SIIE 2024

MIGUEL ÁNGEL CONDE
MARIA DO ROSÁRIO RODRIGUES
FRANCISCO JOSÉ GARCÍA-PEÑALVO

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Editors:

Miguel Ángel Conde González
Universidad de León – Universidad de Salamanca

Maria do Rosário Rodrigues
Instituto Politécnico de Setúbal, Portugal

Francisco José García-Peñalvo
Universidad de Salamanca – ADIE President

SIIE 2024 is organized by the Robotics Group of the Universidad de León and Research GRoup in InterAction and eLearning (GRIAL) of the Universidad de Salamanca
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Volume Editors

Miguel Ángel Conde González

Robotics Group
Dpto. Ingenerías Mecánica, Informática y Aeroespacial
Universidad de León
MIC Building, Campus de Vegazana, s/n
24071 León, Spain
(+34) 987 293418
Email: mcong@unileon.es

GRIAL Research Group
Dpto. Informática y Automática
Universidad de Salamanca
Escuela Politécnica Superior de Zamora
Avenida de Requejo, 33
49029 Zamora, Spain
Email: mconde@usal.es

Maria do Rosário Rodrigues

Dpto. Ciências e Tecnologias
Escola Superior de Educação
Instituto Politécnico de Setúbal
Setúbal, Portugal
Email: rosario.rodrigues@ese.ips.pt

Francisco José García-Peñalvo

Francisco José García-Peñalvo
Dpto. Informática y Automática
Instituto Universitario de Ciencias de la Educación
Universidad de Salamanca
Salamanca, Spain
(+34) 923 294400 ext. 6095
Email: fgarcia@usal.es

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SIIE 2024 Preface

Welcome to the book of Summaries *from the XXVI International Symposium on Computers in Education – SIIE 2024*, a meticulously curated collection of research summaries presented at the Symposium, which forms part of the VII Spanish Congress on Informatics (CEDI 2024). This book aims to provide an accessible yet comprehensive overview of the pioneering work and latest advancements in educational informatics, showcasing innovative research and its practical applications.

SIIE has established itself as a premier international forum where researchers, developers, institutional representatives, and educators converge to share their knowledge, experiences, and the latest developments in learning technologies. The 26th edition of the Symposium, held in the city of A Coruña, Spain, from June 19-21, 2024, places a particular emphasis on the application of Artificial Intelligence (AI) in education, not as something new [1, 2] but as a disruptive technological trend [3]. This focus is particularly pertinent in our contemporary society, where AI's potential to transform educational practices and outcomes is increasingly recognized [4].

In addition to AI, the Symposium covers a broad spectrum of topics integral to educational technology's evolution. These include systems and platforms for eLearning and blended learning, innovative methodologies, augmented reality, virtual reality, remote laboratories, etc. By encompassing such a wide range of subjects, SIIE facilitates a holistic exploration of the ways technology can enhance and revolutionize education.

This year, we received 40 high-quality contributions from researchers around the globe. Following a rigorous peer-review process, 32 papers were selected for publication and presentation. These contributions represent the forefront of research in educational informatics, offering insights into various aspects such as educational computer science, learning analytics, collaborative learning, tools, and methodologies to support education, and the design and evaluation of educational software.

The Symposium's program is structured to provide a comprehensive exploration of these topics through various sessions, each focusing on distinct areas of interest:

- **Computers in Education:** This session includes discussions on cross-platform collaborative graphical editors in engineering education, creating virtual conversational environments for e-learning, and using social media as learning environments. It also features a project on visual narratives of women's legacy in computer science.
- **Artificial Intelligence in Education and Learning Analytics:** Topics include student opinions on using large language models in database courses, enhancing collaborative scenarios with UX methods and AI tools, and analyzing visual attention in online learning. The session also covers using biometrics and behavioral modeling to detect distractions in online learning.
- **Projects and Inclusion:** This session highlights innovative projects such as an online pilot course for inclusive museum education, a unified digital platform for cultural heritage access, initiatives to inspire STEM vocations among indigenous students, and projects related to how to foster STEAM Education

among disabled students by using robotics. It also discusses the challenges of digitizing course catalogs in Erasmus+ contexts.

- **STEAM, Computational Thinking, and Teacher Training:** Presentations include materials for teacher training in ScratchJr, systematic approaches to cataloging learning resources, and methods for predicting analysis indicators in CSCL environments. There is also an evaluation of the usability of a virtual environment for assessing learning outcomes.
- **Doctoral Consortium:** This session provides a platform for PhD students to present their preliminary research. Topics include environments to promote learning motivation in distance education, interactive web environments for learning programming at the high school level, and generative AI chatbots for self-regulated learning measurement and intervention.

Each summary in this volume distills complex research findings into concise and insightful narratives, making them accessible to a broad audience, including researchers, educators, students, and policymakers. The summaries aim not only to inform but also to inspire further research and innovation in the field.

We are confident that this compendium will be a valuable resource, fostering knowledge dissemination and collaboration among those dedicated to advancing educational technology. The contributions presented here highlight the dynamic and interdisciplinary nature of educational informatics, reflecting the diverse and evolving landscape of the field.

As you explore the summaries, we invite you to immerse yourself in the cutting-edge research and innovative ideas shaping the future of education. Whether seeking new insights, deepening your understanding, or aiming to spark new research ideas, we hope this volume provides the inspiration and information you seek.

Thank you for joining us in this journey through the latest advancements in educational informatics. We look forward to the ongoing dialogue and collaboration these contributions will inspire.

Miguel Á. Conde, Maria do Rosário Rodrigues and Francisco J. García-Peñalvo (coeditors of SIIE 2024 Book of Abstracts)

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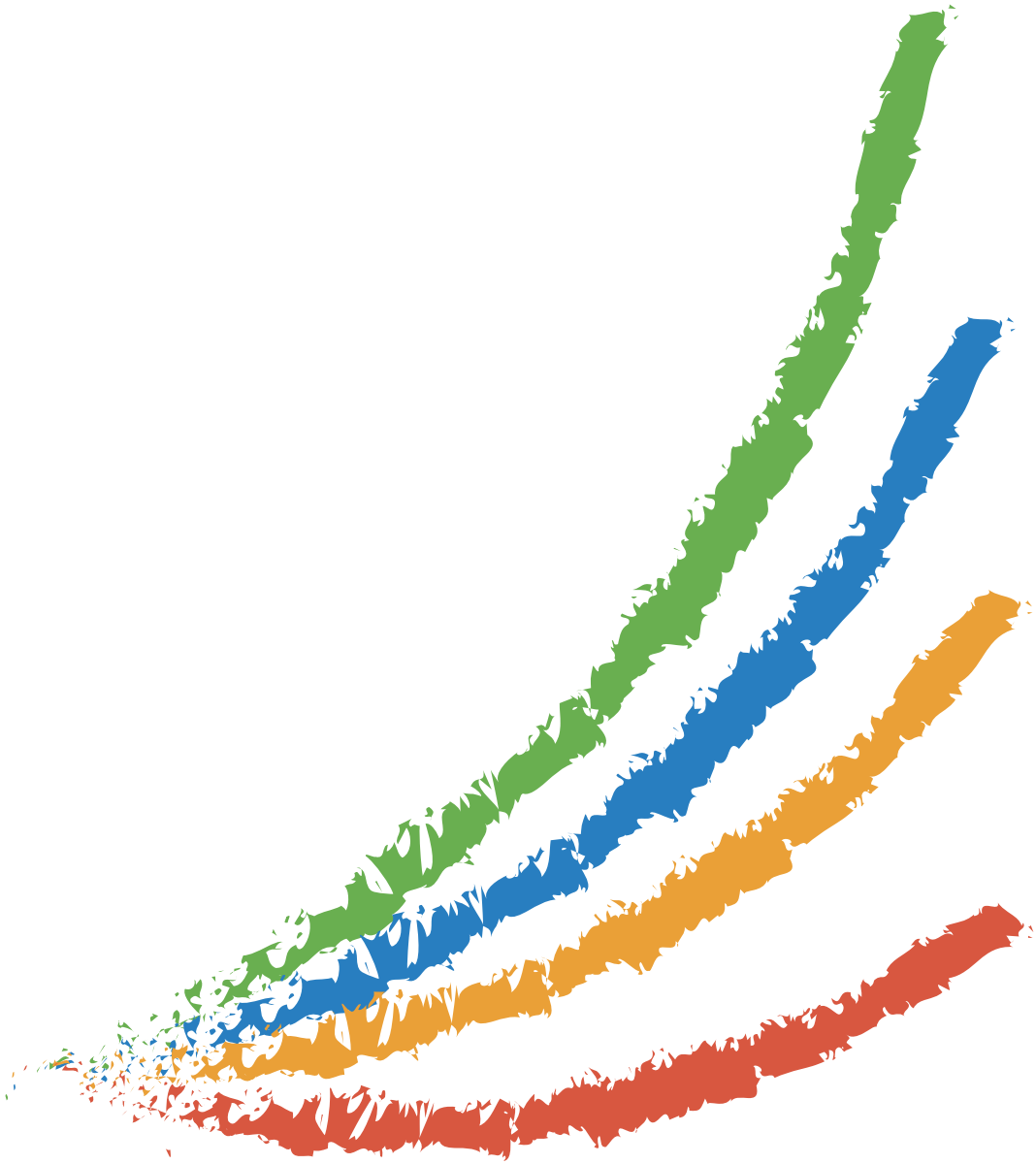
Computers in Education



MOOC como instrumento para a promoção da conservação e restauração de nascentes aplicada à Educação Ambiental

Daniel Augusto Bolsanelo Belcavello
Programa de Pós-Graduação em Educação em Ciências e Matemática
Instituto Federal do Espírito Santo
Vila Velha - Brasil
0000-0003-1518-8889

ManoelAugusto Polastreli Barbosa
Programa de Pós-Graduação em Educação em Ciências e Matemática
Instituto Federal do Espírito Santo
Vila Velha - Brasil
0000-0003-1162-0670

Jeane Santos de Jesus
Programa de Pós-Graduação em Educação em Ciências e Matemática
Instituto Federal do Espírito Santo
Vila Velha - Brasil
0000-0001-6075-438X

Antonio Donizetti Sgarbi
Programa de Pós-Graduação em Educação em Ciências e Matemática
Instituto Federal do Espírito Santo
Vila Velha - Brasil
0000-0003-2955-3939

I. INTRODUÇÃO

Os MOOCs emergem como protagonistas na esfera educacional contemporânea, provendo uma plataforma flexível e abrangente para a disseminação de conhecimentos em diversas áreas. No âmbito específico da Educação Ambiental, a perspicaz aplicação dos MOOCs oferece uma oportunidade ímpar de catalisar a sensibilização e ação sustentável em uma escala global [1].

Possuindo potencial em estabelecer experiências educacionais inclusivas em uma perspectiva global [2], os MOOCs no contexto da Educação Ambiental, revelam-se essenciais, pois as problemáticas ambientais permeiam cada ponto do globo; podendo assim, capacitar participantes de diversas origens a compreenderem, colaborarem e contribuírem para soluções sustentáveis, transgredindo barreiras geográficas e culturais.

Deste modo, o estudo apresentado tem como objetivo abordar a criação de um MOOC com ênfase na Educação Ambiental, sob enfoque do tema Conservação e Preservação de Nascentes, explorando as práticas pedagógicas, estratégias de design instrucional e tecnologias educacionais utilizadas na construção desse curso, que visa promover a sensibilização ambiental e a adoção de comportamentos sustentáveis, contribuindo para a expansão do campo da Educação Ambiental

II. MATERIAIS E MÉTODOS

O estudo em questão é de abordagem qualitativa [3], de natureza aplicada e quanto aos seus objetivos, configura-se como exploratório [4]. Baseia-se na discussão sobre a construção do MOOC "Conservação e restauração de nascentes aplicada a Educação Ambiental", de carga horária total de 20 horas, ofertado no idioma português, com nível de dificuldade intermediário e classificado na grande área de conhecimento do CNPq: Ciências Humanas.

Para elaboração do MOOC, foi escolhido o Modelo ADDIEM [16], acrônimo de Analysis, Design, Development, Implementation e Evaluation in MOOCs, podendo ser traduzido como Análise, Desenho (ou Projeto), Desenvolvimento, Implementação e Avaliação. Suas etapas podem ser descritas de forma simplificada.

A Figura 1 retrata de forma simplificada o modelo ADDIEM, podendo ser observado o que é desenvolvido em cada etapa de produção deste MOOC.

