325-346, (1991).

[Faul, et al., 07] Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behavior Research Methods, 39, 175-191.

[Frank, et al., 92] Frank, F.R. & Miller, N.B. (1992). A primer for soft modeling University., Akron, OH, US.

[Fishbein et al., 75] Fishbein, M., & Ajzen, I. Belief, attitude, intention and behavior: an introduction to theory and research, (1975).

[Fornell, et al., 81] Fornell, C. & Larcker, D.F. (1981). "Evaluating Structural Equation Models with Unobservable Variables and Measurement Error". Journal of Marketing Research, 18, 1), 39–50

[Geser, 12] Geser, G. Open Educational Practices and Resources. Open e-Learning Content Observatory Services (OLCOS) Roadmap 2012.

[Hair, et al., 13] Hair, J.F.; Ringle, C.M.; Sarstedt, M. Partial Least Squares Structural Equation Modelling: Rigorous Applications, Better Results and Higher Acceptance. Long Range Planning, 46, 1–2, (2013).

[Hair, et al., 14] Hair, J. F., Hult, G. T. M., Ringle, C. M., and Sarstedt, M. 2014. A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM). Thousand Oaks, CA: Sage

[Henseler, et al., 15] Henseler, J.; Ringle, C.M. & Sarstedt, M. (2015): A new criterion for assessing discriminant validity in variance-based structural equation modeling. Journal of the Academy of Marketing Science, 43: 115-135.

[Hernández et al., 14a] Hernández, R.; Gütl, C.; & Amado-Salvatierra, H.: Cloud Learning Activities Orchestration for MOOC Environments. In Learning Technology for Education in Cloud. MOOC and Big Data (Vol. 446 CCIS, pp. 25–36). doi:10.1007/978-3-319-10671-7_3 (2014).

[Hulland, 13] Hulland, J. Use of partial least squares PLS) in strategic management research: A review of four recent. Strategic Management Journal, 20, 195, (1999).

[Kay, et al., 08] Kay, R.H., & Loverock, S. Assessing emotions related to learning new software: The computer emotion scale. *Computers in Human Behavior. 24*, 1605-1623King & He, 2006; Nga, Poon & Chan, 2007; van Raaij & Schepers, (2008)

[Law et al., 2010] Law, K.MY, Victor CS L., and Yuen-Tak Yu. Learning motivation in e-learning facilitated computer programming courses. Computers & Education, Volume 55, Issue 1, Pages 218-228, ISSN 0360-1315, (2010).

[Mitchell, et al., 00] Mitchell, R., Boyle B. Knowledge creation measurement methods, Journal of Knowledge Management, Vol. 14 Issue: 1, pp.67-82, (2010).

[Morales, et al., 15] Morales, M., Barchino, R., Medina, A., Hernández, R., (2015). Using Cloud-based Tools: A Study of Motivation and Learning Strategies in Latin America, International Journal of Engineering Education, 31(4), pp. 901–911.

[Morales, et al., 17] Morales Chan, M., de La Roca, M., Alario-Hoyos, C., Barchino Plata, R., Medina, J.A., Hernández Rizzardini, R., Perceived usefulness and motivation students towards the use of a cloud-based tool to support the learning process in a Java MOOC, *Proceedings of the International Conference MOOC-Maker 2017*, 73-82, Antigua Guatemala, Guatemala, November 2017.

[Nunnally, et al., 94] Nunnally, J.C. & Bernstein, I. Psychometric Theory, Rdsepiucsforg, 3, 701, (1994).

[PDST Technology in Education, 15] PDST Technology in Education. (2015). Cloud based Tools & Applications for Learning. Retrieved from: http://www.pdsttechnologyineducation.ie/en/Technology/Advice-Sheets/Cloud-based-Tools-and-Applications.pdf

[Perez et al., 16] Pérez, M.; Maldonado, J.; y Morales. Estado del arte de adopción de MOOCs en la Educación Superior en América Latina y Europa. MOOC-Maker Construction of Management Capacities of MOOCs in Higher Education pp4-8, (2016).

[Reinartz, et al., 09] Reinartz, W. Haenlein, M. & Henseler, J. An empirical comparison of the efficacy of covariance-based and variance-based (SEM), International Journal of Research in Marketing, 26 (4): 332-344, (2009).

[Roldán, et al., 12] Roldán, J. L., & Sánchez-Franco, M. J. Variance-Based Structural Equation Modelling: Guidelines for Using Partial Least Squares in Information Systems Research. (2012).

[Roldán, et al., 16] Roldán, J.L. & Cepeda, G. Seminario Modelos de Ecuaciones Estructurales basados en la Varianza: Partial Least Squares (PLS) para Investigadores en Ciencias Sociales (III Edición), (2016).

[Shah, 2016] Shah, D., By the Numbers: MOOCS in 2016. Class Central. Retrieved October 2017 from https://www.classcentral.com/report/mooc-stats-2016/.

[Spyropoulou et al., 15] Spyropoulou, N.; Demopoulou, G.; Pierrakeas, C.; Koutsonikos, J.; Kameas, A. Developing a Computer Programming MOOC, Procedia Computer Science, Volume 65, Pages 182-191, ISSN 1877-0509, (2015).

[Styhre, et al., 02] Styhre, A., Roth, J., & Ingelgard, A. Care of the other: knowledge-creation through care in professional teams. Scandinavian Journal of Management, 18(4), 503, (2002).

[Taylor, et al., 95] Taylor, S., & Todd, P. A. Understanding Information Technology Usage: A Test of Competing Models. Information Systems Research, 6(4), 144-176, (1995).

[Venkatesh et al., 00] Venkatesh, V., & Davis, F. D. A theoretical extension of the technology acceptance model: Four longitudinal field studies. Management Science, 46(2), 186-204, (2000).

[Walker et al., 12] Walker, S.C and Pearson, J. Intent to Use Technology: Facilitation Effect of Group Presence. International Journal of Business Information and Technology. Vol. 1 No. 1, pp. 1-15, (2012).

2.3 Artículo III – MOOC Using Cloud-based Tools: A Study of Motivation and Learning Strategies in Latin America

2.3.1 Descripción de aportes al objetivo de la tesis

El tercer artículo que forma parte de este trabajo de tesis presenta una revisión de literatura general acerca de la evolución de los MOOCs y el uso de las CBT para el desarrollo de actividades de aprendizaje. En la sección II se describe los fundamentos pedagógicos, características del diseño e infraestructura tecnológica utilizada para la puesta en marcha del MOOC titulado "Herramientas para el aprendizaje basadas en la nube", el cual fue implementado en la plataforma Telescopio[14], primer repositorio de MOOCs en américa latina, iniciativa que surgió como resultado de la motivación de este trabajo de investigación [Morales et al. 2015].

Este curso se estructuro en 4 lecciones de estudio, cada una de ellas presentó un promedio de 8 videos, entre 5-6 minutos de duración, material de apoyo y una serie de actividades de aprendizaje orquestadas con diferentes CBT, orientadas a la generación de espacios de práctica y creación de portafolios digitales. El curso contó con la participación de 2045 estudiantes de más de 50 países.

Este artículo evalúa a los participantes del MOOC descrito anteriormente, en relación a sus orientaciones motivacionales y el nivel de uso de diferentes estrategias cognitivas y metacognitivas, reflejadas en las actividades de aprendizaje, construidas con el apoyo de CBT. Esta evaluación se realizó mediante el uso del Cuestionario de Motivación y Estrategias para el Aprendizaje, por sus siglas en inglés, MSLQ (Motivated Strategies for Learning Questionaire) Pintrich et al. (1991). Este instrumento cuenta con dos secciones, la sección de motivación y la sección de estrategias de aprendizaje.

La sección de motivación está compuesta por 31 ítems que conforman 6 escalas relacionadas a diferentes aspectos motivacionales de los estudiantes; Metas de orientación intrínseca, Metas de orientación extrínseca, Valoración de la Tarea, Creencias de Control del Aprendizaje, Autoeficacia y la Ansiedad ante los exámenes. La segunda sección relacionada al uso de estrategias de aprendizaje, está compuesta por 50 ítems que se relacionan con; el Uso de Estrategias de Repaso, Elaboración, Organización, Pensamiento Crítico, Autorregulación Metacognitiva, Administración del Tiempo y Ambiente de Estudio, Regulación del Esfuerzo, Aprendizaje con Pares y Búsqueda de Ayuda. Todas las preguntas realizadas utilizaron una escala de Likert de 7 puntos, de 1 (no verdadero) a 7 (muy verdadero).

Como resultado de esta investigación se encontró que, en relación al aspecto motivacional los apartados más valorados por los participantes fueron, el "valor de la tarea" (M=6.34, SD=0.80) y la "autoeficacia para el aprendizaje" (M=5.89, SD=1.00), esto sugiere que los participantes del MOOC encontraron las actividades de aprendizaje, interesantes, útiles e importantes (valor de la tarea) y se sienten seguros de su desempeño como estudiantes (tanto en el procesamiento de la información, proceso de estudio y dominio de las habilidades

[14] http//telescopio.galieo.edu

enseñadas).

En relación a las estrategias de aprendizaje utilizadas por los participantes del MOOC, las estrategias de "elaboración" obtuvieron resultados considerablemente altos, esto sugiere que los estudiantes buscan y valoran la construcción de conocimiento a través del establecimiento de conexiones, tales como relacionar nuevas ideas con aprendizajes previos de otros cursos, o fuentes de información, por ejemplo, la realización de resúmenes y la incorporación de lecturas adicionales a la discusión.

Otra estrategia de aprendizaje con valoración alta fue la de "organización", esto representa el uso de recursos gráficos por parte de los participantes, que le permitan una mejor estructuración o visualización del material de estudio. La tercera estrategia mejor evaluada es la de "autorregulación metacognitiva" que representa la planificación, control y regulación del aprendizaje. Se observa una alta correlación entre el valor de las tareas que los estudiantes dan a las actividades de aprendizaje, las motivaciones intrínsecas para tomar el curso, y la eficacia y el buen desempeño que esperan de ellos mismos.

En este sentido, la publicación cumple con el Objetivo Específico 3 de este trabajo de tesis, analizando cuál es el impacto de utilizar las CBT en el diseño de actividades de aprendizaje, en medida de la motivación, permitiendo así mismo el reconocimiento de las estrategias de aprendizaje más efectivas.

Es importante resaltar que este artículo permitió conocer las características de los participantes de un MOOC, con relación a las competencias de autogestión de su aprendizaje, con el fin de implementar una actividad que apoye en forma dinámica al proceso de enseñanza-aprendizaje hacia un proceso más autogestionado.

Concretamente, los resultados de este artículo permiten diseñar un marco de trabajo para la creación y gestión de artefactos de aprendizaje asociados con la taxonomía digital de Bloom para mejorar la experiencia de aprendizaje en MOOCs, cumpliendo de esta forma el Objetivo Específico 5 planteado en la sección 1.1.

2.3.2 Índices de calidad

Morales Chan, M., Barchino-Plata, R., Amelio Medina, J., & Hernández Rizzardini, R.
MOOC using cloud-based tools: A study of motivation and learning strategies in Latin America.
International Journal of Engineering Education
Vol. 31, No. 3, pp. 901-911.
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Este artículo ha sido referenciado por 14 publicaciones, según información proporcionada en GoogleScholar.

La revista IJEE (International Journal of Engineering Education) está referenciada en el ISI Journal Citation Reports (JCR) de Thomson Reuters/Web of Science con un índice de impacto de 0.582. En los últimos 5 años, su índice general de impacto es de 0.566. La revista se publica desde hace treinta años y cuenta con 6 ediciones al año incluyendo ediciones especiales (Special Issues). La revista se encuentra indexada en el Scimago Journal & Country Rank (SJR) con un índice H de 33, con un factor de impacto de SJR (0.799).

2.3.3 Artículo

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MOOC Using Cloud-based Tools: A Study of Motivation and Learning Strategies in Latin America*

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This study describes the motivational and cognitive learning strategies used by students of the large-scale MOOC titled "Cloud-based Tools for Learning," which consists of using free Web 2.0 tools for learning. It is intended to be used by teachers and training professionals who want to innovate their educational practice. A sample of 230 students (11.2% of the 2045 total students enrolled) participated in the study. They answered the motivated strategies for learning questionnaire (MSLQ). The MSLQ has questions about motivation and cognitive learning strategies used by students in a course. The mean scores of the 5 subscales are classified as low, medium, or high. Students ranked motivational strategies high, with relevance to highlight task value, intrinsic goal orientation, and self-efficacy for learning performance, all of them with a "high" classification. The cognitive learning strategies were also classified "high" but slightly lower than motivational section, which had higher ranks in elaboration, organization, and metacognitive self-regulation. Furthermore, we found a correlation between motivation and cognitive strategies. We provide results from a MOOC given by the Telescope project (an initiative with a similar objective as Coursera or EdX) at Galileo University, Guatemala, a technological university with the longest tradition of computer science within the region. The Telescope project is an initiative carried out by the Galileo Educational System (GES) Department, which is in charge of Educational Technology R&D at the University. We examine the importance and relation between the two components, motivation and learning strategies. Hence, such results contribute to a better understanding of the learning process in this particular MOOC and will enable further discussion and insights to improve didactic strategies and the use of innovative cloud-based tools in future MOOCs.

Keywords: massive open online course, cMOOC, xMOOC, MSLQ, cloud-based tools, learning activities
ACM classification Keywords: K.3.1. K.3.2.

1. Introduction

Current results from Coursera and other leaders are more than encouraging, Coursera having over 100 top global universities adhered, over 500 courses, and over 2 million registered users [2]. On the other hand, a recent publication by Les Schmidt about "The MOOC Hype Cycle" [23], using "The Gartner Hype Cycle" suggests that each new technology goes through five phases: (a) the Technology Trigger, (b) the Peak of Inflated Expectations, (c) the Trough of Disillusionment, (d) the Slope of Enlightenment, and finally (e) the Plateau of Productivity. Worth mentioning in the Trough of Disillusionment phase are the igniters: decreased novelty of MOOCs among the population, bad experiences and references, admission burdens including upfront costs to students. The most recurrent criticism is about the high dropout rate (around 90%) [3], which calls into question the quality of the process and the assessment. The open nature of MOOCs implies rethinking our understanding of learners' engagement and disengagement. The participants are heterogeneous [6], from different cultures, education levels, occupations, and compromise levels. Some students are interested in the experience of studying online, others want to generate business opportunities, develop knowledge, learn new tools, or simply validate their knowledge. Furthermore, publications like the one from Phil Hill [18] have characterized student patterns in MOOCs organization, along with a large population of no-shows, into groups of observers, drop-outs, passive participants, and active participants.

Meanwhile, when implementing a MOOC, which consists of only an educational model and a shared set of activities and learning strategies for students, adaptability is a key feature. This has the aim of presenting content with various learning strategies and automated real-time feedback in order to improve completion rates [22]. A critical overview of MOOCs, their opportunities, and the challenges they face mentions that they have raised multiple issues. These issues include the appropriate pedagogical approach, the effective and efficient support of open and self-guided learning, and related business models for sustainability and accreditation solutions to benefit both learners and academic institutions [9]. Therefore, a study of motivational and cognitive learning strategies using cloud-based

* Accepted 24 October 2014.

learning tools will complement further enhancements to MOOCs.

This research proposal measures students' motivational and cognitive learning strategies by using the motivated strategies for learning questionnaire (MSLQ) by Pintrich et al. [16] for this MOOC; it is a widely known instrument with reliable results [17]. In order to measure student motivation when performing activities with cloud-based learning tools, it was also validated that learning strategies are more efficient in a MOOC environment. This research proposes a framework for the creation and management of learning artifacts associated with Bloom's digital taxonomy to improve the learning experience. The rest of the paper is organized as follows: Section 2 presents a pedagogical foundation and the MOOC design, including the learning objectives and learning activities as well as its technological infrastructure, the tools used, and the cloud learning activities orchestration (CLAO). Section 3 presents the study setup and methodology. Section 4 presents the main results from the MSLQ for the MOOC and reports on and discusses the learning experience, followed by a summary and future work in Sections 5 and 6.

2. MOOC using cloud-based tools

The learning setting was designed based on MOOC experiences at Galileo University [10, 11, 13] and motivated by the resulting first findings. In Latin America there are many students enrolling in MOOCs [5], so Galileo University launched an initiative named Telescope to host multidisciplinary MOOCs. Their first experiences have already been published [10, 11, 13].

Enthusiasm is growing and multiple professors and learners representing over 20 Latin American countries are involved, as well as a number of participants from Spain. Galileo University offered MOOC-style course as early as 2005 to 2007, with over 2000 students in a single edition [10]. The use of cloud-based tools for learning, most of them free, has evolved rapidly in recent years [1, 7]. We present a MOOC study based on the course titled "Cloud-based Tools for Learning," targeted at teachers and training professionals who want to innovate their learning activities by using Web 2.0 tools.

2.1 Pedagogical foundation and MOOC design

Many MOOC formats exist [7], but most courses exhibit common defining characteristics that include massive participation, online and open access, lessons formatted as short videos combined with formative quizzes, automated assessment and/or peer and self-assessment, and online forums. We chose to use the xMOOC format, which promotes a teaching model emphasizing "cognitive-behavioral" learning, which follows a more traditional approach to online learning. The xMOOCs replicate the traditional model of an expert tutor and learners as knowledge consumers online, with saved video tutorials and graded assignments [4]. The main objective of this course is to present the opportunities provided by "the cloud" to create effective learning experiences and to innovate through tools that offer many possibilities to backup data, share information and create multimedia content.

2.1.1 Course structure

The course was designed with 4 learning units; for each unit, an introduction described the objectives and activities, Google presentations displayed the content, and a podcast and short videos representing the main resources of the learning content were recorded for the learners. Complementary readings of pre-selected documents and hyperlinks were made available to the participants. Given that the course required the use of software or learning tools in the cloud, a set of tutorial videos and written instructions was created to support students to complete their assignments. An overview of the main aspects of the MOOC is provided in Table 1.

Special focus was given to online collaboration through discussion forums and peer assessment. To overcome the problems of fragmented communication channels, the communication facility was restricted to only one tool to ensure a simple method of communication and had two types of main online discussion forums: (1) Forum of the Week: At the beginning of each week a forum was opened where the tutor started the week with a motivational message, provided the week's agenda, and presented a discussion topic. In this forum the students were able to publish reflections and comment contributions following the thread started by the tutor. (2) Technical Forum: From the beginning of the course, this forum was open for questions and problems arising in the use of the platform.

In addition to the main forums, the application allowed participants to post additional questions that others could respond to and help answer, contribute new topics, or present ideas. Throughout the course, participants could propose topics for discussion, answer questions posed by teammates, vote, comment, and exchange views and information with the rest of the participants. The online collaborative forums followed a gamification [13] approach. Badges were used as electronic rewards for students based on their contributions to the course learning community. This approach increases students' positive emotions by the mere

Table 1. General Description of MOOC

MOOC "Cloud-based tools for Learning" Learning Experience	
Course offered	August 2013
MOOC pedagogical approach	xMOOC (cognitive behavioral teaching model)
Learning and instructional objectives	Acquire knowledge and skills of use to cloud-based tools
Number of learning units	4 units (1 unit per week, 4 weeks in total)
Number of learning activities	8 activities (2 activities per week)
Video resources	12 Video tutorials
Collaboration type	Non-guided discussions. Question-and-answer (Q/A) forums.
Teachers	2 teachers and 2 tutors
Assessment type	Peer assessment & self-grading

fact of their overcoming challenges [4]. For our case we used badges differently, to represent recognition within the community. Among the most awarded were "Professor" for first response with at least one positive vote, "Collaborator" for the first positive vote, and "Student" for the first question with at least one positive feedback.

Participation in the forums had a value of 10% of the final grade of the course on the basis of accumulated points, known as *Karma*. Once the course was completed, each participant was rated for their participation in forums by measuring their karma, which was accumulated by responding, generating questions, voting, and being active in the forums.

2.1.2 Peer assessment

Peer assessment consisted of each participant grading learning activity assignments. A rubric was created for each learning activity and students used the rubric to assess their peers. Students first had to complete their own assignment before randomly doing blind peer assessments. The participation and the level of quality contributions in the peer assessments were counted towards their course grade.

2.2 Learning objectives and learning activities

Every learning unit had a set of instructional objectives and learning activities, and students were expected to complete the set of assignments. The learning objectives of the MOOC can be summarized as to acquire knowledge and skills to use to cloud-based tools for learning, all summarized in Table 2.

2.3 Technological infrastructure and tools

The central access point for the MOOC was the Telescope project infrastructure. It also enabled users to create accounts and log onto the system. For convenience, participants could also register and login from Facebook. The learning management system (LMS) is extended and enhanced at Galileo University and is based on LRN LMS [11]. New and customized course presentation templates were required for the proposed structure of the MOOCs.

For the online discussion forum, OSQA was used. This system is free and is a great solution to connect people to information and to get some elements to help engage more deeply with topics and questions of personal relevance, allowing everyone to collaborate, answer queries, and manage learning. This integration enabled students to go back and forth between the LMS and OSQA. Also, a portlet was developed to inform students of recent and highly relevant contributions. For the peer assessment activities, a new tool was created and integrated into our LMS. This assessment module included a rubric-based feature whereby instructors could create rubrics for the assessment activities. Learning assignments from peers were assigned randomly and anonymously for the peer assessment activities. The LMS calculated the average results to grade the learning activities or to scale the grades, and students could view the peer assessment results; the only condition was that students had to qualify at least two tasks.