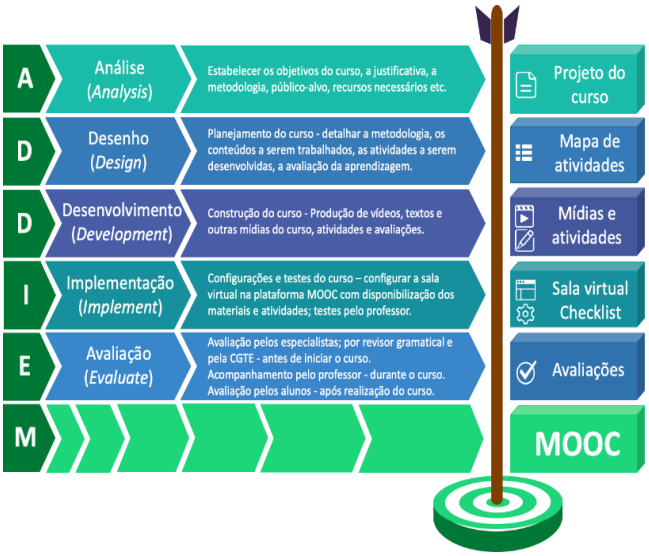


Fig. 1. Representação do Modelo ADDIEM. [5].

III. RESULTADOS E DISCUSSÕES

Este curso, tendo como objetivo principal promover a formação dos participantes quanto ao desenvolvimento de uma abordagem integrada e sustentável na conservação e preservação de nascentes, reconhecendo seu papel elementar na manutenção dos ecossistemas aquáticos e no abastecimento de água para comunidades locais, aborda os princípios e práticas fundamentais da conservação e restauração de nascentes, com ênfase na aplicação desses conhecimentos à Educação Ambiental. Compreendendo a temática central focada na Conservação de Nascentes, os participantes têm a oportunidade de adquirir habilidades para promover a preservação e a sustentabilidade dos recursos hídricos.

O MOOC Conservação e Preservação de Nascente aplicado à Educação Ambiental está organizado da seguinte forma:

TABLE I. ORGANIZAÇÃO DO MOOC CONSERVAÇÃO E PRESERVAÇÃO DE NASCENTES APLICADO À EDUCAÇÃO AMBIENTAL

Tópico	Descrição	Conteúdo	Atividade e recurso	Nota
Boas-vindas	Apresentação do curso e seus objetivos	Vídeo de boas-vindas e	Vídeo dos autores.	

		apresentação do curso.		
		Apresentação: Fórum de discussão online para que os participantes compartilhem suas expectativas e experiências prévias.	Livro Texto e Imagem Interativa no h5p.	
Módulo 1	Introdução às nascentes e seu papel nos ecossistemas aquáticos	Definição e importância das nascentes nos ecossistemas aquáticos.	Livro Texto e Imagem Interativa no Genially.	
		Impacto das atividades humanas e mudanças climáticas nas nascentes.	Vídeo sobre o assunto.	
		Conexão entre nascentes, bacias hidrográficas e abastecimento de água.	Livro Texto e Imagem Interativa.	
		Questionário.	Questionário do tópico.	10
Módulo 2	Desafios e ameaças à conservação de nascentes	Identificação e análise dos principais desafios enfrentados pelas nascentes.	Livro Texto e Imagem Interativa no Genially.	
		Impacto de práticas agrícolas, urbanização e poluição na degradação das nascentes.	Livro Texto.	
		Análise crítica das ameaças emergentes e sua relação com mudanças climáticas.	Livro Texto e Imagem Interativa.	
		Questionário	Questionário do tópico.	10
Módulo 3	Técnicas de restauração sustentável de nascentes	Reflorestamento e recomposição de áreas degradadas.	Livro Texto.	
		Manejo sustentável do solo e vegetação.	Livro Texto e Imagem Interativa no Genially.	
		Integração de ecossistemas aquáticos e terrestres na restauração.	Livro Texto e Imagem Interativa no Genially.	
		Questionário.	Questionário do tópico	10
Módulo 4	Estudos de Caso e Boas Práticas	Análise de casos reais de conservação e restauração de nascentes.	Vídeo sobre o assunto e livro texto.	
		Experiências bem-sucedidas de engajamento comunitário.	Vídeo sobre o assunto e livro texto.	
Avaliação Final	Questionário Avaliativo Final	A avaliação será por meio de questionário de múltipla escolha com objetivo de certificar o participante que obter nota igual ou superior a 60%.	Avaliação Final.	70

Fonte: os autores (2023).

O curso propõe uma metodologia que contempla momentos de estudos individuais com atividades baseadas em auto instrução, exibição de vídeo aulas, animações, textos, jogos interativos, estudos dirigidos e questionários online, além de fórum colaborativo, possibilitando troca de experiências com outros cursistas, que levam a momentos de reflexão sobre sua prática cotidiana no meio ambiente.

IV. CONSIDERAÇÕES FINAIS

Espera-se que os participantes alcancem uma compreensão abrangente dos conceitos fundamentais relacionados às nascentes, reconhecendo sua importância nos ecossistemas aquáticos e compreendendo os desafios enfrentados devido às atividades humanas e mudanças climáticas. Além disso, estima-se que os participantes serão capazes de analisar criticamente estudos de caso, aplicar seus conhecimentos na elaboração de planos abrangentes de conservação de nascentes e demonstrar um compromisso renovado com a sustentabilidade hídrica, tornando-se agentes ativos na preservação desses recursos vitais em suas comunidades.

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Educação matemática inclusiva e deficiência intelectual: uma revisão sistemática de literatura a partir da utlização de uma ferramenta tecnológica

Elcio Pasolini Milli
Programa de Pós-Graduação em Educação em Ciências e Matemática
Secretaria de Estado de Educação do Espírito Santo
Vitória – Brasil
0000-0002-6459-6291

Edmar Reis Thiengo
Programa de Pós-Graduação em Educação em Ciências e Matemática
Instituto Federal do Espírito Santo
Vitória - Brasil
0000-0002-4423-4939

A diversidade do cenário educacional brasileiro tem sido realçada cada vez mais em nossas salas de aula. O acesso, permanência e êxito da pessoa com deficiência, transtorno global do desenvolvimento ou altas habilidades/superdotação deve ser garantido em nossas escolas. De fato, o público-alvo da educação especial tem crescido no panorama educacional brasileiro. De acordo com as Sinopses Estatísticas da Educação Básica referente ao Censo Escolar realizado no ano de 2019, "o número de matrículas da educação especial chegou a 1,3 milhão em 2019, um aumento de 34,4% em relação a 2015" [1]. Ao considerar os alunos com deficiência intelectual matriculados em classes comuns, envolvemos a vida escolar de mais da metade do público da educação especial. Estamos falando de 709.683 estudantes.

Considerando esse cenário, apresentamos os resultados de uma revisão sistemática de literatura (RSL) cujo objetivo foi traçar um perfil das pesquisas que mapearam trabalhos envolvendo aprendizagens de conceitos matemáticos de alunos com deficiência intelectual e suas contribuições para o campo da educação matemática inclusiva. Essa revisão foi desenvolvida como parte de uma pesquisa de doutorado profissional vinculada ao Programa de Pós-graduação em Educação em Ciências e Matemática (Educimat) do Instituto Federal do Espírito Santo (Ifes) - Brasil.

Ao discutir educação inclusiva é necessário conceber um processo dinâmico, em evolução e em constante transformação. A Organização das Nações Unidas para a Educação, a Ciência e a Cultura - Unesco aponta um caminho: "Reconhecer que a educação inclusiva é um processo contínuo que visa oferecer qualidade da educação para todos, respeitando a diversidade e as diferentes necessidades e habilidades, características e expectativas de aprendizagem dos alunos e comunidades, eliminando todas as formas de discriminação" [2].

Ao considerar a pessoa com deficiência intelectual precisamos sobretudo conhecê-la, entender suas particularidades e potencialidades, e respeitar a diferença [3]. Segundo a American Association on Intellectual and Developmental Disabilities – AAIDD [4], a deficiência intelectual se caracteriza por limitações no funcionamento intelectual e no comportamento adaptativo, que abrange as habilidades sociais e práticas cotidianas, com início antes dos 22 anos de idade.

No entanto, entendemos a deficiência intelectual para além de um olhar médico/biológico, que está relacionada às práticas socioculturais. Tendo em vista as pesquisas desenvolvidas no cenário educacional junto àquelas mapeadas nesse texto, um dos caminhos em construção é a perspectiva adotada na educação matemática inclusiva, presente na literatura educacional e nas práticas pedagógicas.

Nos estudos sobre a Defectologia [5], o autor faz reflexões a frente de seu tempo e discorre sobre as questões das diferenças para além de um padrão proposto pela normalidade. "A criança cujo desenvolvimento está complicado pelo defeito não é simplesmente uma criança menos desenvolvida que seus coetâneos normais, mas desenvolvido de outro modo" [5]. Essa concepção valoriza o entendimento que a deficiência não é uma desvantagem, concebida por um desenvolvimento inferior, mas sim entendida como outra maneira de pensar, ser e agir.

Diante dessa perspectiva, muitas pesquisas nessa área do conhecimento ainda se encontram em fase de experimentação de materiais didáticos, de recursos tecnológicos e espaços de tentativas e aperfeiçoamentos das práticas pedagógicas voltadas para a educação matemática numa perspectiva inclusiva. Buscando atender a essa demanda de conhecer os trabalhos e apontar um processo de busca de forma sistemática, a RSL contribui para compreender de forma estrutural o processo de busca e síntese dos dados [6]. Dessa forma a RSL é um método para mapear as áreas de incertezas e identificar onde pouca ou nenhuma pesquisa relevante foi feita, apontando a necessidade de novos estudos [6].

Para efetuar essa busca, utilizamos uma ferramenta tecnológica chamada "Buscad", desenvolvida no Programa de Pós-Graduação em Educação em Ciências e Matemática – Educimat do Instituto Federal do Espírito Santo – Ifes [7]. Esse buscador acadêmico foi aprimorado para auxiliar na realização de Revisões de Literatura sendo "[...] um artefato desenvolvido no Microsoft Excel, presente no pacote Office 365, 32 bits, no sistema operacional Microsoft Windows 10, compilado no formato XLSM, tipo próprio para planilhas com acesso livre e gratuito" [7].

Para tanto, ao aplicar as *strings* de busca nas bases de dados sobre deficiência intelectual, educação matemática e mapeamento pudemos localizar 77 trabalhos. A partir desse corpus de análise, iniciamos os processos de tratamento dos dados conforme protocolo da RSL definido previamente. Primeiramente analisamos informações técnicas de inclusão dos trabalhos a fim de eliminar duplicações e trabalhos fora do formato previamente estabelecido. Dos 77 trabalhos, 26 estavam duplicados, devido a bases diferentes buscar o mesmo artigo. Assim restaram 51 trabalhos dos quais 3 foram excluídos por serem editorais de revistas.

Seguindo com o protocolo foram aplicados os critérios técnicos de qualidade. Dos 48 trabalhos, 17 atenderam aos índices dos fatores de impacto, do Qualis da revista em que

o artigo foi publicado e do Total de Termos de Busca (TTB). Esses 17 trabalhos passaram para a etapa seguinte da revisão sistemática de literatura, os quais foram submetidos à avaliação pelos pares. Ao final dessa etapa, com a leitura dos trabalhos por completo, dos 17 trabalhos apenas 8 atenderam os critérios estabelecidos no protocolo.

Ao analisar esses textos notamos que as datas de suas publicações são recentes em relação a história da educação matemática inclusiva. Apesar do recorte temporal não delimitar uma data inicial, observamos que existe uma concentração das publicações nos últimos 5 anos com base na representatividade dessas produções acadêmicas.

Quanto a tipologia dos trabalhos, tivemos 5 artigos, 2 dissertações e uma tese, mapeados em diferentes bases. Destacamos 8 trabalhos mapeados em 7 bases de dados diferentes, ressaltando a abrangência desse estudo e a diversidade de busca nessas importantes bases de dados.

Quanto aos objetivos dos trabalhos, foram traçados três pontos de contato entre as pesquisas: a utilização de recursos didáticos no processo de ensino de matemática, como a utilização de jogos digitais e materiais manipuláveis [8] [9] [10]; o delineamento de processos metodológicos para o ensino de matemática como a sequência de intervenções [11], o STEM (Science, Technology, Engineering and Math) [12], o CRA (Concrete-Representational-Abstract) [9] e o VRA (Virtual-Representational-Abstract) [13]; e por fim, a investigação no campo da representação política, social e cultural que aponta discussões para os processos inclusivos e o respeito às diferenças [10] [14] [15].

Em relação aos resultados, retomamos aos três pontos de contato entre os objetivos das pesquisas e propomos um diálogo com as análises apontadas pelas investigações em relação ao ensino de matemática para pessoas com deficiência intelectual. Destacamos as seguintes frentes: o refinamento de recursos diversificados e materiais instrucionais; o aprimoramento dos processos metodológicos; e a necessidade de ampliar as discussões socioculturais sobre inclusão e valorização da diversidade.

O primeiro ponto de contato discute a importância da diversificação dos materiais instrucionais nos processos de ensino e aprendizagem de matemática de alunos com deficiência intelectual. Ressaltam a relevância de oferecer diferentes possibilidades de acesso ao conhecimento matemático por meio de recursos que possam atender as especificidades do indivíduo e as interações construídas no espaço educacional [2].

Em diálogo com essa perspectiva, no segundo ponto são apresentadas discussões sobre os processos metodológicos envolvidos na utilização de recursos e materiais instrucionais [13]. São apontadas discussões sobre a construção do conhecimento matemático e a transição das representações entre o concreto e o abstrato. Ressaltam a necessidade de ampliar esse campo de investigação a fim de consolidar metodologias com possibilidades pedagógicas para o ensino de matemática.

E por fim, não menos importante, são provocadas discussões sobre os processos inclusivos e a valorização das diferenças no ensino de matemática [3]. São apontadas demandas para ampliar esse campo de investigação trazendo discussões socioculturais [5], para possibilidade de práticas equitativas que abarquem uma agenda global para a educação matemática inclusiva.

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Formação de Educadores Ambientais a partir do MOOC Três Momentos Pedagógicos

Daniel Augusto Bolsanelo Belcavello
Programa de Pós-Graduação em Educação em Ciências e Matemática
Instituto Federal do Espírito Santo
Vila Velha - Brasil
0000-0003-1518-8889

ManoelAugusto Polastreli Barbosa
Programa de Pós-Graduação em Educação em Ciências e Matemática
Instituto Federal do Espírito Santo
Vila Velha - Brasil
0000-0003-1162-0670

Jeane Santos de Jesus
Programa de Pós-Graduação em Educação em Ciências e Matemática
Instituto Federal do Espírito Santo
Vila Velha - Brasil
0000-0001-6075-438X

Antonio Donizetti Sgarbi
Programa de Pós-Graduação em Educação em Ciências e Matemática
Instituto Federal do Espírito Santo
Vila Velha - Brasil
0000-0003-2955-3939

I. INTRODUÇÃO

Os MOOCs são cursos caracterizados por serem acessíveis a todos, sem restrições, e, adicionalmente, possuem a capacidade de expansão para atender a um grande e indefinido número de participantes. Devido à sua natureza aberta, esses cursos são destinados a qualquer pessoa, dispensando requisitos de qualificação para a inscrição, proporcionando uma experiência completa, inteiramente online e gratuita [1].

Ao integrar MOOCs como uma estratégia na Educação Ambiental, destaca-se a importância de combinar a escala desses cursos com métodos pedagógicos eficazes. A proposta vai além da simples disseminação de informações, buscando inspirar a ação. Nesse sentido, os MOOCs atuam como catalisadores para a implementação de projetos práticos, desafiando os participantes a aplicarem seus conhecimentos na resolução de problemas ambientais, conferindo, assim, uma dimensão tangível à aprendizagem [2].

Nessa seara, diversas discussões permeiam a respeito da importância da construção do conhecimento científico no decorrer do processo de ensino e aprendizagem. Para isso, dentre as diversas maneiras de estabelecer uma dinâmica de atuação docente em sala de aula, contemplando os aspectos essenciais para a formação do estudante, a abordagem denominada "momentos pedagógicos", divididos em três etapas distintas, cada uma com funções específicas: problematização inicial, organização do conhecimento e aplicação do conhecimento, tem sido amplamente utilizada [3] [4].

Deste modo, a proposta apresentada visar unir a amplitude alcançada pelos MOOCs à uma abordagem didático-pedagógica consolidada para a promoção da Educação Ambiental, visando a formação de educadores ambientais e suas respectivas instrumentalizações. O presente curso justifica-se pela necessidade formativa prévia e posterior aplicação dos Três Momentos Pedagógicos, seja em espaços formais ou não-formais de educação. De forma específica, esse direcionamento enfoca na Educação Ambiental como campo do conhecimento de relevância para a sociedade.

Sendo assim, o estudo apresentado tem como objetivo abordar a criação de um Curso Online Aberto e Massivo, do inglês Massive Open Online Course (MOOC), sobre a temática Três Momentos Pedagógicos com ênfase na Educação Ambiental. O MOOC será ofertado na Plataforma de Cursos Abertos do Instituto Federal do Espírito Santo (IFES).

II. MATERIAIS E MÉTODOS

O estudo abordado é de natureza qualitativa [5] e tem uma abordagem aplicada, caracterizando-se como exploratório em seus objetivos [6]. Ele se concentra na discussão sobre a elaboração do MOOC "Três Momentos Pedagógicos sob o enfoque da Educação Ambiental", com uma carga horária total de 20 horas, ministrado em português, de nível intermediário e classificado na grande área de conhecimento do CNPq como Ciências Humanas.

O MOOC "Três Momentos Pedagógicos sob o enfoque da Educação Ambiental" é desenvolvido no âmbito do Projeto Rio Doce Escolar. O propósito deste projeto é proporcionar a formação em Educação Ambiental direcionada a educadores que desempenham suas funções em escolas públicas de educação básica localizadas em quatro municípios ao longo da Bacia Hidrográfica do Rio Doce no Estado do Espírito Santo (ES): Baixo Guandu, Colatina, Marilândia e Linhares [7].

A metodologia utilizada para o desenvolvimento do MOOC, foi o Modelo ADDIEM [8], que é um acrônimo para Análise, Desenho, Desenvolvimento, Implementação e Avaliação em MOOCs. Suas etapas podem ser simplificadamente descritas da seguinte forma:

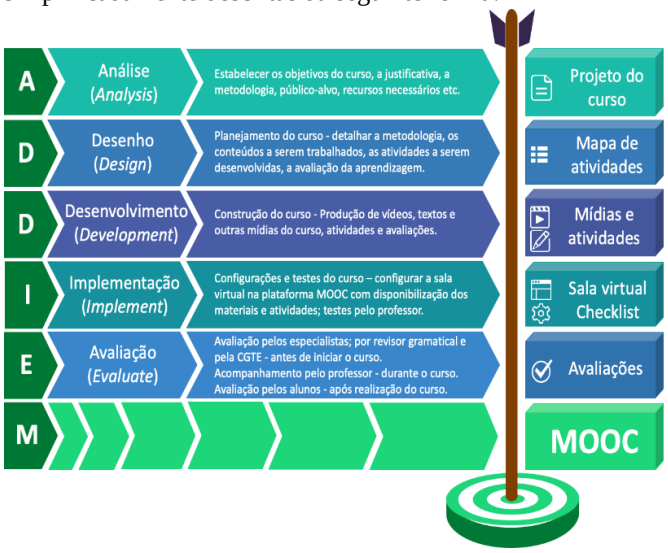

Fig. 1. Representação do Modelo ADDIEM. [8].

A análise dos dados se dará de forma qualitativa [6], de modo a qualificar as construções realizadas no processo de

construção do MOOC Três Momentos Pedagógicos sob o enfoque da Educação Ambiental.

III. RESULTADOS E DISCUSSÕES

Este curso, tendo como objetivo principal desenvolver competências e habilidades quanto a utilização da metodologia de ensino Três Momentos Pedagógicos aplicada à Educação Ambiental. Atrelado a isso, busca alcançar os seguintes objetivos específicos: compreender o conceito de Três Momentos Pedagógicos: problematização inicial, organização do conhecimento e aplicação do conhecimento; aplicar os Três Momentos Pedagógicos sob o enfoque da Educação Ambiental em práticas em espaços formais e não-formais; e, conhecer sugestões de aplicação dos Três Momentos Pedagógicos em espaços formais e não-formais de educação. O MOOC Três Momentos Pedagógicos sob o enfoque da Educação Ambiental está organizado da seguinte forma:

TABLE I. ORGANIZAÇÃO DO MOOC TRÊS MOMENTOS PEDAGÓGICOS SOB O ENFOQUE DA EDUCAÇÃO AMBIENTAL

Tópico	Descrição/Objetivos	Conteúdo	Atividade e recurso	Nota
Boas-vindas	Apresentação do curso e de seus objetivos	Vídeo de boas-vindas e apresentação do curso.	Vídeo dos autores	
		Apresentação: Fórum de discussão online para que os participantes compartilhem suas expectativas e experiências prévias.	Livro texto e recurso Fórum	
Módulo 1	Os Três Momentos Pedagógicos: problematização inicial, organização do conhecimento e aplicação do conhecimento	Conceituação Inicial	Vídeo sobre o assunto	
		Problematização Inicial	Livro Texto e Imagem Interativa no Genially	
		Organização do Conhecimento	Livro Texto e Imagem Interativa no Genially	
		Aplicação do Conhecimento	Livro Texto e Imagem Interativa no Genially	
		Questionário	Questionário do tópico	15
Módulo 2	Os Três Momentos Pedagógicos sob o enfoque da Educação Ambiental	Contextualização dos Três Momentos Pedagógicos sob o enfoque da Educação Ambiental	Livro Texto e Vídeo dos Autores	
		Questionário	Questionário do tópico	15
Módulo 3	Sugestões de aplicação dos Três Momentos Pedagógicos em espaços formais e não-formais de educação.	Experiências exitosas com a utilização dos Três Momentos Pedagógicos	Livro texto e Imagem Interativa no Genially	
			Vídeo dos Autores	
			Livro Texto e Imagem Interativa no Genially	
Avaliação Final	Questionário Avaliativo Final	A avaliação será por meio de questionário de múltipla escolha com objetivo de certificar o participante que obter nota igual ou superior a 60%.	Avaliação Final	70

Fonte: os autores (2023).

O processo formativo adota uma metodologia que combina períodos de estudo autônomo, incorporando atividades focadas na autoinstrução, visualização de videoaulas, animações, textos, jogos interativos, estudos direcionados e questionários online. Adicionalmente, integra fóruns colaborativos para facilitar a interação e a troca de experiências entre os participantes, incentivando momentos de reflexão sobre suas práticas cotidianas.

A criação de um curso que adote a metodologia dos Três Momentos Pedagógicos na Educação Ambiental representa, assim, uma oportunidade para proporcionar uma experiência educacional dinâmica, participativa e profundamente conectada com as questões ambientais contemporâneas. Ao integrar problematização, organização do conhecimento e aplicação prática, esse curso pode se tornar uma ferramenta valiosa na formação de indivíduos comprometidos com a preservação ambiental e o desenvolvimento sustentável, de forma crítica, participativa e colaborativa.

IV. CONSIDERAÇÕES FINAIS

Diante da criação do MOOC Três Momentos Pedagógicos sob o enfoque da Educação Ambiental, espera-se que os participantes alcancem uma compreensão abrangente dos conceitos fundamentais relacionados aos Três Momentos Pedagógicos, vislumbrando possibilidades de utilização da abordagem em seus respectivos campos de atuação, especialmente, direcionados à Educação Ambiental.

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Curso MOOC Cultura oceânica e poluição dos rios: a relação entre as duas realidades

Jeane Santos de Jesus
Programa de Pós-Graduação em Educação em Ciências e Matemática
Instituto Federal do Espírito Santo
Vila Velha - Brasil
0000-0001-6075-438X

Daniel Augusto Bolsanelo Belcavello
Programa de Pós-Graduação em Educação em Ciências e Matemática
Instituto Federal do Espírito Santo
Vila Velha - Brasil
0000-0003-1518-8889

Manoel Augusto Polastreli Barbosa
Programa de Pós-Graduação em Educação em Ciências e Matemática
Instituto Federal do Espírito Santo
Vila Velha - Brasil
0000-0003-1162-0670

Manuella Villar Amado
Programa de Pós-Graduação em Educação em Ciências e Matemática
Instituto Federal do Espírito Santo
Vila Velha - Brasil
0000-0003-2405-0320

Antonio Donizetti Sgarbi
Programa de Pós-Graduação em Educação em Ciências e Matemática
Instituto Federal do Espírito Santo
Vila Velha - Brasil
0000-0003-2955-3939

I. INTRODUÇÃO

A divulgação científica de conhecimentos sobre o oceano, a vida marinha e outras informações pertinentes tornou-se assunto de discussão na atualidade, assim como, um dos Objetivos de Desenvolvimento Sustentável (ODS) na Agenda de 2030 pela Organização das Nações Unidas (ONU). Em seu objetivo 14, a ONU estabelece a busca pela Conservação e uso sustentável dos oceanos, mares e dos recursos marinhos, para o desenvolvimento sustentável [1].