2.4 Cloud learning activities orchestration (CLAO)

The cloud-based learning activities were organized and deployed using the CLAO, an interoperability system and environment engineered at GES from Galileo University, which is a pluggable environment in the MOOC infrastructure where professors can organize learning activities and orchestrate multiple cloud-based tools from a pedagogical perspective. CLAO provides a seamless interoperability with cloud-based tools and the MOOC environment and has an analytics engine to obtain data from learners when they are using the cloud-based tools within the learning activities.

3. Methodology

This study is based on a survey of 230 students who answered an intermediate questionnaire between the second and third week of course, all summarized in Table 3. A first questionnaire (before beginning the course) representing 60% of the students enrolled revealed that for 76.71% of the students it was their first MOOC, 54.52% indicated that they

Table 2. MOOC learning topics, instructional objectives, and selected cloud-based tools

Learning Topic	Instructional Objectives	Activities and Cloud-based Tools	Assessment type
Unit # 1 Cloud-based Learning Concept, characteristics and opportunities of cloud-based learning	Identify the benefits of creating cloud-based learning experiences. Determine how the cloud can be used in learning environments. Collaborate in the recognition of cloud-based learning tools that can be used in learning environments.	Creating a PLE's diagram and the integration of a personal avatar Faceyourmanga[1]	Auto-grading
		Developing an essay about cloud-based learning in Google Docs[2]	Peer assessment
Unit # 2 Presentation and Documentation of Cloud-based Learning Tools Characteristics, use, and application of the tools	Create educative resources through presentation and documentation of cloud-based learning tools and apply them within learning environments appropriate to their educational needs.	Designing a Prezi[3] presentation	Peer assessment
		Development of a personal biography through a timeline and integration of a business card Dipity and Cacoo[4]	Peer assessment
Unit # 3 Communication and Collaborative Cloud-based Learning tools Characteristics, use and application of the tools	Create educative resources through communication and collaborative cloud-based learning tools and apply them within learning environments appropriate to their educational needs.	Design an interactive wall that integrates multimedia resources such as images, articles, and a podcast. Padlet and Soundcloud[5]	Peer assessment
		Multimedia presentation to show a project and multimedia resources such as mental map, images, and more. Google Viewer, Mindmeister, Skype[6]	Peer assessment
Unit # 4 Interactive and Multimedia Cloud-based Learning Tools Characteristics, use and application of the tools	Create educative resources through interactive and multimedia cloud-based learning tools and apply them within learning environments appropriate to their educational needs.	Create a learning game like a crossword puzzle or a quiz on all topics of the course. Educaplay[7]	Peer assessment
		Develop an animated online video to present a topic Goanimate[8]	Peer assessment

[1] Faceyourmanga, http://www.faceyourmanga.com/
[2] Googledocs, http://www.google.com
[3] Prezi, http://prezi.com/
[4] Dipity and Cacoo; http://www.dipity.com/ & https://cacoo.com/lang/es/
[5] Padlet and Soundcloud, http://padlet.com/ & https://soundcloud.com/
[6] Google Viewer, Mindmeister, Skype, http://www.google.com
[7] Educaplay, http://www.educaplay.com/
[8] GO animate, http://goanimate.com/

had enrolled in the course because it was related to their work. The 91.52% indicated they had never used the cloud tools that will be introduced in the course, although they have used: Skype (75%), Google Drive (55.42%) and Dropbox (54.12%).

3.1 Study setup and methodology

This study was developed by GES department at Galileo University; it aims to identify the cognitive learning strategies and motivations that underpin the learning process within a MOOC, more specifically the MOOC "Cloud-based Tools for Learning." Particular attention is given to motivational scales, which are closely related to enrolling in a MOOC. By obtaining an understanding of students' motivations and learning strategies in a MOOC that heavily uses cloud-based tools for learning activities, we could enrich future courses and improve the overall student experience.

We used the motivated strategies learning questionnaire (MSLQ) [17], which is a student self-report questionnaire that assesses the use of different cognitive learning strategies and motivational orientations in a specific course [16]. The MSLQ consists of two sections, the motivation section and the learning strategies section. The motivation section has 6 subscales that assess students' goals and value beliefs for the course, i.e., their beliefs about their skills to succeed in the course. The learning strategy section has 5 subscales about students' cognitive and metacognitive strategies. There are four subscales of resource management.

Questions use a 7-point Likert scale, from 1 (not true) to 7 (very true). Hence, from a cognitive social learning perspective it considers aspects that are determined by the context and are dynamic [9].

MSLQ was sent as an online survey to all MOOC participants, and it was optional and confidential. A

Table 3. Demographic Data

Registered participants	2045
Participants who completed intermediate questionnaire	230 (11.2%)
Age	M = 38 (S = 9.76) Min = 17 years/ Max = 68
Gender	Female: 35.50% Male: 64.50%
Country	Guatemala (57.82%) Peru (5.61%) Spain (4.78%) Mexico (4.78%) El Salvador (4.35%) All others (22.66%)
Students who passed the course	121(59%)
Final grades for passing students (over 100)	M = 81.11
Forum activities	1068 questions / 3511 answers 407 people with at least 1 forum participation
Academic level of the participants	Pre-university:16.45% Professional: 52.38% Master's degree: 29.00% Doctoral degree: 2.16%

Table 4. Reliability of the MSLQ questionnaire, by subscales

Motivation scales		
Subscale	**Reliability original application***	**Reliability this study application**
Intrinsic goal orientation	0.74	0.73
Extrinsic goal orientation	0.62	0.74
Task value	0.90	0.87
Control beliefs	0.68	0.68
Self-efficacy for learning and performance	0.93	0.88
Test for anxiety	0.80	0.87
Learning strategies scale		
Rehearsal	0.69	0.82
Elaboration	0.76	0.86
Organization	0.64	0.77
Critical thinking	0.80	0.75
Meta-cognitive self-regulation	0.79	0.89
Time and study environment	0.76	0.73
Effort regulation	0.69	0.61
Peer learning	0.76	0.89
Help seeking	0.52	0.73

Note: *(Pintrich et al., 1991).

sample of 230 students answered. The survey was sent in the second week of the course and left open to answer for a week. Of those who answered the survey, 121 approved of the course. All data processing and statistical analyses were performed using SPSS statistical package software version 20.0 (SPSS Inc., Chicago, IL, USA).

4. Results

4.1 Reliability

Cronbach's alpha coefficient was used to measure the internal consistency and reliability of the questionnaire, as shown in Table 4. Once compared with the original publication of the MSLQ [17], we noted that this study has similar reliability to the original one.

4.2 MSLQ for the MOOC

Motivation and Cognitive Learning Strategies are described in this study, using each one of the subscales, based in the proposed by MSLQ authors [17].

Also relevant aspects for each sub-scale are presented. Additionally, three intervals to locate groups were used for this study: low, medium and high ranks. As noted in Tables 5 and 6, the students

Table 5. Descriptive statistics of the motivational component

Component	Subscale	Mean	SD	Variance	Range
Value component	Intrinsic goal orientation (IGO)	5.87	0.98	0.96	High
	Extrinsic goal orientation (EGO)	4.99	1.48	2.19	High
	Task value (TV)	6.34	0.8	0.7	High
Expectancy component	Control beliefs (CB)	5.63	1.1	1.2	High
	Self-efficacy for learning and performance (SELP)	5.89	1	1	High
	Test anxiety (TA)	3.41	1.6	2.7	Medium

Table 6. Descriptive statistics of cognitive strategies

Component	Subscale	Mean	SD	Variance	Range
Cognitive and meta-cognitive strategies component	Rehearsal (R)	4.4	1.5	2.4	Medium
	Elaboration (E)	5.22	1.3	1.6	High
	Organization (OR)	5.12	1.3	1.7	High
	Critical thinking (CT)	4.86	1.2	1.4	High
	Meta-cognitive self-regulation (MSR)	5.03	1.1	1.2	High
Resource management strategies	Time and study environment (TSE)	4.53	0.95	0.9	High
	Effort regulation (ER)	5.02	1.1	1.2	High
	Peer learning (PL)	3.38	1.9	3.7	Medium
	Help seeking (HS)	3.45	1.4	2	Medium

scored high in the motivation scale, while in learning strategies, they scored the cognitive and metacognitive strategies highly, and in the resource management strategies they scored medium.

4.2.1 Motivation section

This group had a very characteristic motivational profile (Table 5), the highest mean values were for task value (M = 6.34, SD = 0.80) and then, almost at the same value were self-efficacy for learning and performance (M = 5.89, SD = 1.00) and the intrinsic goal orientation components (M = 5.87, SD = 0.98). Thereby, it is possible to suggest that students found the course material and contents interesting, useful, and important (task value). Students showed a high confidence to accomplish and master the tasks and had their own intrinsic motivations (challenge, curiosity, mastery) and beliefs that their learning efforts would have a positive outcome, probably in the current profession and work.

Although grades and other goals seemed less important (extrinsic), meaning the learning task is not an end to itself, they were still important for students. In the following sub-sections the findings will be presented in detail.

4.2.1.1 Value component

For task value, 80% of the subscale got over 83% answers close to "very true." In particular, 89% of the students expressed liking the course (M = 6.48, SD = 1.00) and that they found it very useful to learn the course material (M = 6.39, SD = 0.87). For the reason of doing the tasks, it appears clear that intrinsic goals (M = 5.87, SD = 0.98) are slightly more relevant than extrinsic ones (M = 4.99, SD = 1.48). Students indicated satisfaction in "understanding the course as thoroughly as possible" (M = 6.23, SD = 1.20) and that when they have the opportunity; they choose tasks where they can learn even if it does not guarantee good grades (M = 5.82, SD = 1.40). The "good grades" motivation was indicated with less satisfaction (M = 4.65, SD = 1.87), the lowest in the value component, although most of them graded with good capabilities to get better grades than their peers (M = 5.50, SD = 1.59). To demonstrate their newly learned abilities to friends and employers was of medium value (M = 4.81, SD = 1.99), although still highly relevant to 44% of the students.

4.2.1.2 Expectancy component

The self-efficacy for learning and performance (M = 5.89, SD = 1.00) and the control of learning beliefs (M = 5.63, SD = 1.10) subscales both scored highly, meaning that students' beliefs are that their efforts in the MOOC will bring them positive outcomes, that they will study more strategically and effectively, and that this will lead them to success and mastery in the course. Students found themselves certain they could understand the basic concepts (M = 6.39, SD = 0.99) and that they could master the skills taught (M = 6.10, SD = 1.13). The control of learning beliefs subscale shows a great variation in responses. For example, students believe that if they study appropriately they will learn (M = 6.29, SD = 1.01) but interestingly show a lower agreement with the following two statements that got the same mean value, first the one that says, "If I don't understand the course material, it is because I didn't try hard enough" (M = 5.05, SD = 1.87), and second, "It is my own fault if I don't learn the material in this course" (M = 5.05, SD = 1.86). It is relevant to mention that 47% of the students would not get an excellent grade in the class.

4.2.1.3 Affective component

This is the lowest mean value for the whole questionnaire (M = 3.41, SD = 1.60), which indicates mid-level anxiety, with its components of concern, preoccupation, and worry that negatively affect academic performance. They were concerned about taking tests and the consequences of failing them as the highest concern (M = 4.01, SD = 2.13); in contrast, they show confidence while taking a test not thinking negatively compared with other students (M = 2.93, SD = 1.98).

We also assessed if there was any correlation between the subscales of the instrument. There were significant positive correlations between the motivation subscales. The task value correlates with the intrinsic goal orientation subscale (r (230) = 0.667, $p = 0.01$) and with the self-efficacy of learning and performance subscale (r (230) = 0.770, $p = 0.01$).

4.2.2 Learning strategies section

To represent the students' learning strategies, we can see that an important cognitive mean value at elaboration, building internal connections to prior knowledge with what has been learned (M = 5.22, SD = 1.30), organization (M = 5.12, SD = 1.30), and metacognitive self-regulation (planning, monitoring, and regulating) (M = 5.03, SD = 1.10) were the highest-degree motives. Resource management and effort regulation had significant values (M = 5.02, SD = 1.10), and interestingly enough we found lower perceived relevance of peer learning (M = 3.38, SD = 1.90) and help seeking (M = 3.45, SD = 1.40).

4.2.2.1 Cognitive and metacognitive strategies component

Elaboration strategies scored consistently high, such as relating ideas to what they already know (M = 5.53, SD = 1.49) and to other courses (M = 5.47, SD = 1.56), making connections between the concepts and online course material (M = 5.39, SD = 1.61), and incorporating ideas from course readings into discussion (M = 5.40, SD = 1.64). For metacognitive self-regulation, when students are confused while reading they go back and try to figure it out (M = 5.85, SD = 1.33), in contrast 39% of the students reported they challenge themselves with questions while reading, and only 38% solve their own questions once confused. It is relevant to mention that 70% of the students review the content before they actually study thoroughly. In critical thinking we found a low level of questioning before being convinced (M = 3.63, SD = 2.02), but in contrast students use the course as a base to further develop their own ideas (M = 5.45, SD = 1.51).

Rehearsal learning strategies scored mid-range (M = 4.40, SD = 1.50). Organization strategies got high scores, such as for finding the most important ideas, which 70% of the students reported as true or very true (M = 5.86, SD = 1.27). Furthermore, we see a different opinion when asked about outlining important concepts; only 39% agreed with that.

4.2.2.2 Resource management component

The time and study management subscale scored mid-range (M = 4.53, SD = 0.95) while the effort regulation subscale scores higher (M = 5.02, SD = 1.10). Students responded close to "very true" to the following: 47% found themselves in other activities rather investing time in the course, and 41% found difficulty having a study schedule, as expected. 50% reported set aside a regular place for studying, and 44% said they make good use of their study time. The group presented good effort even if feeling lazy or bored (M = 5.18, SD = 1.98) and worked hard even if they didn't like the learning activity (M = 5.13, SD = 1.69). In help-seeking most other students did not want any help when facing problems (M = 3.82,SD = 2.12); only 21% were close to "very true" in their response to trying to work with classmates to complete course assignments, and a low 22% responded that way to setting aside time for study group.

When exploring correlations within the learning strategy section, the elaboration subscale correlated with several of the subscales of the section, such as the organization subscale (r (230) = 0.779, p = 0.01) and the metacognitive self-regulation subscale (r (230) = 0.834, p = 0.01). The Table 7 presents the results of the correlation coefficient to Pearson.

4.3 Study factor analysis and cluster

Factorial analysis was used to reduce the number of measures to a number of factors in order to try to provide a clearer interpretation of data. We conducted the analysis with all variables, making no a priori assumptions about the associations among the variables. The KMO (Kaiser-Myer-Olkin) measure of sampling adequacy returned 0.912 and Bartlett's test of sphericity returned 13,477,138 ($p < 0.001$). Therefore, the data were adequate for performing the analysis. We extracted 13 factors that accounted for 68.5 of the overall variance. The commonality is greater than 0.5. The data are between 0.568 and 0.818.

The first factor, accounting for 31.71% of the variance, included 18 variables. These variables have as main features management of the course

Table 7. Correlations between the scales of the MSLQ as Pearson

	R	E	OR	CT	MSR	TSE	ER	PL	HS
IGO	0.376**	0.562**	0.512**	0.550**	0.637**	0.309**	0.316**	0.189**	0.099
EGO	0.508**	0.393**	0.461**	0.423**	0.387**	0.306**	0.139*	0.372**	0.293**
TV	0.235**	0.543**	0.480**	0.453**	0.526**	0.333**	0.354**	0.041	–0.005
CLB	0.359**	0.478**	0.378**	0.404**	0.481**	0.089	0.090	0.215**	0.136*
SELP	0.304**	0.589**	0.541**	0.526**	0.592**	0.439**	0.395**	0.145*	0.097
TA	0.431**	0.196**	0.230**	0.308**	0.205**	–0.081	–0.360**	0.490**	0.340**

** Correlation is significant at the 0.01 level (bilateral).
* Correlation is significant at the 0.05 level (bilateral).

documentation, practical application of the course, and positive attitude and constancy in work. The second component represented 11.27% of the overall variance and included 18 variables. These variables are characterized by relation of ideas to documentation and self-assessment.

The third component accounted for a 5.074% share of the variance, and it included 8 variables. These variables are characterized by difficulty with and negative attitude toward studying. The fourth component accounted for a 3.91% of the variance and included 6 variables. These variables have as main features study based on word memorization, teamwork, and consultation questions for teachers and other students.

The fifth component accounted for 2.49% of the variance and included 8 variables. These variables are characterized by extension of the course document, regular time, and fixed place of study. The sixth component accounted for 2.16% of the variance and included 4 variables. These variables have as main features individual study and difficulty with time.

The seventh component accounted for 2.12% of the variance and included 3 variables. These variables are characterized by a main goal of highlighting and getting good grades. The eighth component accounted for a 1.85% of the variance and included 3 variables. These variables have as main features discussing the material, learning by memorizing course documentation, and use of graphic material.

The ninth component accounted for a 1.70% of the variance and included 2 variables. These variables are characterized by preparation before class. The tenth component accounted for 1.65% of the variance and included 2 variables. These variables have as main features approaches to training and improving concentration.

The eleventh component accounted for 1.60% of the variance and included 1 variable. This variable is characterized by challenging material. The twelfth component accounted for 1.52% of the variance and included 2 variables. These variables have as main features guilt compression and learning. The thirteenth component accounted for 1.42% of the var-

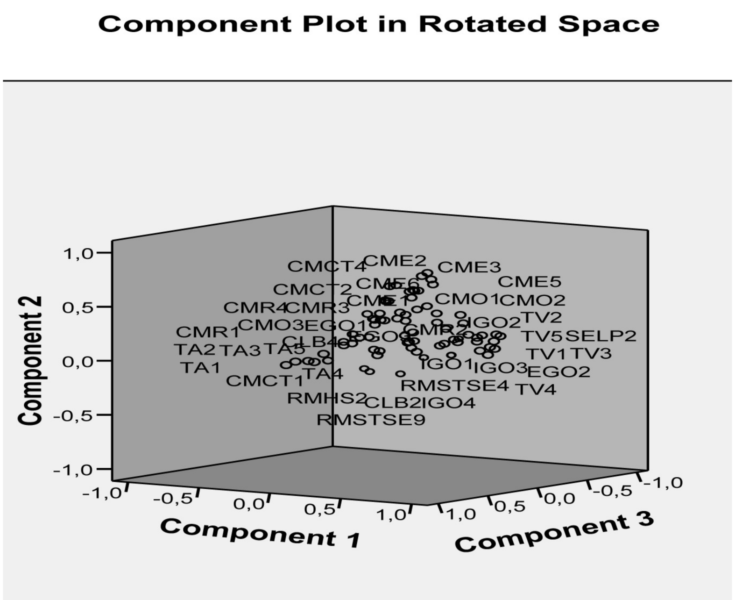

Fig. 1. Component plot in rotated space of the factorial analysis.

iance and included 1 variable, the final score, and the clustering coefficient. This variable is characterized by compression of the material. The component plot (Fig. 1) provided a visual representation of the variables outlining the three factors.

Our study has 3 clusters; the first cluster has 32, the second has 87, and the third has 111. The first cluster consists of components 5, 6, 8, 10 and 13, the second clusters consists of components 2 and 9, and finally the third cluster consists of 1, 3, 4, 7, 11, and 12.

5. Discussion

This study of the MSLQ for the MOOC titled "Cloud-based Tools for Learning" sought to describe and identify the motivational factors and learning strategies that the students followed. There is a group of students (76.71%) for whom this was their first online learning experience, and the lack of an adaptation phase may have negatively affected them [18]. Based on the results provided in this study, the students had higher scores in the motivational scales compared to the learning strategies scales presented. As expected in the MOOC, students begin with high motivation levels, but appropriate levels of commitment shown in the learning strategies will prove them successful within a course in terms of grading. This study does not address the other types of students as seen in the MOOCs overview section.

It was found that students enroll in a MOOC course for intrinsic motivations and they stay in the course because of the value of the learning tasks and because they feel they can become proficient in them. Students' learning beliefs are that they are capable of learning, but they are less comfortable with recognizing their own responsibility in learning the material. This can be related to cultural factors [19], but it is not yet determined why this is the current outlook within the student population.

Only 53% of the students chose answers close to "very true" about whether they believed they would get an excellent grade. This might be related to the dropout rates we observe in MOOCs and soft commitment to course completion or that at the time of the questionnaire students were in the middle of the course; there were 230 responses and only 121 completed the course successfully.

High correlation is seen between the task value students give to the learning assignments, the intrinsic motivations for taking the course, and the efficacy and good course performance they expect of themselves.

Concerns regarding exams highly affect a group of the students (31% of them). Although it is outside of the scope of the current study, it would be very interesting to link how this anxiety subscale relates to actual MOOC performance and completion for each individual.

The learning strategies that were scored highly indicated that metacognitive self-regulation learning strategies have very important roles, such as planning the activities to learn, monitoring one's own learning during the process, and continually tuning and adjusting those activities. Furthermore, metacognitive strategies present an interesting perspective with many contrasts. Our findings highlight that students agree with making sure to understand what they are reading, but only some of them (below 45%) actually confirmed specific strategies such as questioning themselves, answering unsolved questions, or reviewing the MOOC content again.