Assim, diante da realidade local no momento pós-desastre/crime socioambiental ocorrido no dia cinco de novembro de 2015 com o rompimento da Barragem da Samarco em Mariana - MG, com os rejeitos da mineração despejados no Rio Doce e chegando ao Oceano [2], pode-se discutir a relação entre a poluição do rio e os impactos que causam na saúde da vida marinha, fortalecendo assim, a necessidade de discussões a partir da CTS [3].

Com este intuito, desenvolveu-se o curso MOOC "Cultura Oceânica e poluição dos rios: a relação entre as duas realidades" com o objetivo de promover uma discussão introdutória sobre a conservação, restauração e uso sustentável do oceano e seus recursos a partir de informações que facilitem o entendimento da relação de causa e efeito entre comportamento individual e coletivo e os impactos que ameaçam a saúde do oceano.

Deste modo, o objetivo do presente estudo foi o de analisar a criação, validação e avaliação do MOOC Cultura oceânica e poluição dos rios: a relação entre as duas realidades.

Desenvolvido pelos autores deste estudo, o MOOC "Cultura Oceânica e poluição dos rios: a relação entre as duas realidades" está associada ao Instituto Federal do Espírito Santo (IFES), Campus Vila Velha – ES, por meio do Projeto Rio Doce Escolar: Formação de Educadores em Educação Ambiental nas Escolas Capixabas do Rio Doce [4]. O curso está disponibilizado na Plataforma de Cursos Abertos do IFES, administrada pelo Centro de Referência em Formação e em Educação a Distância (CEFOR).

II. MATERIAIS E MÉTODOS

A. Classificações e contextualização do estudo

O estudo em questão é de abordagem qualitativa [5], de natureza aplicada e quanto aos seus objetivos, configura-se como exploratório [6]. Baseia-se na discussão sobre o curso MOOC "Cultura Oceânica e poluição dos rios: a relação entre as duas realidades".

Para a elaboração do MOOC, optamos pelo Modelo ADDIEM [7], que é um acrônimo para Analysis, Design, Development, Implementation e Evaluation in MOOCs, traduzido como Análise, Desenho, Desenvolvimento, Implementação e Avaliação. Vamos descrever de maneira resumida suas etapas.

Na fase de Análise, é o momento de estabelecer os objetivos do curso, justificativa, metodologia, público-alvo, idioma, recursos necessários, equipe envolvida, formas de suporte, pré-requisitos, resultados esperados e avaliação da aprendizagem, entre outros. É nesse estágio que o Projeto de Curso é elaborado [7].

A etapa seguinte é o Desenho ou Projeto (Design), centrado no planejamento do curso. Durante essa fase, é crucial aprofundar-se na metodologia, nos conteúdos que serão abordados, atividades planejadas e avaliação da aprendizagem, com foco na elaboração do mapa de atividades [7].

No Desenvolvimento, ocorre a produção de videoaulas, textos e outras mídias para o curso, incluindo a elaboração de atividades e avaliações [7].

Na Implementação, são realizadas as configurações da sala virtual no provedor de MOOCs, inserindo materiais e atividades. No caso desta pesquisa, utiliza-se o Moodle como plataforma. Nessa fase, o professor realiza testes, verificando o acesso dos alunos aos conteúdos e atividades conforme as expectativas [7].

Com base nas avaliações dos especialistas, o professor ajusta o material e encaminha a um revisor de Português (ou da língua do curso). Em seguida, uma avaliação técnica é conduzida por uma equipe especializada em tecnologia e design educacional, seguida de ajustes finais, se necessário [7].

Após a conclusão dessa fase inicial de avaliação, o MOOC está pronto para ser lançado na Plataforma de Cursos onde será disponibilizado. Durante o primeiro semestre, o professor monitora as postagens nos fóruns, as atividades dos alunos e os chamados recebidos pelo sistema de suporte (sendo o único contato com o cursista), a fim de identificar possíveis ajustes e melhorias a serem feitas no período de atualização do curso e manutenção da plataforma. As avaliações preenchidas pelos alunos ao final do curso são ferramentas importantes de

análise, auxiliando o professor na compreensão da experiência dos alunos [7].

A coleta de dados foi realizada por meio do processo de validação feito pelos especialistas e da avaliação do MOOC feito pelos cursistas na plataforma Moodle e na disciplina de Trilha de Alfabetização Científica, da Formação do Projeto Rio Doce Escolar. O processo de validação do MOOC contou com a participação de três professoras especialistas, uma pós-doutora e duas mestras, cursistas de doutorado. O trio é especialista e atua na área de Educação em Ciências. A validação ocorreu com a análise do MOOC, onde as especialistas avaliaram o curso com base em três eixos: Eixo Tecnológico e Estrutural: avaliação das características das tecnologias utilizadas, qualidade de apresentação, funcionamento técnico e a estrutura geral do curso. Eixo Pedagógico: avaliação relacionada as metodologias utilizadas, atividades e processo avaliativo. Recomendação do curso: avaliação quanto ao nível de recomendação do curso. Observações gerais sobre o curso: itens identificados com necessidade de melhoria e restruturação. Eixo Aderência aos pressupostos do Projeto Rio Doce Escolar: questões com relação a aderência do curso com os pressupostos do Projeto Rio Doce Escolar.

A avaliação do MOOC foi realizada por meio da aplicação de um questionário composto de oito questões, sendo sete delas, objetivas, e uma delas, discursiva. Os questionamentos continham o intuito de avaliar as produções audiovisuais e os materiais textuais utilizados, assim como a adequação, organização e a contribuição do conteúdo à proposta do curso e ao processo de ensino e de aprendizagem, a adequação das atividades avaliativas e práticas propostas, as expectativas, recomendações e avaliações quanto ao curso.

III. RESULTADOS E DISCUSSÕES

A. *Validação do MOOC "Cultura Oceânica e poluição dos rios: a relação entre as duas realidades"*

O MOOC "Cultura Oceânica e poluição dos rios: a relação entre as duas realidades" foi avaliado a partir dos quatros eixos: Tecnológico e Estrutural, Pedagógico e Aderência aos pressupostos do Projeto Rio Doce Escolar.

No Eixo Tecnológico e Estrutural, três dos itens avaliados foram amplamente contemplados. Quanto ao item "a linguagem está bem estruturada e gramaticalmente correta" foi assinalado pelas professoras avaliadoras como item a ser revisado, todavia, o curso ainda passaria por revisão textual por um especialista.

No Eixo Pedagógico, em sua maioria, os itens foram completados na perspectiva das revisoras especialistas. Todavia, a avaliadora 3, sugeriu a revisão da resolução de imagens utilizadas para que o conteúdo fique mais claro e estruturado. Junto a isso, questionou-se qual seria o grau de recomendação do curso aos cursistas, as três avaliadoras avaliaram em 10 pontos. Ainda neste eixo, solicitou-se observações gerais sobre o curso, a avaliadora 1 sugeriu a alteração do curso de 20 horas para 30 horas de carga horária, uma vez que foi considerado que o curso possui uma gama ampla de materiais. Enquanto, a avaliadora 2 realizou sugestões quanto a detalhamento de alguns itens do curso, assim como a disponibilização de materiais complementares.

No Eixo "Aderência aos pressupostos do Projeto Rio Doce Escolar", em sua maioria, os itens foram contemplados. Todavia, as avaliadoras descreveram sugestões em alguns deles. A avaliadora 2 considerou a possibilidade de explorar o diálogo entre a Educação Ambiental Formal e Não Formal. Por sua vez, a avaliadora 3 também ressaltou a necessidade de exploração deste item, assim como o enfoque dado a Educação Ambiental e a reflexão crítica da realidade.

B. *Avaliação do MOOC "Cultura Oceânica e poluição dos rios: a relação entre as duas realidades"*

A avaliação do MOOC se deu sob as produções audiovisuais e os materiais textuais utilizados, a adequação, organização e a contribuição do conteúdo à proposta do curso e ao processo de ensino e de aprendizagem, a adequação das atividades avaliativas e práticas propostas, as expectativas, recomendações e avaliações quanto ao curso.

Inicialmente, os dois primeiros quesitos relacionavam-se a classificação quanto aos vídeos e materiais textuais. Em sua maioria, os materiais foram considerados de fácil compreensão e profundidade adequada, todavia, dois cursistas apontaram que gostariam que os vídeos fossem mais detalhados. Por se tratar de cursos MOOC e com baixa carga horária, por vezes, os materiais produzidos, principalmente, audiovisuais, precisam ser sintetizados para que atendam as especificidades do curso, entretanto, esse é um fator a ser reavaliado diante de seu processo de revisão para a reoferta. Quanto a adequação, organização e facilidade proporcionada pelo conteúdo em relação a aprendizagem e a proposta do curso, em sua maioria, os cursistas concordaram plenamente na contribuição do material.

Quanto as expectativas e a avaliação do curso, aponta-se atendimento às expectativas dos cursistas e considerações como "muito bom". A avaliação resultou em elevado nível de recomendação da formação, assim como relatos de agradecimento, superação e de satisfação quanto a constituição do MOOC.

IV. CONSIDERAÇÕES FINAIS

O MOOC mostrou-se como um importante ponto de partida para discussões sobre a relação entre oceano e rios, reforçando a importância de se desenvolver a cultura oceânica na população como forma de conservação e de pensamento crítico em relação a temática. Seu processo de validação e de avaliação mostraram-se satisfatórios, entretanto, apontaram considerações de relevância para melhorias e adequações a serem realizadas para sua reoferta.

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Enabling Digital Literacy Through Social Media as Learning Scenarios

Ana Pérez-Escoda
University Antonio de Nebrija
Madrid, Spain
aperezes@nebrija.es
https://orcid.org/0000-0002-4895-0043

Laura Martínez-Otón
University Antonio de Nebrija
Madrid, Spain
lmartinezot@nebrija.es
https://orcid.org/0000-0002-2535-8282

Eglée Ortega Frrnández
University Antonio de Nebrija
Madrid, Spain
eortegafe@nebrija.es
https://orcid.org/0000-0001-7103-2403

Luis Miguel Pedrero-Esteban
University Antonio de Nebrija
Madrid, Spain
lpedrero@nebrija.es
https://orcid.org/0000-0003-4949-2360

The work presented explores the evolving role of social networks as significant spaces for communication, information dissemination, and education. The authors highlight the transformative impact of social media, emphasizing its unprecedented influence on interaction and communication in contemporary society. Drawing parallels with the historical role of traditional media as the 'fourth estate' or 'fourth power', the authors suggest that social networks have ushered in a new era, positioning them as a powerful 'fifth power' due to their pervasive cultural and societal impact.

The emergence of social networks has not only expanded the scope of freedom of expression but has also introduced challenges related to the dissemination of misinformation, hoaxes, and fake news. This proliferation of misleading information underscores the urgent need for enhanced media literacy skills among users to navigate the complexities of the digital landscape effectively. The authors highlight the dual nature of social networks as platforms for both expression and chaos, emphasizing the importance of equipping individuals with the necessary skills to critically evaluate and engage with the information they encounter online [1].

Social media are framed as potential dynamic learning environments that require strategic educational designs to integrate them effectively into the learning process. By exploring the impact of social networks on communication and education, the authors aim to shed light on the significance of digital literacy in fostering critical thinking skills among university students in their engagement with social media platforms.

UNESCO's stance aligns with the study's objective of exploring the educational potential of social networks for enhancing students' digital skills and media literacy [2]. By framing social media as valuable learning environments, UNESCO underscores the importance of integrating these platforms into educational settings to empower students in their academic and professional development. The need for effective education through media literacy, particularly in the context of the digital society's challenges, such as disinformation and fake news is highlighted in line with the project presented.

By positioning social media as primary communication spaces for young people, the study underlines the significance of promoting knowledge and critical thinking skills to navigate the informational disorder prevalent in online environments [3].