Moreover, elaboration strategies, which consist of building connections between learned topics, got the highest score. It is relevant to mention that students also experienced elaboration during discussion, but it was observed that only 19.90% participated in forum discussion. The value of participating in discussion was understood, but this did not actually occur.

The findings observed in the study demonstrate that a great majority of the students prefer to go through a *scanning* phase [7, http://www.tandfonline] with the content before studying it thoroughly. Critical thinking got an above-mid-range value. This may also be related to cultural behaviors [19], although students tended to agree with using the course as a starting point in their learning, which is consistent with the defined course scope, which is to serve as an introduction to the use of cloud-based tools for learning. It was well-known that students would face problems using new tools [18]—about 91.52% reported never having used cloud-based tools before—and considering the degree to which critical thinking is related to the problem-solving process, it may have been that students' correct and extensive use of cloud-based tools was rather limited, therefore further analysis is required but is out of the scope of the present publication. Because rehearsal strategies ended up having less relevance, we can relate this to the nature of the course, which was practical rather than theoretical.

It is important to point out that the resource management strategies component offers us very interesting information about students' views of the learning process within a MOOC, where they give moderate importance to peer learning and help-seeking, both closely related. Within the MOOC environment both activities occur in the online discussion forums. It is presumable that the large amount of learners, which is well known by the students, and the perceived difficulty to organize communications correctly may inhibit students' finding peers with whom they can share experiences and ask questions. Furthermore, the same behavior is observed in the student-to-tutor interaction. The students confirmed that about 80% do not try to study with peers, and is important to mention that no peer interaction has been incentivized besides participation in online discussion forums and through peer assessment, which is actually done isolated and blind.

The time and study environment component points out a key issue in online learning, and as we report here about half of students struggle with time commitment, making good use of that time, and having a good place to learn. All of this hinders course performance and motivation. Effort regulation is the students' ability to control their effort and attention; it is goal commitment. The students responded with a relatively high value (see Table 6), which is especially significant considering that the course is free, massive, and online. Despite the limitations and challenges faced by this study, it has relevant results to further improve MOOC experiences and to make special considerations in developing new courses, especially regarding motivations and learning strategies that affect students taking part in a MOOC.

6. Conclusion and future work

The student's present high motivations in the MOOC, they see each learning activity as relevant to their own contexts, and they see themselves as intrinsically motivated and as having capabilities to perform well in the course. Having a solid learning strategy in place for MOOCs will probably increase commitment to the learning experience and decrease the high dropout rates very common among MOOCs, where organization, elaboration, and metacognitive strategies are fundamental to success. Despite the current low peer interaction and help-seeking indicated by students, it is of great interest to create communities that to do not *reset or restart themselves* with every course ending. Instead, the learning community must be enabled to continue, reinforce itself, and grow across time independently of course schedules and editions, as in educational resources such as Khan Academy [4]. Hence the frontier between xMOOCs and educational resources might blur in the future.

A wider MOOC comparison of control of learning beliefs will be of high interest to the research community. As well as to contrast those learning beliefs among different cultures and countries, with special attention to factors such as learning responsibility.

The next step is to correlate the current results of the MSLQ with actual performance in the course, including participation, completion, and other variables. Further sampling in multiple types of MOOCs of different knowledge fields should be obtained.

It is necessary to investigate and determine what the specific reasons are that a large number of students do not actively seek help and how to incentivize them at scale. In general, we will need to crossmatch results of the MSLQ with our learning analytics technology to get more confirmatory and conclusive results.

The research in the factorial analysis shows that students with a high degree of variance perform better at managing learning resources, as they can cope with the course in a more positive manner. On the other hand, they are identified with factors relating to the behavior of the students.

References

1. V. Chang and C. Gütl, Generation Y learning in the 21st century: Integration of virtual worlds and cloud computing services. In Z. Abas et al. (Eds.), *Proceedings of Global Learn Asia Pacific, AACE, Penang, Malaysia*, (May 2010), pp. 1888–1897.
2. Coursera Blog, A Triple Milestone: 107 Partners, 532 Courses, 5.2 Million Students and Counting, http://blog.coursera.org/post/64907189712/a-triple-milestone-107-partners-532-courses-5-2 (Accessed October 23, 2013).
3. J. Daniel, Making Sense of MOOCs: Musings in a Maze of Myth, Paradox and Possibility, *Journal of Interactive Media in Education*, 2012, 3.
4. T. Daradoumis, R. Bassi, F. Xhafa and S. Caballé, A review on massive e-learning (MOOC) design, delivery and assessment, *Eighth International Conference on P2P, Parallel, Grid, Cloud and Internet Computing*, 2013.
5. Domínguez Adrián, Saenz-de-Navarrete Joseba, De-Marcos*Luis, Fernández-Sanz Luis, Pagés Carmen and Martínez-Herráiz José-Javier, Gamifying learning experiences: Practical implications and outcomes, *Computers and Education*, **63**, 2013, pp. 380–392.
6. Á. Fidalgo Blanco, F. J. García-Peñalvo and M. L. Sein-Echaluce, A methodology proposal for developing adaptive cMOOC. In F.J. García-Peñalvo (Ed.), *Proceedings of the First International Conference on Technological Ecosystem for Enhancing Multiculturality*, NewYork, NY, USA: ACM. (TEEM'13), 2013, pp. 553–558.
7. A. Fini, The technological dimension of a massive open online course: The Case of the CCK08 course tools, The International Review of Research in Open and Distance Learning. Special Issue—Openness and the Future of Higher Education, Feb., 2013.
8. T. Garcia and W. McKeachie, The making of the motivated strategies for learning questionnaire, *Educational Psychologist*, **40**, 2005, pp. 117–121.
9. D. Glance, M. Forsey and M. M. Riley, The pedagogical foundation of massive online courses, 2012, First Monday Journal, retrieved from http://firstmonday.org/ojs/index.php/fm/article/view/4350/3673 on 12//13, DOI: http://dx.doi.org/10.5210%2Ffm.v18i5.4350
10. R. Hernández, V. Chang, C. Gütl and H. Amado, An Open Online Course with Accessibility Features, In *World Conference on Educational Multimedia, Hypermedia and Telecommunications*, **1**, 2013, pp. 635–643.
11. R. Hernández, C. Gütl, V. Chang and M. Morales, MOOC in Latin America: Implementation and Lessons Learned, *The 2nd International Workshop on Learning Technology for Education in Cloud Springer Proceedings in Complexity*, 2014, pp. 147–158.

12. R. Hernandez, B. H. Linares, A. Mikroyannidis, H. Schmitz, Cloud services within a ROLE enabled personal learning environment, *Proceedings of the 1st International Work- shop on Cloud Education Environments* (WCLOUD 2012), November 2012, Vol. 945, CEUR Workshop Proceedings ISSN 1613-0073.
13. R. Hernández Rizzardini, C. Gütl, V. Chang and M. Morales, MOOCs Concept and Design using cloud-based Tools: Spanish MOOCs Learning Experiences, in Foley A. (ed), *Proceedings of The Sixth Conference of MIT's Learning International Networks Consortium* (LINC), June 16–19, 2013, Cambridge, USA: MIT.
14. R. Hernandez, A. Pardo and C. Delgado, Creating and deploying effective eLearning experiences using .LRN. *IEEE Trans. on Education*, **50**(4), 2007. pp. 345–351, November.
15. J. J. Lee and J. Hammer, Gamification in Education: What, How, Why Bother? *Academic Exchange Quarterly*, **15**(2), 2011; Accessed 3 Feb 2013 from http://www.gamifyingeducation.org/files/Lee-Hammer-AEQ-2011.pdf
16. P. Pintrich and T. García, Intraindividual differences in students' motivation and self regulated learning, *German Journal of Educational Psychology*, **7**, 1993, pp. 99–107.
17. P. Pintrich, D. Smith, T. Garcia and W. McKeachie, A manual for the use of the motivated strategies for learning questionnaire (MSLQ). Ann Arbor, MI: University of Michigan, 1991.
18. Phil Hill, Emerging Student Patterns in MOOCs: A (Revised) Graphical View, E-Literate, March 10, 2013 http://mfeldstein.com/emerging-student-patterns-in-moocs-a-revised-graphical-view/
19. Phil Hill, The most thorough summary (to date) of mooc completion rates. E-Literate, February 26, 2013 http://mfeldstein.com/the-most-thorough-summary-to-date-of-mooc-completion-rates/
20. G. Salmon, E-moderating: the key to teaching and learning online. London: Kogan Page, 2000
21. E. Shiraev, Cross-Cultural Psychology: Critical Thinking and Contemporary Applications, http://media.matthewsbooks.com.s3.amazonaws.com/documents/tocwork/020/9780205253234.pdf
22. N. Sonwalkar, The First Adaptive MOOC: A Case Study on Pedagogy Framework and Scalable Cloud Architecture—Part I. MOOCs Forum, (2013). 1(P), 22-29. doi:10.1089/mooc.2013.000
23. J. Tapson, Moocs and the Gartner Hype Cycle: a very slow tsunami , 23 September , 2013, http://pandodaily.com/2013/09/13/moocs-and-the-gartner-hype-cycle-a-very-slow-tsunami

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3. Otras publicaciones

Para la elaboración de este trabajo se han seleccionado tres artículos enmarcados al objetivo principal de esta tesis doctoral. Sin embargo, durante el proceso del doctorado se tuvo la oportunidad de desarrollar una plataforma educativa de MOOCs (http://telescopio.galileo.edu) donde se diseñó y elaboró 19 cursos de diferentes temáticas, orientados principalmente a la empleabilidad. Así mismo, se coordinó, diseñó y elaboró otros 19 MOOCs en la plataforma mundial edX (www.edx.org) y se coordinó el proyecto MOOCMaker (www.moocmaker.org) para Universidad Galileo. Este proyecto fue financiado por la comisión europea Erasmus+, el cual tenía como propósito principal desarrollar capacidades técnicas y metodológicas para la producción de MOOCs en las instituciones de educación superior de América Latina.

Todo lo anterior, permitió la producción de otros artículos con resultados intermedios o relacionados que, a pesar de no ser seleccionados para el compendio, son de mucho interés para la comprensión global del presente trabajo de tesis.

Estas publicaciones pueden agruparse por importancia en 2 grupos principales: Capítulos de libro y Conferencias Internacionales. A continuación, se presentan los artículos publicados en cada una de estas categorías.

3.1 Capítulos de Libro

3.1.1 Datos de la publicación

Nombre del Libro: Formative Assessment, Learning Data Analytics and Gamification

Este libro discute los retos asociados con la evaluación del progreso de los estudiantes dada la explosión de los entornos de e-learning, como los MOOCs y los cursos en línea que incorporan actividades como el diseño y el modelado. Este libro muestra a los educadores cómo obtener eficazmente datos inteligentes de entornos educativos en línea que combinan la evaluación y la gamificación.