Having this backdrop in mind, the objective of the educational innovation project, partially presented here: "Media Literacy and Social Networks" focused on taking advantage of the benefits and usefulness of social networks in the educational context for the promotion of media literacy, digital skills, and learning using them as suitable pedagogical resources for their characteristics in the communicative context, such as the creation of content, the development of learning communities and the ease of collaboration that they allow. However, prior to this stage, a previous study was carried out to establish the students´ perception of social media as learning and self-development scenarios.

The study delves into the academic and educational use of social networks among young people, emphasizing the necessity of understanding students' perceptions of social media as learning and self-development scenarios. The educational innovation project, "Media Literacy and Social Networks," aims to leverage the benefits of social networks in educational contexts to promote media literacy, digital skills, and collaborative learning.

The research questions posed around students' perceived need for training in social media use, the importance of social media as self-development environments, and the specific areas in which students believe social networks have the most significant impact. Through a quantitative methodology employing a questionnaire with 94 study variables, the study seeks to gather insights into students' digital identity, perception and consumption of social media, and awareness of fake news.

The study reveals that all students in the sample, both undergraduate and postgraduate, unanimously agreed on the importance of certain aspects related to social media, such as voice in society, intercultural dialogue, and ethics. This high level of agreement indicates a shared recognition among students of the positive contributions social media can make to societal discourse and ethical considerations.

However, statistically significant differences were observed in students' perceptions of social media's role in areas such as citizen's rights, digital education, and wise clicking. Postgraduate students exhibited a higher level of agreement on the potential of social media to contribute to citizen's rights, digital education, and wise clicking compared to undergraduate students. These findings suggest that

postgraduate students may have a more nuanced understanding of the educational and societal benefits of social media compared to their undergraduate counterparts.

The results also highlight the need for further exploration of how social media can be harnessed for educational purposes, particularly in enhancing digital literacy and critical thinking skills among students. By identifying areas of agreement and divergence in students' perceptions of social media, the study provides valuable insights for educators and policymakers seeking to leverage social networks as effective learning environments for promoting media literacy and digital skills among university students.

Conclusions reflect an innovative approach that allow students to articulate their need for training in social media use and underscored the significance of these platforms in various areas of their lives. The findings suggest that social media plays a crucial role in students' self-development, necessitating a shift in educational paradigms to incorporate digital literacy and critical thinking skills within the curriculum. The overwhelming majority of respondents expressing a need for social media training underscores the importance of preparing students to navigate the digital landscape effectively.

By recognizing social networks as valuable tools for personal and professional development, educators can bridge the gap between leisurely social media use and academic integration. The study underscores the interconnectedness of personal, academic, and professional development in the digital age, emphasizing the need for educational institutions to adapt to the changing landscape of communication and information dissemination.

In conclusion, the study highlights the critical role of social media in shaping students' perceptions and self-development. By acknowledging the educational potential of social networks and the importance of media literacy, the authors advocate for a proactive approach to integrating social media into educational practices. The findings underscore the need for educational institutions to equip students with the necessary skills to effectively navigate the complexities of the digital world effectively. By embracing social media as learning environments, educators can empower students to critically engage with information, enhance their digital skills, and prepare them for success in an increasingly interconnected and digital society [4].

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Enhancing Engineering Education: Generation of Cross-platform Collaborative Graphical Editors

1st Yoel Arroyo
Faculty of Soc. Sci. and Inf. Tech.
University of Castilla-La Mancha
45600 Talavera de la Reina, Spain
Yoel.Arroyo@uclm.es

2nd Ana I. Molina
School of Informatics
University of Castilla-La Mancha
13071 Ciudad Real, Spain
AnaIsabel.Molina@uclm.es

3rd Ana M. Torres
Institute of Technology
University of Castilla-La Mancha
16002 Cuenca, Spain
Ana.Torres@uclm.es

4th Jorge Mateo
Institute of Technology
University of Castilla-La Mancha
16002 Cuenca, Spain
Jorge.Mateo@uclm.es

5th Miguel Á. Redondo
School of Informatics
University of Castilla-La Mancha
13071 Ciudad Real, Spain
Miguel.Redondo@uclm.es

I. Introduction

In recent years, the use of Computer-Supported Collaborative Learning (CSCL) techniques has gained importance in education, and its effectiveness has been widely corroborated [1]. This trend is not limited only to education at primary and secondary levels, but extends to the university environment, including disciplines such as computer science and telecommunications. The integration of CSCL tools in higher education can provide valuable opportunities to foster group learning, a crucial competence. In addition, the current context, marked by the recent COVID-19 pandemic, has further accelerated this trend, leading to significant changes in university classrooms [2], [3]. This adaptation highlighted the importance of CSCL tools to facilitate collaboration and group learning, allowing students to interact and work together effectively, whether in face-to-face or virtual environments [4], [5].

Furthermore, the use of cross-platform systems in higher education classrooms is becoming increasingly relevant [6]. These kinds of systems allow students to collaborate and learn effectively, regardless of the device they are using. This is especially important in an increasingly digital and connected world, where students may need to access learning materials and collaborate from different devices and locations. In this context, it is also fundamental to highlight the concept of awareness, defined as the understanding or perception of the collaborative group [7]–[9]. Awareness consists in the incorporation of various widgets and features in the final user interface, such as real-time visualization of group activity, availability indicators, notifications of changes in shared documents and the creation of interactive spaces, between others. These features strengthen coordination and communication in any collaborative environment and, in turn, improves the effectiveness of group learning [10]. Therefore, it is important to take it into account in the design and development of any collaborative system.

This paper presents a proposal for the creation of cross-platform collaborative graphical editors for its use in engineering subjects, which often require the creation of diagrams or models. The importance of having these tools for learning in university studies is indisputable. In particular, in training in computer and telecommunications engineering, where the use of diagrams is a common process in the initial phases of any project. In turn, an adequate feedback from teachers and students contributes to understanding how these tools influence the group learning process. Therefore, the proposal might also add the possibility to share learning tasks, facilitating the coordination and communication in the collaborative learning process.

II. A Proposal for the Generation of Cross-platform collaborative graphical editors

In order to develop a solution to be used across various platforms/devices and by diverse user groups, we have selected a range of technologies, programming languages and frameworks existing in recent literature. Thus, the client code of the cross-platform graphical editors has been implemented using GoJS [1], which allows the graphical editors implemented to be accessible on different devices. However, they do not inherently incorporate all the necessary collaborative functionality and lacks of an adequate awareness support. To address this problem, collaboration functionality has also been added to the final graphical editors through the use of two complementary technologies: TogetherJS [2] and Glitch [3]. This dual implementation strategy ensures seamless real-time collaboration among users.

[1]GoJS: https://gojs.net/latest/index.html
[2]TogetherJS: https://togetherjs.com/
[3]Glitch: https://glitch.com/

To date, two collaborative and cross-platform graphical editors have been implemented as use case examples of the proposal. Specifically, potential users can create and design use case diagrams and FIR signal filtering diagrams. Use case diagrams are very common in computer engineering projects, as they provide a high-level view of the system's functionality by illustrating the ways users can interact with it. On the other hand, FIR signal filtering diagrams graphically represent a type of digital filter used in signal processing. They are essential for understanding and designing signal processing systems, being of a great value in the field of telecommunications engineering, as they allow students to visualize and more effectively understand complex signal processing procedures.

The design and creation of these diagrams can be carried out on three different devices: interactive whiteboards or tabletops, desktops or laptops and tablets. As noted, smartphones have been excluded from the proposal. This decision was made due to perceived difficulties in interacting with the graphical elements on editors' canvases, mainly caused by the small screen dimensions, thus hindering not only the user experience (UX) but also the learning experience.

In relation to the use of the proposal, two potential learning scenarios are perceived: 1) in the classroom, where teachers can create a collaborative session with the students to make real-time changes to a specific diagram and discuss them in the classroom; and 2) remotely, in which the most common scenario would be groups of students working collaboratively and remotely on a learning task.

In addition, this proposal incorporates various elements/widgets with the aim of providing adequate support for communication, coordination and awareness in each of the collaborative graphical editors. The set of elements/widgets incorporated in the proposal is as follows: 1) screen sharing, that enables users to view the same screen in real-time; 2) chat, providing an integrated chat that allows users to communicate while collaborating; 3) audio chat, which offers the ability to chat also via audio; 4) telepointer, within users can view and follow the telepointer of other participants, and uses each participant's profile color and name to facilitate collaboration and visual communication; 5) avatar, allowing customization of the name and profile picture so that other participants can identify a specific user in a collaborative session; and 6) visual interactions, that notifies visually and in real-time the interactions made by a participant. One of the most important advantages is that users are able to share screen, chat or notify their interactions regardless whether is using an interactive whiteboard, a tablet or a personal computer.

Finally, it is also worth noting that certain generic functionality, important to consider in any CSCL system, has also been developed and added in the proposal. Specifically, both teachers and students can save and open the diagrams, either to share them in the elaboration of a task or for its evaluation by the teacher. These diagrams are saved in JSON format, making them easy to share. Additionally, also exists the possibility to directly export a diagram in SVG format.

III. Conclusionsand future work

The proposal presented in this paper is designed to provide and create cross-platform graphical editors that not only facilitates the collaborative solving of learning tasks in higher education, but also incorporates an adequate awareness support to improve both user and learning experiences. It is aimed to enhance the interaction and collaboration between teachers and students. Furthermore, being cross-platform enables its use across different devices such as interactive whiteboards or tabletops, desktops/laptops and tablets. This flexibility allows for a more flexible and accessible learning environment, attending to the diverse needs and preferences of each user. We believe that our proposal can significantly improve the current state of CSCL by addressing its existing limitations. Furthermore, in an era where subscriptions and micro payments are the norm, it is vital to recognize the importance of providing more open-source solutions.

As future work, further evaluations are intended to be conducted on cross-platform collaborative editors created to date, both use case diagrams and FIR signal filtering diagrams. Additionally, if satisfactory results are obtained in the initial evaluations with final users, a wider range of domains within computer sciences and telecommunications subjects will be explored. Finally, as a more potential and distant goal, the aim is to achieve the semiautomatic generation of these kinds of editors, taking advantage of the model-driven development (MDD) paradigm.

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Creación de entornos virtuales conversacionales para el e-learning

Rubén Baena-Perez
Departamento de Ingeniería Informática, Universidad de Cádiz
Puerto Real, Spain
ruben.baena@uca.es

Iván Ruiz-Rube
Departamento de Ingeniería Informática, Universidad de Cádiz
Puerto Real, Spain
ivan.ruiz@uca.es

José Miguel Mota
Departamento de Ingeniería Informática, Universidad de Cádiz
Puerto Real, Spain
josemiguel.mota@uca.es

Anke Berns
Departamento de Filología Francesa e Inglesa Universidad de Cádiz
Cádiz, Spain
anke.berns@uca.es

Antonio Balderas
Departamento de Ingeniería Informática, Universidad de Cádiz
Puerto Real, Spain
antonio.balderas@uca.es

***Resumen*—El aumento de las actividades virtuales ha evidenciado la necesidad de mejorar las experiencias en línea, como la enseñanza de idiomas. Los Entornos de Aprendizaje Virtual (EVA) han avanzado gracias a tecnologías como la Realidad Virtual (RV) y los chatbots, pero su desarrollo requiere habilidades de programación avanzadas. Este trabajo introduce extensiones para MIT App Inventor que simplifican la creación de aplicaciones de aprendizaje móvil con chatbots en RV, incluyendo el monitoreo de la actividad estudiantil. Utiliza lenguajes de programación en bloques y diagramas de Notación y Modelado de Procesos de Negocio (BPMN). Las extensiones se probaron en la aplicación de aprendizaje de idiomas *Let's date!*, que mostró ser efectiva en la enseñanza del alemán.**

***Index Terms*—Chatbots, End-User Development, E-learning, Analítica de Aprendizaje, Realidad Virtual, MIT App Inventor**

I. Introducción

Los recientes avances tecnológicos han impulsado el aprendizaje electrónico, destacando la importancia de los Entorno Virtual de Aprendizaje (EVA), y promoviendo el desarrollo de la Minería de Datos Educativos (MDE) y las Analíticas de Aprendizaje (AA). Estas herramientas son clave para adaptarse a la educación digital y sus desafíos [1].

En este marco, la Realidad Virtual (RV) en entornos de aprendizaje permite inmersiones en entornos 3D, aunque presenta retos como su complejidad y la dificultad de alcanzar realismo convincente. Esto ha generado interés en los entornos de 360 grados, que ofrecen experiencias más auténticas y son menos complejos de desarrollar [2]. Además, el crecimiento de los chatbots, avanzados por el Procesamiento de Lenguaje Natural (PLN), ha enriquecido las interacciones usuario, aunque falta definir estrategias educativas para su implementación [3]. Paralelamente, la adopción de lenguajes de programación visual bajo el enfoque de Desarrollo por el Usuario Final (*End-User Development*) (EUD) permite a no programadores crear aplicaciones de aprendizaje interactivas, democratizando el desarrollo y ampliando el acceso a la tecnología educativa [4].

Este documento resume el trabajo de Baena et al [5] sobre extensiones para MIT App Inventor 2 (AI2) que facilitan la creación de entornos de aprendizaje de RV interactivos mediante chatbots, permitiendo a los profesores monitorear las actividades de los estudiantes.

II. Autoría de escenarios interactivos mediante modelado y programación visual

Este estudio investiga la integración de diagramas de flujo, lenguajes de bloques y PLN para desarrollar experiencias de aprendizaje conversacionales, discutiendo las herramientas de programación visual y modelado de flujos de trabajo, junto con los componentes de ejecución.

II-A. Herramientas de autoría

Se describe el uso de una herramienta de programación visual y un entorno basado en Modelo de Proceso de Negocio y Notación (*Business Process Model and Notation*) (BPMN) para definir comportamientos de aplicaciones.

II-A1. Programación visual de aplicaciones: AI2 es una plataforma de código abierto diseñada para facilitar el desarrollo de aplicaciones Android mediante el uso de Blockly. Para desarrollar entornos de aprendizaje móvil basados en RV con interacción por voz, se crearon varias extensiones que facilitan la ejecución de flujos de trabajo, la renderización en RV, la gestión de diálogos por voz y el seguimiento de la experiencia del usuario

II-A2. Modelado de flujos de trabajo: Para la ejecución efectiva de procesos modelados con BPMN es esencial automatizar y coordinar las tareas. Al modelar secuencias de escenas de RV para dispositivos móviles con BPMN, buscamos facilitar su automatización. Clave en este proceso es la asignación de significados precisos a los elementos fundamentales de BPMN, especialmente a las tareas que desempeñan roles cruciales dentro de los flujos de trabajo. A continuación,

definiremos los significados específicos para algunas de estas tareas especializadas:

- Tarea de servicio: entrega un vídeo de 360º para sumergir a los usuarios en contextos realistas e inmersivos;
- Tarea de usuario: inicia la captura de un mensaje de voz del usuario y su comprensión a través de un agente de una plataforma de PLN;
- Tarea manual: con esta tarea, la aplicación solicitará una acción de confirmación por parte del usuario a través de un botón en una interfaz de diálogo no RV.

II-B. Componentes de ejecución

Para este proyecto se han desarrollado varios componentes esenciales. A continuación, se presenta una breve descripción de cada uno de ellos:

- **Componente de Ejecución de Flujos de Trabajo:** Habilita a las aplicaciones móviles para gestionar acciones basadas en las respuestas de los usuarios. Permite secuenciar el flujo de actividades descritos en el XML del modelo BPMN y ofrece métodos para gestionar los procesos
- **Componente de Renderización RV/360º:** Soporta la visualización de vídeos panorámicos RV/360º en móviles, accesibles desde plataformas de streaming. Facilita control de reproducción, ajuste de volumen y gestión de interacciones del usuario con la RV.
- **Componente de Diálogo:** Facilita análisis de voz y generación de respuestas mediante plataformas PLN. Requiere configuración inicial y provee herramientas para la gestión de voz y respuestas del agente conversacional.
- **Componentes de Seguimiento de la Experiencia del Usuario:** Recopila datos de interacción del usuario en entornos de aprendizaje. Permite la transmisión de datos en tiempo real o por lotes y la configuración de acceso a un Almacén de Registros de Aprendizaje (*Learning Record Store*) (LRS)

III. Evaluación

La viabilidad de las extensiones de AI2 se demuestra a través de un caso práctico con la app *Let's date!* [6] (véase la figura 1), diseñada para inmersión en conversaciones reales en idiomas extranjeros. El estudio, realizado con 24 estudiantes en un curso introductorio de alemán en la Universidad de Cádiz, incluyó el uso de gafas de RV en clase. Posteriormente, se aplicó un cuestionario Modelo de Aceptación de Tecnología (*Technology Acceptance Model*) (TAM) [7] para evaluar la aceptación de la app en cuanto a facilidad de uso, utilidad y la intención de uso futuro.

Los resultados fueron prometedores: 18 de 24 estudiantes encontraron la app fácil de usar, mientras que ninguno la consideró difícil. Respecto a su utilidad para aprender alemán, 23 estudiantes afirmaron que la app les ayudó a mejorar su aprendizaje del idioma, destacando su potencial para mejorar la comprensión, pronunciación, expresión oral y vocabulario.

Además, 22 estudiantes mostraron una actitud muy positiva hacia el uso de apps de RV para el aprendizaje de idiomas,

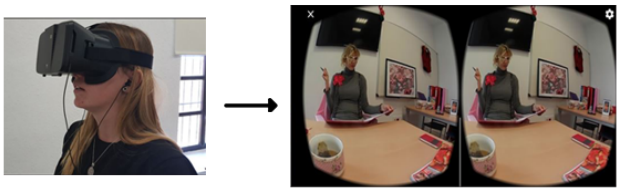

Figura 1. Estudiante utilizando la app *Let's date!*

resaltando el potencial motivador y la naturaleza interactiva y amena de la app. Respecto a la percepción de disfrute, 19 estudiantes indicaron que perdieron la noción del tiempo al interactuar con la app, y 17 se sintieron inmersos en el entorno virtual.

IV. Conclusiones

Este estudio presenta un entorno de desarrollo para usuarios no expertos que facilita la integración de RV y chatbots en aplicaciones, incluyendo también funcionalidades para recopilar datos de usuarios. A través de la aplicación *Let's date!*, se validó la eficacia de esta herramienta en mejorar habilidades específicas, recibiendo además comentarios positivos por su facilidad de uso. No obstante, se enfrentan desafíos como las limitaciones en la especificación BPMN. En trabajos futuros, se planea realizar estudios adicionales para mejorar la usabilidad de los bloques para RV y expandir su aplicación en escenarios más complejos.

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A Parsons' puzzles activity to help with nested loops programming learning

Anabela Gomes
Polytechnic Institute of Coimbra, ISEC
CISUC, University of Coimbra
Coimbra, Portugal
anabela@isec.pt

Francisco Lapa Silva
CISUC-Department of Informatics Engineering, University of Coimbra
Pólo II, 3030-290, Coimbra, Portugal
francisco.lapamsilva@gmail.com

António José Mendes
CISUC-Department of Informatics Engineering, University of Coimbra
Pólo II, 3030-290, Coimbra, Portugal
toze@dei.uc.pt

***Abstract*—** Learning to program for the first time is challenging [1-5]. Studies show high failure rates [6-7] are typical due to students' difficulties. Many students struggle understanding and applying repetitive structures to solve problems [8]. This problem is usually even more evident when the exercises require nested loops [9]. The difficulties are generally increased by learning strategies that ask students to write programs from scratch. This paper describes an experiment using an alternative approach to support nested loop learning. It involves using Parsons' problems with the support of a specific Moodle plugin [10].

Parsons' problems give the student the necessary programming instructions to solve a particular problem [11]. However, these instructions are unordered, and the student's task is to order them so that the resulting program solves the proposed problem. This approach is more straightforward for students than asking them to solve the same problem from scratch [12]. Hence, it may be an interesting approach for beginners, especially those who show more difficulties and cannot autonomously develop complete programs. At the same time, they expose the students to good programming practices. The difficulty level of the problems presented can be variable, and different programming concepts can be used.

During a class, the students were asked to answer 12 questions involving loops and nested loops through a Parsons puzzles activity, producing the output in Figure 1.

The study involved 24 students registered in the first programming course of the first year of a Biomedical Engineering Degree at a Portuguese higher education institution. The language used was Python.

After studying simple loops, students were briefly introduced to nested loops. Then, they participated in a two-hour session in which they were given twelve Parsons' problems to solve using Moodle with CodeRunner. For each of them, the student received an unordered set of instructions that, if correctly ordered, would solve the problem and create the intended output.

At the end of the session, the aim was to collect feedback from the students to understand their views about the activity. To this end, students were asked to complete a form detailing 'What they liked most,' 'What they liked least,' 'Suggestions for improvement,' and 'If they think a tool of that type could help them to program better.

The general average obtained was 73%. We considered each question to have the same weight to get this result. As mentioned before, the result in each question depended on the number of attempts before the correct solution was achieved (10% discount for each wrong attempt).

Q1	**Q2**	**Q3**	**Q4**
1 2 3 4 5	1234 1234 1234 1234 1234	1 12 123 1234 12345	54321 5432 543 54 5
Q5	**Q6**	**Q7**	**Q8**
12345 1234 123 12 1	54321 5432 543 54 5	1 21 321 4321 54321	54321 4321 321 21 1
Q9	**Q10**	**Q11**	**Q12**
5 54 543 5432 54321	* *** ***** ******* *********	********* ******* ***** *** *	* *** ***** ******* ********* ******* ***** *** *

Fig. Intended output of the twelve Parsons' questions

Looking at each question individually, it is possible to verify averages ranging from 96% in Q4 to 38% in Q6. Analyzing each question individually, it is interesting to note that all have a maximum of 100%, meaning that at least one student solved it on the first attempt. Conversely, only questions Q4 and Q5 had a minimum above 0. The zero score could be obtained if the student doesn't answer the question or if they make ten or more unsuccessful attempts. Only one student left the final four questions unanswered, meaning that in the other questions, at least one student used an unsuccessful trial-and-error approach.

Students generally performed better in questions whose solutions followed the same strategy or programming pattern as previous questions. Some of them struggled when the solution introduced some novelty.

As mentioned, some weeks later, the students participated in an assessment that included one question related to nested loops. The grades obtained by the participating students align well with their performance in the Parsons' problems. In this test question, the total average was 70%, with a minimum of 5%, a maximum of 100%, and a standard deviation of 39%.

It is possible to verify that the time spent by most students was similar. On average, they spent 63.04 minutes with a standard deviation of 13.45 minutes, a minimum of 17 minutes (only one student), and a maximum of 76 minutes. No correlation was obtained between the time spent and grade performance (neither from Parsons' activity nor the paper test). However, the time per question is variable. The time spent in Q1 was higher than expected, considering the task's simplicity, possibly due to the students' initial adaptation to

the tool. Q2 took a slightly longer time. This was expected due to the introduction of the nested loops. Questions Q3 to Q5 took considerably less time, possibly due to their similarity with Q2. These were also the questions with better grades. Q6 had the lowest grades. Most students spent much more time on this question than the previous ones, showing difficulties in solving it. Overall, this question required more time for several students, which is interesting as Q6 wasn't the most complex question. This question also showed very high differences in the students' time, ranging from approximately 1 minute to 27 minutes. Even though the total time taken by most students was homogeneous and no correlation was obtained between the time spent and grade performance (neither from Parsons' activity nor the paper test), the increase in time spent on more complex questions was noticeable.

To better understand the results, we also analyzed the students' failed attempts to solve each question. Naturally, this relates to the time students spent on each question and the grades, as each failed attempt led to a 10% discount on the grade. Not surprisingly, most students solved Q4 and Q5 on the first attempt. Verifying that only one student solved the twelve questions on the first attempt is also possible. Generally, the students who made the most attempts, particularly on questions Q2, Q6, Q7, and Q10, were the weakest. This was confirmed in the different assessment moments in the course, as those students failed to get approval for the course. The high number of attempts likely resulted from a trial-and-error strategy used by these students when faced with their inability to answer the questions.