Editorial: ELSEVIER
ISBN: 978-0-12-803637-2
DOI: https://doi.org/10.1016/C2015-0-00087-9
CHAPTER: 14

- Hernández, R., **Morales, M.,** & Guetl, C. (2016). An Attrition Model for MOOCs: Evaluating the Learning Strategies of Gamification. In Formative Assessment, Learning Data Analytics and Gamification (pp. 295-311)

3.1.2 Breve resumen

En este trabajo se revisa la literatura existente sobre las tasas de deserción escolar y se analizan los factores de deserción y retención, la clasificación de grupos de estudiantes en línea abiertos y el embudo de la participación en un entorno de aprendizaje abierto. Además, este estudio proporciona los resultados de dos cursos impartidos por el Proyecto Telescopio (una iniciativa similar a Coursera o Edx) en la Universidad Galileo. Se realiza un análisis comparativo entre el método de aprendizaje convencional y el método de aprendizaje gamificado (lúdico).

3.1.3 Relación con la tesis

La publicación realiza un aporte al ObjEsp1**,** que busca estudiar y analizar el estado del arte del uso de CBT para la construcción de actividades de aprendizaje en un ambiente virtual. En este trabajo se utilizaron CBT y se analizó su comportamiento, aportando además resultados relacionado con la implementación de estrategias de aprendizaje.

3.2 Artículos en congresos internacionales

Datos de la publicación: **Morales, M.**, de la Roca, M., Alario-Hoyos, C., Plata, R. B., Medina, J. A., & Rizzardini, R. H. (2017). Perceived usefulness and motivation students towards the use of a cloud-based tool to support the learning process in a Java MOOC. International Conference MOOC-Maker 2017 ceur-ws.org/Vol-1993/9.pdf **Breve resumen:** El objetivo de este estudio fue investigar la percepción, motivación y utilidad de los estudiantes hacia el uso de una herramienta basada en la nube, llamada Codeboard en un MOOC de programación con Java. Los resultados mostraron la utilidad de incluir Codeboard para desarrollar actividades formativas, para comprobar el progreso del aprendizaje y el impacto de las mismas herramientas sobre el proceso de aprendizaje de los estudiantes reflejado en aspectos tales como la motivación, el aprendizaje y los beneficios percibidos.	**Relación con la tesis:** La publicación cumple el ObjEsp1, y ObjEsp3, presentando un análisis del estado del arte del uso de CBT para la construcción de actividades de aprendizaje en un ambiente virtual. Así mismo, el artículo expone el impacto de utilizar una CBT como parte de una serie de actividades de aprendizaje definidas para un MOOC. Los resultados presentados en este artículo, ponen en evidencia los principales beneficios de utilizar CBT, así como la percepción de utilidad y la motivación de los estudiantes hacia el uso de este tipo de herramientas. Permite aportar fundamentos para confirmar las preguntas de investigación RQ4 y RQ5 relacionadas a facilitar el proceso de aprendizaje del estudiante.
Datos de la publicación: De La Roca**, M., Morales,** M., Teixeira, A. M., Sagastume, F., Rizzardini, R. H., & Barchino, R. (2018). MOOCs as a Disruptive Innovation to Develop Digital Competence Teaching: A Micromasters Program edX Experience. European Journal of Open, Distance and E-learning, 21(2).	**Relación con la tesis:** La publicación realiza un aporte al ObjEsp4 de este trabajo de tesis. Implementando una serie de CBT en los diferentes MOOCs desarrollados en edX, con lo que se busca promover la comunicación y colaboración entre maestro-estudiante y estudiante-estudiante. La puesta en marcha de estos cursos, también permitió validar cuales

Breve resumen: Este artículo describe la experiencia de desarrollar un programa MicroMasters lanzado en la plataforma edX. Todos los MOOCs que componen este programa fueron diseñados con un enfoque colaborativo y pedagógico mediante la creación de unidades prácticas que permiten a los profesores aprender herramientas específicas basadas en la nube (CBTs), diseñar sus propias actividades de aprendizaje y aprender a incorporarlas en diferentes contextos. En cada uno de los MOOCs fueron utilizadas CBT para el desarrollo de actividades de aprendizaje.	son las estrategias de aprendizaje más efectivas y los aspectos que motivan el uso de las CBT (ObjEsp3)
Datos de la publicación: De La Roca, **M., Morales**, M., Amado-Salvatierra, H., Barchino, R., & Hernández, R. (2018). La efectividad del uso de simuladores para la construcción de conocimiento en un contexto MOOC. Conferencia Internacional MOOC-Maker 2018. Medellín, Colombia. **Breve resumen:** Este artículo presenta un ejemplo exitoso de integración de un simulador de circuitos en las actividades de aprendizaje de un MOOC. Los resultados de la primera edición muestran una evaluación muy positiva de la utilidad de este tipo de herramienta y como ésta puede apoyar a los estudiantes en su formación, brindándoles la oportunidad de practicar y experimentar lo aprendido en cada tema.	**Relación con la tesis:** Esta publicación está relacionada con el ObjEsp1, y ObjEsp3, presentando el estado del arte del uso de CBT para la construcción de actividades de aprendizaje en MOOCs. Evidencia los principales beneficios de utilizar CBT como recursos para la realización de actividades de aprendizaje. Brinda un panorama general en relación a la aceptación y adopción de este tipo de herramientas, en curso relacionado con temáticas más práctica. El uso del simulador permitió a los participantes del curso practicar y validar su aprendizaje de una forma dinámica e interactiva.
Datos de la publicación: Sagastume, F., **Morales, M.,** Sandoval, C., Amado, H., Plata, R. B., & Rizzardini, R. H. (2017). Desafíos y consideraciones prácticas en el diseño e implementación de un MOOC para la enseñanza de herramientas web 2.0. ATICA 2017. Universidad Católica del Norte, Medellín Colombia. pp 667-674 **Breve resumen:** Este artículo está enfocado en compartir los desafíos y consideraciones prácticas que se tuvieron al diseñar e implementar el MOOC "Tecnologías Digitales Emergentes para la Enseñanza Virtual" que forma parte del	**Relación con la tesis:** La publicación cumple el ObjEsp3, presentando la experiencia de utilizar CBT como recursos en las actividades de aprendizaje. Describiendo los desafíos y consideraciones prácticas tomadas en cuenta en el diseño e implementación de este tipo de herramientas. Esto permitió conocer la percepción y reacción de los estudiantes ante este tipo de recursos.

MicroMaster Program e-Learning: crea actividades y contenidos para la enseñanza virtual, que Universidad Galileo imparte actualmente en la plataforma edX en la modalidad self-paced. En este curso, se implementaron una serie de actividades de diseño y desarrollo de recursos utilizando herramientas web 2.0	
Datos de la publicación: **Morales, M.**, Hernández, R., & Gütl, C. (2014). Telescope, a MOOCs initiative in Latin America: Infrastructure, best practices, completion and dropout analysis. In Frontiers in Education Conference (FIE), 2014 IEEE (pp. 1-7). IEEE. DOI: 10.1109/FIE.2014.7044103. CORE (2017) =B **Breve resumen:** Este artículo presenta el proyecto Telescopio, organizado y alojado en la Universidad Galileo de Guatemala, iniciativa para la región latinoamericana con el mismo objetivo que Coursera o EdX. Primero se presenta y analiza el estado actual de los MOOCs, mostrando el progreso real, el alcance más amplio en el campo académico y su potencial como herramienta de apoyo a la educación en el contexto latinoamericano.	**Relación con la tesis:** Este trabajo aporta al análisis del estado del arte del uso de CBT para la construcción de actividades de aprendizaje en un ambiente virtual, enfocado principalmente al contexto latinoamericano. Los hallazgos de este artículo contribuyen principalmente a lograr el ObjEsp1.
Datos de la publicación: Rocael Hernández Rizzardini, **Miguel Morales**, Christian Gütl, and Vanessa Chang (2013). MOOCs Concept and Design using Cloud-based Tools: Spanish MOOCs Learning Experiences. In Proc. of LINC 2013 Conference, June 2013, Boston, USA **Breve resumen:** Este trabajo presenta la experiencia de implementar CBTs en dos MOOC desarrollados en la plataforma telescopio, fundada por Universidad Galileo. Describe principalmente la experimentación y los resultados de las dos experiencias, demostrando resultados prometedores en términos de aspectos motivacionales, emocionales y educativos.	**Relación con la tesis:** La publicación cumple con el ObjEsp1, ObjEsp2, y ObjEsp3, presentando además del estado del arte del uso de CBT en instituciones de educación superior, la solución a las preguntas de investigación, RQ4, RQ5 y RQ6, afirmando que el uso de CBT para el desarrollo de actividades de aprendizaje de un MOOC, facilita el proceso de aprendizaje del estudiante. Así mismo, confirma que la actitud de los estudiantes hacia el uso de las CBT está influenciada principalmente por la facilidad de uso y la utilidad percibida. Por último, se pudo comprobar que la identificación de la comunidad, motivación y creación de conocimiento,

Durante el artículo se presenta la estructura general del MOOC, así como los ejemplos de las actividades de aprendizaje implementadas en ambos cursos y los resultados obtenidos de esta acción.	influyen en la percepción de la utilidad de las CBT.

Tabla 2. Otras publicaciones relacionadas

4. Conclusiones y trabajo futuro

El objetivo de esta sección es presentar y discutir los resultados de investigación alcanzados en esta tesis doctoral. En la subsección 4.1 se analizan las contribuciones generales, relacionando principalmente los resultados obtenidos durante las diferentes publicaciones y los objetivos específicos presentados en la subsección 1.2. Por último, en la subsección 4.2 se describen las acciones puntuales a desarrollar como parte del trabajo futuro concerniente al uso de CBT en MOOCs.

4.1 Conclusiones

Esta investigación se centró principalmente en el desarrollo de un marco de trabajo para la creación y gestión de artefactos de aprendizaje haciendo uso de CBT, con el objetivo de mejorar la experiencia de aprendizaje de un estudiante en un MOOC.

A su vez, el estudio se ha dirigido a los siguientes objetivos específicos enunciados en la sección 1.2 del trabajo de investigación:

(1) Presentar una revisión bibliográfica acerca del uso de CBT para la construcción de actividades de aprendizaje en ambientes virtuales. Requiriendo la ampliación de las líneas de investigación relacionadas al uso y adopción de CBT en la educación superior, modelos que permiten evaluar la aceptación de tecnologías y el uso educativo que estás pueden tener en los procesos de enseñanza-aprendizaje.

En este sentido, durante el desarrollo de cada uno de los trabajos que conforman este compendio y en las publicaciones complementarias presentadas en la sección 3, se realizó una revisión holística de la literatura relacionada con el uso de CBT para la construcción de actividades de aprendizaje en ambientes virtuales; esta revisión muestra el uso potencial de estas herramientas en instituciones de educación superior, experiencias de uso, así como los aspectos técnicos a considerar en la integración de las CBT en los sistemas de gestión de aprendizaje (LMS). La revisión de literatura reflejada en los artículos descritos en las secciones 2.1, 2.2, y 2.3, evidencia un creciente uso de CBT en entornos virtuales por parte de las instituciones de educación superior, ofreciendo de esta forma, nuevas oportunidades para el aprendizaje virtual, a la vez que promueven un cambio en la forma que las personas aprenden. Las CBT, al ser gestionadas a través de la computación en la nube, ofrecen un alto grado de escalabilidad y flexibilidad, bridando a su vez, la posibilidad de acceder a los recursos, en cualquier momento y lugar. En general, varios autores coinciden en que las CBT promueven la creación de un ambiente idóneo para el desarrollo de la educación social, brindando espacios para la colaboración e interacción entre todos los participantes del proceso de aprendizaje.

(2) Identificar los principales factores que determinan la adopción de una CBT para la construcción de actividades de aprendizaje en un ambiente virtual, no haciendo diferenciación si son CBT gratuitas o de pago.

Para la propuesta del marco de trabajo, es indispensable evaluar si los usuarios finales aceptan y adoptan el uso de una CBT como recurso de apoyo para el desarrollo de actividades de aprendizaje en un MOOC. Así como evidenciar el uso educativo que podría tener en este tipo de entornos virtuales.

Para ello, se puede observar en el artículo 1 (sección 2.1), que el uso educativo de las CBT se explica desde la perspectiva de la adopción del estudiante. En este sentido, se demostró a través de un modelo de ecuaciones estructurales, que los principales factores que determinan la adopción de una CBT en un entorno virtual, son la utilidad, usabilidad, facilidad de condiciones, identificación con la comunidad y motivación, siendo la variable utilidad la más alta.

Además, si un estudiante adopta una CBT, existe una alta correlación de que la relacione con un uso educativo. En este sentido, como parte de la propuesta del marco de trabajo, el uso educativo se asocia con la taxonomía de Bloom. Los resultados obtenidos muestran que los estudiantes relacionan más estrechamente el uso de estas herramientas a las habilidades de pensamiento de orden inferior de la taxonomía, siendo estas, recordar, comprender y aplicar.

Por otra parte, el artículo 2 evidencia que la facilidad de uso y la utilidad percibida por parte de un estudiante MOOC influyen positivamente en la actitud de uso de la CBT. Además, se encontró que la identificación con la comunidad de estudiantes influye positivamente en la creación de conocimiento y la motivación.

En base a lo anterior, se puede indicar que los principales actores del proceso de enseñanza-aprendizaje se encuentran interesados en el uso de CBT innovadoras, altamente visuales y atractivas para el aprendizaje, sin embargo, es importante resaltar la necesidad de contar con un entorno educativo que permita integrar varias CBT de tal forma que puedan ser orquestadas y gestionadas desde la misma plataforma MOOC, permitiendo la generación de actividades de aprendizaje que promuevan una dinámica diferente a lo definido normalmente en un MOOC.

(3) Identificar cuál es el impacto de utilizar CBT, en el diseño de actividades de aprendizaje para un MOOC. Evaluando, cuales son las estrategias de aprendizaje más efectivas y los aspectos que motivan el uso de las mismas, durante la participación de un MOOC.

Como se da a conocer en los trabajos relacionados presentados en los artículos 1 y 2 (secciones 2.1 y 2.2) la mayoría de plataformas MOOC, no proporcionan herramientas dinámicas e interactivas para la creación de actividades de aprendizaje que permitan enriquecer el proceso de aprendizaje, rompiendo el esquema monótono de visualización de videos y realización de exámenes auto calificables. En este sentido, se demostró a lo largo de este compendio que el uso de CBT en MOOCs tiene un valioso impacto en la mejora de los procesos de aprendizaje y la experiencia del estudiante, así como una amplia variedad de beneficios en diferentes aspectos. Los resultados de la investigación, así como los evidenciados en las diferentes experiencias presentadas en la literatura, mostraron que las CBT mejoran la motivación de los estudiantes para aprender y completar el curso, reduciendo en gran manera, las altas tasas de abandono en MOOCs.

A continuación, la tabla 3 presenta un listado de beneficios identificados al utilizar CBT como recurso de apoyo para el desarrollo de actividades de aprendizaje en MOOCs. Los beneficios se clasifican desde la perspectiva del estudiante, profesor y técnico u organizativo.

Vista de estudiantes	Vista de profesores	Vista técnico y organizativo
Aumentan la motivación para aprender	Permiten una mejor evaluación y seguimiento del alumno	Reducen el tiempo de desarrollo, mantenimiento y actualizaciones.
Generan mayor interés y compromiso a la hora de realizar las actividades de aprendizaje	Brindan formas alternas de entrega de información y conocimientos a los alumnos.	Son altamente escalables y flexibles
Mejoran la comunicación y colaboración entre los participantes del MOOC	Mejoran la interactividad en el MOOC	Permiten la integración con diferentes plataformas MOOC
Favorecen a la adquisición y retención de conocimientos, de forma dinámica e interactiva	Potencializan el proceso de enseñanza-aprendizaje	

Tabla 3. Beneficios de utilizar CBT en MOOCs

Como se puede observar, el impacto de utilizar CBT en el desarrollo de actividades de aprendizaje es muy grande desde cualquier perspectiva de análisis.

En lo que respecta a la motivación y el nivel de uso de diferentes estrategias cognitivas y metacognitivas, reflejadas en las actividades de aprendizaje construidas con el apoyo de CBT, el artículo 3, muestra una alta correlación entre el valor de las tareas que los estudiantes dan a las tareas de aprendizaje, las motivaciones intrínsecas para tomar el curso, y la eficiencia y el buen desempeño que esperan de ellos mismos. Entre las estrategias de aprendizaje mejor valoradas descritas en la sección 2.3, se resaltan dos de ellas, (a) Las estrategias de autorregulación, que tienen roles muy importantes, tales como planificar las actividades a aprender y monitorear su propio aprendizaje y (b) Las estrategias de elaboración, que consisten en establecer conexiones entre los temas aprendidos. Contar con una estrategia de aprendizaje adecuada para el desarrollo de actividades en MOOCs, probablemente aumentará el compromiso con la experiencia de aprendizaje.

(4) Analizar cómo influye el uso de CBT, para el mejoramiento de la comunicación y colaboración entre maestro-estudiante, estudiante-estudiante y estudiante-maestro, en un entorno MOOC.

Después de revisar y analizar los datos presentados en la sección 2.1, se demuestra que, el uso de una CBT como recurso de apoyo para la elaboración de actividades de aprendizaje en un MOOC, mejoran la comunicación entre estudiante y estudiante. Sin embargo, para el mejoramiento de la comunicación y colaboración entre maestro-estudiante, los resultados sugieren que no representan ningún beneficio.

(5) Proponer un marco de trabajo para la creación y gestión de actividades de aprendizaje, utilizando CBT asociadas con la taxonomía digital de Bloom, facilitando al profesor la elección de la CBT, la definición de los objetivos didácticos para el diseño de la actividad y los métodos de evaluación que permitan evidenciar el aprendizaje del estudiante.

Dentro del proceso de investigación se planteó el desarrollo de diferentes escenarios que permitieran utilizar distintas CBT para la generación de actividades de aprendizaje en MOOCs, y a su vez se evaluará la efectividad de las herramientas para el desarrollo de conocimiento; así como los aspectos emocionales, motivacionales y de usabilidad, con el objetivo de inferir sobre su posible adopción, uso, eficiencia y potencial.

Adicionalmente, se buscó explicar el uso educativo de las CBT en términos de su adopción y aplicación para el desarrollo de actividades de aprendizaje, en base a la taxonomía digital de Bloom que proporciona un marco para enfocarnos en lo que esperamos que los estudiantes aprendan.

En base a los resultados obtenidos, se propone un marco de trabajo para la creación y gestión de artefactos de aprendizaje haciendo uso de CBT. Ver figura 1.

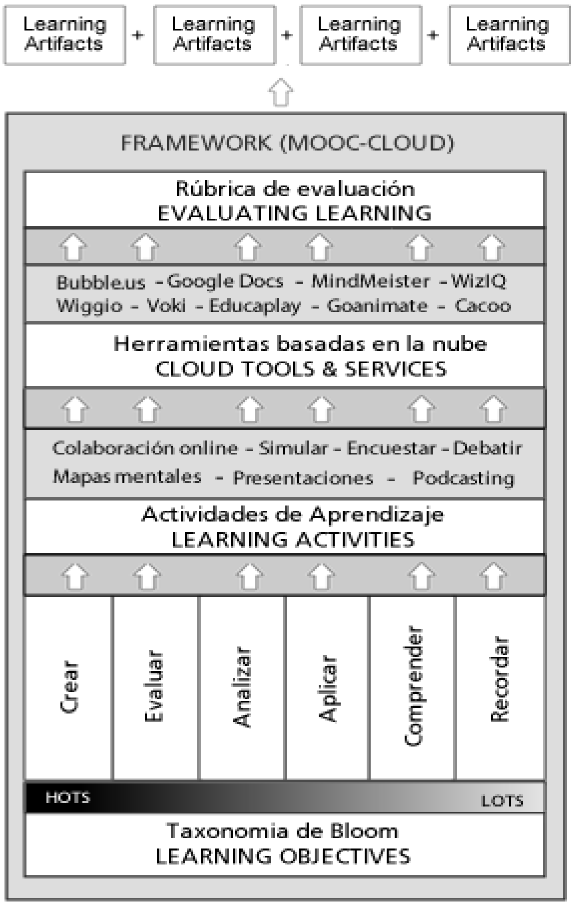

Figura 1. Marco de trabajo propuesto

El objetivo principal de este marco de trabajo es establecer una estructura metodológica que permita visualizar el alcance y las limitaciones que puede tener el uso de una CBT en un MOOC. El marco está compuesto por tres apartados, (a) Diseño de actividades de aprendizaje: su función es facilitar la definición de los objetivos didácticos para el diseño de la actividad. Para ello, se plantea que el profesor seleccione los niveles cognitivos principales asociados a la taxonomía de Bloom (habilidades de pensamiento de orden inferior o superior) que le permitan lograr alcanzar los objetivos planteados. A partir de esta selección, el profesor podrá escoger un tipo de actividad de aprendizaje (definidas por objetivo/fin didáctico) que potencialice la obtención de dicha habilidad.