Students answered positively when asked if they felt that Parsons' problems could be helpful for their programming learning. They mentioned several reasons, such as: they offer an easier, more intuitive, and engaging way to approach programming, resembling a game-like experience; because it is as more enjoyable and faster than traditional methods; due to its interactive nature, making the teaching and learning process more engaging and less monotonous; it is especially beneficial when students do not know how to proceed; it assists in comprehending each programming step more thoroughly; it provides guidance on solving new and complex aspects not yet discovered, for understanding the logic behind correct instruction order and its impact; it aids in better comprehension of code structure and flow through trial and error; it helps in grasping the significance of indentations, particularly in initial Python learning; it allows many trial attempts, enabling better mistake comprehension and self-evaluation; it initiates the development of critical and logical thinking skills; it offers a more straightforward method to comprehend exercise solutions; because it provides a different programming exercise experience; diverse activities and application methods contribute to better overall understanding and alleviate monotony; it facilitates the clarification of doubts that might not arise when coding from scratch, thanks to the trial-and-error method.

The students responded positively to the activity according to their current programming level. However, some undesirable behaviors were detected, especially the students' ability to anticipate the necessary pattern by comparing it to previous questions, not because they fully understood the solution. More diverse problems can be used in future experiments to overcome this limitation. Also, distractors (lines of code not necessary for the solution) can be considered to limit the similarity between the lines of code given in each problem.

Interestingly, students who struggled academically found the activity particularly helpful, as they believed learning from presented solutions could guide them toward adopting correct programming practices. On the other hand, more proficient students preferred the challenge of coding from scratch. This observation raises questions about the suitability of the activity for future use, suggesting a need for further reflection and potential adjustments to better cater to the needs of different student groups. Possibly, it makes sense, mainly in the very early learning stages.

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VirtualEdu: Una plataforma para la creación de entornos de aprendizaje con realidad virtual por usuarios no expertos

VirtualEdu: A platform for the creation of virtual reality learning environments by non-expert users

Rubén Baena-Perez
Departamento de Ingeniería Informática, Universidad de Cádiz
Puerto Real, Spain
ruben.baena@uca.es

José Miguel Mota
Departamento de Ingeniería Informática, Universidad de Cádiz
Puerto Real, Spain
josemiguel.mota@uca.es

Manuel Palomo-Duarte
Departamento de Ingeniería Informática, Universidad de Cádiz
Puerto Real, Spain
manuel.palomo@uca.es

Carlos Dominguez-Alcazar
Universidad de Cádiz
Puerto Real, Spain
carlos.dominguezalcazar@alum.uca.es

Antonio Balderas
Departamento de Ingeniería Informática, Universidad de Cádiz
Puerto Real, Spain
antonio.balderas@uca.es

Juan Manuel Dodero
Departamento de Ingeniería Informática, Universidad de Cádiz
Puerto Real, Spain
juanma.dodero@uca.es

***Resumen*—Los avances tecnológicos en educación han llevado a la creación de herramientas que hacen uso de tecnologías como la Realidad Virtual (RV) para mejorar el aprendizaje. Este estudio presenta VirtualEdu, una combinación de una aplicación web y una móvil, que facilita la creación y gestión de Entornos Virtuales de Aprendizaje (EVA) basados en RV. Diseñada para que docentes sin conocimientos técnicos puedan usarla fácilmente, VirtualEdu incluye interacción por voz y recopilación de datos de uso, ofreciendo análisis para optimizar la enseñanza. La evaluación futura en contextos reales ayudará a adaptar VirtualEdu a necesidades específicas, potenciando su eficacia pedagógica.**

***Abstract*— Technological advancements in education have led to the creation of tools that utilize technologies such as Virtual Reality (VR) to enhance learning. This study introduces VirtualEdu, a platform that integrates a web application and a mobile app, facilitating the creation and management of VR-based Virtual Learning Environments (VLEs). Designed for ease of use by educators without technical expertise, VirtualEdu features voice interaction and usage data collection, providing analytics to optimize teaching strategies. Future evaluations in real-world settings will help tailor VirtualEdu to specific needs, enhancing its pedagogical effectiveness**

***Index Terms*—Entornos Virtuales de Aprendizaje, Realidad Virtual, Interacción por voz**

I. Introducción

La digitalización juega un papel esencial en la educación, facilitando el aprendizaje a distancia y la adaptación de diversas estrategias pedagógicas [1]. La expansión del e-learning a través de Entorno Virtual de Aprendizaje (EVA) ofrece acceso a contenidos, fomenta la interacción y facilita la evaluación, elementos que incrementan la confianza y satisfacción estudiantiles, vitales para su compromiso y la retención de información [2], [3].

El uso de EVA genera datos valiosos para análisis en áreas como la Minería de Datos Educativos (MDE) y el Analíticas de Aprendizaje (AA), pero interpretar estos datos puede ser desafiante para docentes sin habilidades técnicas. Adicionalmente, la Realidad Virtual (RV) enriquece los entornos educativos con interactividad e inmersión, aunque su desarrollo puede ser complejo para quienes carecen de experiencia técnica.

Este estudio introduce VirtualEdu, una plataforma diseñada para la creación y gestión de EVA que incorporan RV. VirtualEdu incluye una aplicación web y VirtualEduAPP, una aplicación móvil, ambas diseñadas para enriquecer la experiencia educativa mediante funciones de interacción por voz y monitorización avanzada de las interacciones de los usuarios.

El artículo está estructurado en secciones sobre Trabajos Relacionados, Entorno de Desarrollo, Validacion y Conclusiones, revisando literatura relevante, detallando las funcionalidades de VirtualEdu y discutiendo los resultados obtenidos de las pruebas de la plataforma.

II. Trabajos relacionados

Las herramientas de autoría para EVA en RV son esenciales para proporcionar experiencias educativas inmersivas, permitiendo a los profesores adaptar contenidos sin necesidad de

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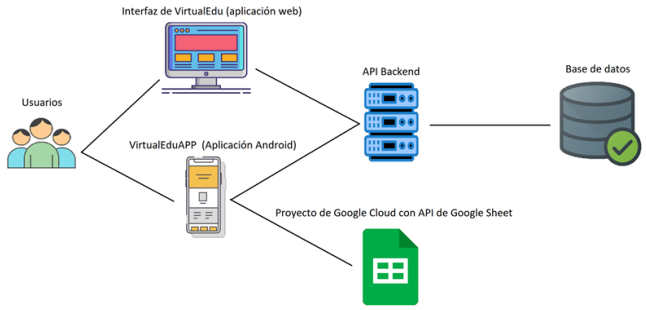

Figura 1. Diagrama arquitectónico de la plataforma VirtualEdu

conocimientos técnicos avanzados [2]. Plataformas como CoSpaces Edu[1] y ClassVR[2] ofrecen distintos niveles de facilidad de uso y personalización, pero pueden enfrentar limitaciones en flexibilidad y escalabilidad, especialmente en contextos de recursos limitados.

La investigación resalta la efectividad de estas herramientas en diversos contextos educativos, mejorando la interacción y realismo de los entornos virtuales [4], [5]. Sin embargo, un desafío persistente es la insuficiente recolección de datos sobre interacciones de los usuarios, lo que limita la evaluación del desempeño estudiantil. Además, la falta de funcionalidades como la interacción por voz puede reducir la inmersión y accesibilidad en estos entornos educativos.

III. Entorno de desarrollo

La arquitectura de VirtualEdu proporciona una experiencia educativa virtual mediante dos interfaces principales: una aplicación web y una móvil para Android, como se muestra en la figura 1.

VirtualEdu permite a los profesores gestionar entornos virtuales de aprendizaje (EVA) a través de una interfaz web intuitiva, organizando escenas que pueden incluir vídeos en 360 grados dentro de una estructura jerárquica tipo árbol de decisiones. La plataforma ofrece herramientas avanzadas para la creación, modificación, y evaluación de escenas, permitiendo ajustar estrategias educativas y proporcionar retroalimentación personalizada basada en el análisis detallado de los resultados de los estudiantes. En la aplicación móvil VirtualEduAPP, los estudiantes acceden a los escenarios disponibles usando sus credenciales web, interactuando a través de comandos de voz, lo cual fomenta un aprendizaje autónomo y una evaluación basada en habilidades comunicativas.

Los códigos fuente de la API de backend[3], el frontend[4], y la aplicación móvil VirtualEduAPP[5] de VirtualEdu están disponibles en GitHub.

[1]https://www.cospaces.io
[2]https://www.classvr.com/
[3]https://github.com/C4rlos99/VirtualEdu-API
[4]https://github.com/C4rlos99/virtualedu
[5]https://github.com/C4rlos99/VirtualEduAPP

IV. Validación

Para garantizar la funcionalidad óptima de *VirtualEdu*, se implementaron pruebas exhaustivas en dos plataformas principales: la aplicación web y *VirtualEduAPP* para dispositivos Android. Las pruebas en la aplicación web abordaron la usabilidad, accesibilidad y compatibilidad, evaluando el comportamiento en diversos navegadores y tamaños de pantalla. Por otro lado, las pruebas en la aplicación móvil se enfocaron en el rendimiento en dispositivos Android, con especial atención en las funcionalidades de interacción por voz y la visualización de vídeos en 360 grados.

Además, se realizaron pruebas de integración, seguridad y carga para mejorar tanto el rendimiento como la seguridad de las plataformas. Herramientas como Postman[6] y Espresso[7] fueron cruciales en el proceso de pruebas automatizadas y de backend.

V. Conclusiones

Este estudio introduce VirtualEdu, una plataforma que incluye una aplicación web para que los profesores creen y gestionen Entornos Virtuales de Aprendizaje (EVA) en Realidad Virtual (RV), y VirtualEduAPP, una aplicación móvil que facilita el acceso y uso de estos EVA a los estudiantes. La plataforma apunta a resolver desafíos como la dificultad de usuarios no expertos en desarrollar entornos de RV, integrar la interacción por voz y recopilar datos para análisis posterior.

Aunque VirtualEdu ya cuenta con una versión funcional, aún no ha sido implementada en entornos educativos reales. Los próximos pasos incluyen evaluar la herramienta en contextos de enseñanza reales para identificar áreas de mejora y ajustar la plataforma a las necesidades y expectativas de los usuarios.

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Visualizing Women's Contributions: The Use of Infographics to Teach Computing History

M. del Carmen de Castro-Cabrera*
Dept. of Computer Science and Engineering
University of Cadiz
Av. Universidad de Cádiz, 10
Puerto Real, 11519, Cádiz, Spain
maricarmen.decastro@uca.es

Gabriel Guerrero-Contreras
Dept. of Computer Science and Engineering
University of Cadiz
Av. Universidad de Cádiz, 10
Puerto Real, 11519, Cádiz, Spain
gabriel.guerrero@uca.es

***Abstract*—This paper investigates the enhancement of computer science education through collaborative learning and the integration of women's contributions into the curriculum to address gender disparities in STEM. The study describes an educational project where students create infographics about women in computing, promoting gender equality in line with the United Nations Sustainable Development Goals. Results demonstrate that this approach improves students' engagement, collaboration skills, and awareness of influential women in computing, effectively addressing knowledge gaps and challenging gender stereotypes. Future work will expand this project to include diverse figures in computing and explore the long-term impact on students' attitudes towards gender equality in STEM and their career intentions.**

***Index Terms*—STEM Gender Equality, Collaborative Learning, Computer Science Education**

I. Introduction

This paper explores the enhancement of computer science education through collaborative learning and the acknowledgment of women's contributions, advocating for their integration into the curriculum to address gender disparities in STEM and promote inclusivity [1]–[4]. It describes an educational project where students employ collaborative strategies to create infographics about women in computing, supporting the broader goals of gender equality aligned with the United Nations Sustainable Development Goals [5].

II. Related Work

Studies such as those by Jaleniauskiene et al. [6], Tarkhova et al. [7], and Bushaala et al. [8] highlight the significant benefits of infographics in enhancing educational outcomes, promoting active learning, and developing critical skills like digital and visual literacy. Additionally, research on Computer-Supported Collaborative Learning (CSCL) by Giannakos and Darra [9] and Maraza-Quispe et al. [10] demonstrates its effectiveness in fostering collaboration among students through various digital platforms, enhancing cooperative skills vital for modern educational environments. Some emerging studies are beginning to recognize the critical roles women have played in the history and evolution of computing. De Castro-Cabrera and Guerrero-Contreras [11] detail an educational project that involves students in documenting women's contributions to computer engineering, promoting a more inclusive view of computing history. Lopes [12] investigates the motivations and challenges women face in computing, while Mochetti [13] provides a comprehensive historical account of women's enduring impact on the field from its mechanical beginnings to the digital age, advocating for greater recognition and integration of these contributions into the academic narrative.