(b) Herramientas basadas en la nube: este apartado provee al profesor de un catálogo de CBT categorizadas por su funcionalidad y asociación con el desarrollo de las habilidades de pensamiento de orden inferior o superior de la taxonomía de Bloom, facilitando de esta forma la elección de la CBT. (c) Rúbrica de evaluación: provee al profesor de una serie de criterios y estándares de evaluación, relacionados con los objetivos de aprendizaje, que permiten valorar el aprendizaje, los conocimientos y las competencias, alcanzadas por el estudiante. Con lo anterior, se pretende crear artefactos de aprendizaje que permitan evidenciar al estudiante de un MOOC el conocimiento adquirido.

En conclusión, esta tesis muestra una serie de casos de estudio prácticos en donde se implementa el marco de trabajo propuesto para la creación y gestión de artefactos de aprendizaje haciendo uso de CBT, evidenciando los factores que determinan la adopción de una CBT, describiendo el impacto y los beneficios de utilizar CBT en el diseño de actividades de aprendizaje para un MOOC y analizando cómo influye el uso de CBT, para el mejoramiento de la comunicación y colaboración entre los diferentes actores de un MOOC.

4.2 Trabajo futuro

El trabajo realizado en esta tesis doctoral, ha permitido la identificación de oportunidades de mejora en relación a temas de orquestación y gestión de actividades de aprendizaje en ambientes cloud, así como en temas relacionados a la interoperabilidad de las CBT e integración de este tipo de recursos en plataformas MOOC como edX.

Lo anterior, ha permitido plantear el desarrollo de un XBlock (arquitectura de componentes diseñada para facilitar la creación de nuevas experiencias educativas en línea dentro de una plataforma Open edX) que permita la aplicación del marco de trabajo propuesto, de tal forma que un docente puede activarlo, y desde edX, a través de diferentes interfaces, pueda seleccionar la habilidad de orden superior o inferior de la taxonomía de Bloom que se desea desarrollar, le presente un conjunto de plantillas de actividades de aprendizaje que faciliten la definición de los objetivos didácticos, le muestre una recomendación de una CBT adecuada para este fin, y despliegue la actividad implementada en la CBT y visualizada desde edX, así como la rúbrica de evaluación adecuada. De esta forma un profesor podría orquestar y gestionar sus actividades de aprendizaje de una forma integral, de tal manera que los resultados de aprendizaje asociados a la actividad de aprendizaje se vieran reflejados en las asignaciones y ponderaciones del curso. Así mismo, el estudiante no tendría necesidad de gestionar diferentes usuarios y accesos (uno diferente para cada CBT que se utilice durante el curso), y también eliminaría la necesidad de salir del entorno de la plataforma para hacer uso de la CBT.

De igual manera, se detectaron como futuras líneas de investigación, (a) el análisis del aprendizaje (learning analytics) aplicado al proceso de la construcción de artefactos de aprendizaje. Considerando, que toda la orquestación, gestión e implementación de actividades de aprendizaje apoyadas con el uso de CBT se llevaría a cabo desde la plataforma MOOC, se facilita el registro del comportamiento de los estudiantes frente al uso de CBT, así como en temas relacionados a la frecuencia de acceso, interacciones, foros de discusión, entre otros aspectos.

La segunda línea investigación estaría dada por (b) el desarrollo de portafolios digitales basados en artefactos de aprendizaje que permitan demostrar las destrezas, habilidades, experiencias y competencias desarrolladas por parte del estudiante.

5. Referencias bibliográficas

Alario-Hoyos, C., Kloos, C.D., Estévez-Ayres, I., Fernández-Panadero, C., Blasco, J., Pastrana, S., Villena-Roman, J. (2016). Interactive activities: the key to learning programming with MOOCs. In Proceedings of the EUROPEAN STAKEHOLDER SUMMIT on experiences and best practices in and around MOOCs (EMOOCS 2016).

Alario-Hoyos, C., Estévez Ayres, I., Delgado Kloos, C., Crespo García, R.M., Villena Román, J., Ruiz Magaña, J., (2017) Integration of External Tools to Foster Learner Interaction in MOOCs: The Example of Codeboard *Actas de la International Conference MOOC-Maker 2017*, MOOC-Maker 2017, pp. (1-10).

Anderson, L., & Krathwohl, D., (2001). "A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives". New York, NY, USA: Longman.

Aroyo, L. M., Dolog, P., Houben, G. J. P. M., Kravcik, M., Naeve, A., Nilsson, M., & Wild, F. (2006). Interoperability in personalized adaptive learning. Journal of Educational Technology & Society, 9(2), (pp. 4-18).

Bates, T., (2011). "Understanding web 2.0 and its implications for education". In Lee, M. and McCoughlin, C. (Eds.): Web 2.0-Based E-Learning: Applying Social Informatics for Tertiary Teaching, pp. (22-41), Information Science Reference, Hershey PA.

Bein, D., Bein, W., & Madiraju, P. (2009). The impact of cloud computing on web 2.0. Economy Informatics Journal, 9(1). Retrieved from http://www.egr.unlv.edu/~bein/pubs/eij-final_Bein_Masiraju.pdf

Bozkurt, Aras; Keskin, Nilgun & de Waard, (2016). "Research Trends in Massive Open Online Course ¨ (MOOC)". Theses and Dissertations: Surfing the Tsunami Wave. Open Praxis, 8(3) (pp. 203–221)

Daniel, J., (2012). "Making Sense of MOOCs: Musings in a Maze of Myth, Paradox and Possibility", Journal of Interactive Media in Education.

De la Roca, M., Morales M., Teixeira, A., Hernández, R., & Amado-Salvatierra, H., (2018). "The Experience of Designing and Developing an edX's MicroMasters Program to Develop or Reinforce the Digital Competence on Teachers". Learning with MOOCS (LWMOOCS), (pp. 34-38).

Forment, M. A., Guerrero, M. J. C., Mayol, E., Piguillem, J., Galanis, N., García-Peñalvo, F. J., & González, M. Á. C., (2012). "Docs4Learning: Getting Google Docs to work within the LMS with IMS BLTI," Journla of Universal Computer Science, 18, 11), pp (1483- 1500).

Guetl, C., Rizzardini, R. H., Chang, V., and Morales, M., (2014a). "Attrition in MOOC: Lessons learned from drop-out students". In Learning Technology for Education in Cloud. MOOC and Big Data. Springer, (pp. 37-48).

Guetl, C., Chang, V., Hernández Rizzardini, R., & Morales, M., (2014b). "Must we be concerned with the Massive Drop-outs in MOOC? An Attrition Analysis of Open Courses". In Proceedings of International Conference of Interactive Collaborative Learning (pp. 1–8).

Hernández, R., Guetl, C., & Chang, V., (2013). "MOOCs Concept and Design using Cloud-based Tools:

Spanish MOOCs Learning Experiences". The Sixth Conference of MIT's LIT Consortium, Cambridge, USA.

Hernández, R., Guetl, C., Chang, V., & Morales, M. (2014a). MOOC in Latin America: Implementation and Lessons Learned. The 2nd International Workshop on Learning Technology for Education in Cloud, (pp.147–158).

Hernández, R.; Guetl, C.; & Amado-Salvatierra, H., (2014b). "Cloud Learning Activities Orchestration for MOOC Environments. In Learning Technology for Education in Cloud". MOOC and Big Data Vol. 446 CCIS, (pp. 25–36).

Hernández, R., & Guetl, C. (2015). Towards a Flexible Cloud Education Environment - A Framework for E-learning. Fonseca D., Redondo E. (Eds.). Handbook of Research on Applied E-Learning in Engineering and Architecture Education.

Ministerio de Educación, Cultura y Deporte. Resolución de 26 de noviembre de 2014, de la Comisión Nacional Evaluadora de la Actividad Investigadora, por la que se publican los criterios específicos aprobados para cada uno de los campos de evaluación. (2014)

Morales, M., Hernández, R., & Gütl, C. (2014). Telescope, a MOOCs initiative in Latin America: Infrastructure, best practices, completion and dropout analysis. In Frontiers in Education Conference (FIE), 2014 IEEE (pp. 1-7). IEEE.

Morales Chan, M., Hernandez Rizzardini, R., Barchino Plata, R., & Amelio Medina, J., (2015). "MOOC using cloud-based tools: A study of motivation and learning strategies in Latin America". International Journal of Engineering Education, 31(3), (pp. 901–911).

Morales, M., de la Roca, M., Alario-Hoyos, C., Plata, R. B., Medina, J. A., & Rizzardini, R. H. (2017). Perceived usefulness and motivation students towards the use of a cloud-based tool to support the learning process in a Java MOOC. International Conference MOOC-Maker 2017 ceur-ws.org/Vol-1993/9.pdf

Morales Chan, M., Barchino Plata, R., Amelio Medina, J., Alario-Hoyos, C., y Hernandez Rizzardini, R., (2018). "Modeling Educational Usage of Cloud-Based Tools in Virtual Learning Environments". *IEEE Access*, vol. 7, (pp. 13347-13354).

Olmedilla, D., Saito, N., & Simon, B. (2006). Interoperability of Educational Systems. Editorial of Special Issue. Educational Technology & Society, 9(2), (pp. 1-3).

Pérez, M.; Maldonado, J.; & Morales, N., (2016). "WPD1.1 Estado del arte de adopción de MOOCs en la Educación Superior en América Latina y Europa". MOOC-Maker Construction of Management Capacities of MOOCs in Higher Education, (pp. 4-8).

Shah, D., (2018). "By The Numbers: MOOCS in 2018". Class Central. [Online] Accesible: https://www.class-central.com/report/mooc-stats-2018/. Accedido el 14 de diciembre 2018

Shehadeh, A. & Gütl, C., (2016). "WDP1.10 The application of cloud-based tools in MOOCs: Experiences and findings". MOOC-Maker Construction of Management Capacities of MOOCs in Higher Education.

Shehadeh, A., Amado, H., Morales, M., Hernández, R., and Gütl, C., (2018). "The adoption of cloud-based tools in MOOC settings - advantages and challenges". RE@D - Revista de Educação a Distância e Elearning, Volumen No.1.

Universidad de Alcalá. Reglamento de elaboración, autorización y defensa de la Tesis Doctoral. Aplicación del RD 99/2011, de 28 de enero. BOE 10 de febrero de 2011. Aprobado en la Comisión de Estudios Oficiales de Posgrado y la Comisión de Doctorado en Sesión de 18 de enero de 2012. (2011)

Usluel, Y. K., & Mazman, S. G., (2009). "Adoption of Web 2.0 tools in distance education". Procedia-Social and Behavioral Sciences, 1(1), pp. 818-823.

Washington, L.; Sequera, J. L., (2015). Collaboration in the Cloud for Online Learning Environments: An Experience Applied to Laboratories. Creative Education, 6, (pp. 1435–1445).

6. Lista de tablas y figuras