* Corresponding author

III. Methodology

In the development of the activity, initially, first-year computer engineering students are surveyed to assess their prior knowledge and expectations before the course begins. On the first day, the activity is introduced, and students are briefed on requirements, formats, and deadlines for creating infographics on figures such as Barbara Liskov, Grace Murray Hopper, and Margaret Hamilton. Using Moodle, students form groups and are assigned one of the women to research and present through an infographic, guided by specific examples and digital tools provided by the instructors. The process from preparation to evaluation spans several weeks, starting with material preparation and topic assignments in the first week, followed by infographic development and a classroom exhibition in the sixth week where students present their work in seminar sessions.

IV. Evaluation

The evaluation for this course comprises several components developed throughout the term, culminating in a final exam. The overall course grade is calculated by combining the results from the final exam, which accounts for 70%, with the results from various class activities, which make up the remaining 30%. Included in this 30% is the infographic activity discussed in this paper. During the term, students engage in theory lectures, problem-solving seminars, and practical sessions. Seminar performance, which constitutes 15% of the final grade, is assessed based on weekly problems that students solve and submit. Practical sessions contribute another 13% to the grade, evaluated through questionnaires administered via the virtual classroom. The infographic activity itself accounts for 2% of the final grade. The overall numerical grade ranges

from 0 to 10 points, with a minimum of 5 points required to pass the course. Thus, the maximum contribution of the infographic activity to the final grade is 0.2 points. Groups that fully met the requirements outlined in the instructions and effectively presented their infographics received the full 0.2 points, enhancing their overall grades. Conversely, groups that only partially met the requirements received a smaller increment of 0.1 points added to their final grades. Participation was high, with 87.63% of the enrolled students completing the activity. The infographics were assessed based on clarity, adherence to requirements, and presentation quality. The final survey is composed of three Likert scale questions that assess perceptions of the task's difficulty upon completion and a free-response question that asks participants to name three women significant to the history of computer science, mirroring an earlier survey. The specific survey items include: (1) Assessment of the difficulty in understanding the content and/or acquiring skills related to the subject. Respondents can choose from the following options; (2) Evaluation of how the activity enhanced understanding of the content and/or skill acquisition for the course; (3) Assessment of the difficulty in gathering information about the assigned woman; and (4) Identification of three women who have made significant contributions to the field of computer science.

V. Results

The study revealed varying levels of participation and outcomes. While 78% of women and 89% of men participated, the pre-activity survey indicated a significant number of students anticipated medium to high difficulty. However, post-activity responses showed a shift, with over 80% of students finding the task to be of little to medium difficulty, suggesting that the activity effectively demystified the perceived complexity of the content. The surveys also highlighted a significant increase in student awareness of influential women in computing, with the percentage of students unable to name any notable women dropping from 26% initially to just 2% after the activity. This improvement was mirrored in the students' feedback, where many expressed newfound appreciation for the contributions of women to the field, often noting their historical under-recognition. The activity not only enhanced content understanding and appreciation but also fostered engagement and provided valuable insights into students' perceptions of learning, with many acknowledging the visual and interactive format of infographics as a particularly effective educational tool.

VI. Conclusion and Future Work

This study examined the effects of integrating collaborative learning and the recognition of women's contributions into computer science education through infographic projects. Results demonstrated that this method not only heightened awareness of women's roles in the history of computing but also improved students' engagement, collaboration skills, and understanding of the content. The activity successfully increased students' recognition of influential women in computing, indicating its effectiveness in addressing knowledge gaps and challenging stereotypes about gender roles in the field. Despite only a modest impact on final grades, there was a positive association between participation in the project and academic performance, suggesting that such educational strategies could enhance student outcomes and promote gender inclusivity.

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Una propuesta de interfaz colaborativa para mesa multitáctil para el aprendizaje de la programación

Pedro Paredes
Departamento de Informática y Estadística
Universidad Rey Juan Carlos
Madrid, España
pedro.paredes@urjc.es

Jaime Urquiza
Departamento de Informática y Estadística
Universidad Rey Juan Carlos
Madrid, España
jaime.urquiza@urjc.es

Maximiliano Paredes-Velasco
Departamento de Informática y Estadística
Universidad Rey Juan Carlos
Madrid, España
maximiliano.paredes@urjc.es

Craig Anslow
Victoria *University of Wellington*
Wellington, New Zealand
craig.anslow@vuw.ac.nz

Michael Homer
Victoria University of Wellington
Wellington, New Zealand
craig.anslow@vuw.ac.nz

Guillermo J. García-Delgado Álvarez
Departamento de Informática y Estadística
Universidad Rey Juan Carlos
Madrid, España
guj.garciadelga.2018@alumnos.urjc.es

***Abstract*— Enseñar aspectos fundamentales de la informática en niveles preuniversitarios ha sido un tema relevante durante varios años. Los entornos de programación visual basados en lenguajes de bloques, como Scratch, han ganado protagonismo debido a su capacidad para simplificar la entrada en el dificultoso campo de la programación. Por otro lado, el aprendizaje colaborativo es una de las metodologías más efectivas y ampliamente utilizadas en las aulas. Nuestra investigación se centra en diseñar una interfaz colaborativa que permita el trabajo en grupo entre múltiples estudiantes dentro de un espacio de trabajo compartido y soportado por el uso de mesas multitáctiles para el aprendizaje de la programación. Se presenta el proceso de desarrollo de la interfaz orientado por co-diseño con estudiantes y se describen el prototipado de baja y alta fidelidad generados.**

Keywords—component, formatting, style, styling, insert (*key words****)***

I. Introducción

La programación basada en bloques es ampliamente utilizada para enseñar conceptos de programación en la educación primaria y secundaria. Además, el aprendizaje colaborativo es una metodología bien conocida y efectiva utilizada en esos contextos [2]. Por otro lado, las mesas táctiles multitáctiles han demostrado sus ventajas en el apoyo a actividades colaborativas y en la mejora de experiencias de aprendizaje [3]. Sin embargo, existen pocas aproximaciones que combinen entornos de programación basados en bloques, aprendizaje colaborativo y mesas táctiles multitáctiles [5,6].

En este trabajo se describe el diseño de un prototipo de baja fidelidad donde los estudiantes jóvenes o niños pueden trabajar juntos para crear sus propios programas de ScratchJr [1] utilizando una mesa táctil como espacio de trabajo compartido. La producción del prototipo siguió un proceso de co-diseño con estudiantes de dos grados diferentes: educación infantil e informática. Los primeros compartieron su conocimiento sobre las características de los niños entre 3 y 6 años y su experiencia usando ScratchJr, mientras que los últimos pusieron en práctica los principios de HCI y diseño de UI. Con este enfoque se desarrolló una experiencia que duró el primer cuatrimestre del curso 2022/2023 en la Universidad Rey Juan Carlos donde participaron 4 profesores y 23 estudiantes de dos grados diferentes: Grado de Educación Infantil y Grado de Ingeniería de Computadores. Los estudiantes fueron divididos en cinco grupos mezclando estudiantes de ambos grados. Produjeron prototipos de baja fidelidad que fueron evaluados y utilizados para producir el que se presenta en este trabajo.

II. Descripción del prototipo

A. Prototipos de baja fidelidad

El proceso de diseño del prototipo de baja fidelidad siguió tres pasos. En primer lugar, se llevó a cabo un proceso participativo de co-diseño con estudiantes. En segundo lugar, se evaluaron los prototipos producidos por los estudiantes. Finalmente, el prototipo de baja fidelidad se diseñó utilizando los principales requisitos de la aplicación, los prototipos de los estudiantes y sus evaluaciones.

En esta fase de co-diseño los estudiantes generaron cinco prototipos. Uno de los prototipos fue descartado ya que el grupo no había tenido tiempo de crear un artefacto útil para la investigación. Los otros cuatro fueron evaluados por tres expertos en diseño de interfaces colaborativas. Para ello, se utilizaron grabaciones, fotografías y los prototipos con cartulinas, papel y colores creados por los estudiantes.

A modo de ejemplo de unos de los prototipos de baja fidelidad generado se muestra la Fig. 1, donde se puede ver que la pantalla de trabajo de este prototipo está centrada en un cuadro central más pequeño, dejando los lados para la extensión de actividades. En la parte superior hay botones de control: configuración/iniciar, ejecución/deshacer/comunicar y un botón de menú principal. En la parte inferior hay varios botones vacíos para la extensión de funciones. Finalmente, mucho más visibles son cuatro lápices que sugieren edición. Al hacer clic en ellos, se ocultan solo áreas de la mesa (una esquina en forma de L de la mesa) pero la zona de la escena del programa siempre es visible. Para cada uno de los prototipos evaluados, se identificaron ventajas y desventajas desde el punto de vista de la usabilidad. Por ejemplo, en el mencionado prototipo de la Fig. 1 se identificó como ventajas la posibilidad de utilización del modo de pantalla completa, disposición de cuatro lados de la mesa con el bolígrafo para permitir que cualquiera edite, la parte central visualiza la apariencia/ejecución de lo que se construyen, las funcionalidades básicas de construcción aparece en los laterales y trata de no ocultar la parte central y que las funcionalidades poco frecuentes (configuración y plantillas) en la parte central, aparecen y desaparecen en un pop-up. Tras este análisis de todos los prototipos se seleccionó el más adecuado y a partir del mismo se desarrolló un prototipo de alta fidelidad.

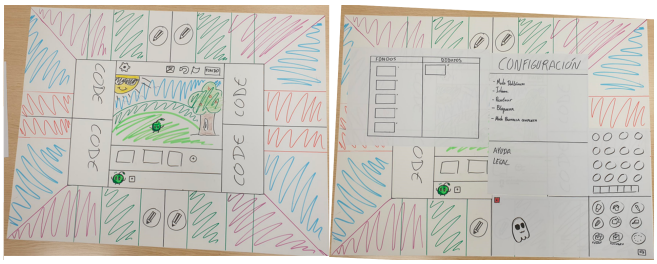

Fig. 1. Prototipo de baja fidelidad de la fase de co-diseño

B. *Prototipo de alta fidelidad*

La interfaz de usuario del prototipo de alta fidelidad se adapta al número de usuarios conectados en cada momento. La Fig. 2 muestra una captura de pantalla del prototipo con tres usuarios creando un script básico. La interfaz de usuario está estructurada en tres partes principales basado en un diseño estructural colaborativo [4]. En primer lugar, dos botones situados en las esquinas superiores izquierda y derecha de la pantalla permiten acceder a la pantalla de inicio y a los ajustes, respectivamente. A través del botón de ajustes se pueden configurar tres características: volumen, brillo y notificaciones. El espacio colaborativo presenta un área principal para mostrar la ejecución de los scripts, que ocupa la mayor parte del espacio. Dentro de esta área, se muestran varios botones de ScratchJr para gestionar la ejecución de scripts y diseñar escenas, incluyendo iniciar la ejecución, reiniciar la ejecución y acceder a la galería de escenas (ver Fig. 2, marca A). En segundo lugar, en el centro de la interfaz de usuario, dos botones gestionan los usuarios conectados. La marca B de la Fig. 2 muestra estos botones etiquetados con los símbolos "+" y "-", que permiten añadir o eliminar usuarios de la sesión. Además, en esta área se muestra un emoticono que representa a cada usuario conectado. Por último, se muestran varios espacios individuales (ver Fig. 2, marcas C). Estos espacios ofrecen un panel de bloques para crear scripts de manera individual.

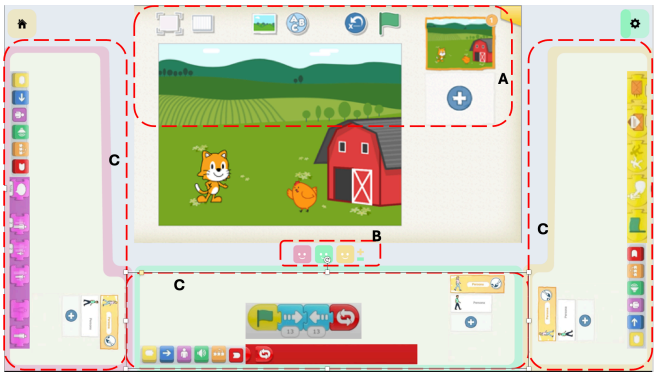

Fig. 2. Prototipo de alta fidelidad

Una decisión de diseño importante es aprovechar el conocimiento previo del usuario sobre ScratchJr. Por lo tanto, el entorno imita las interfaces de ScratchJr para la edición de fondo y caracteres (apariencia y scripts) y la ejecución de scripts utilizando bloques de programación con la misma apariencia. Los bloques están agrupados en varias categorías como movimiento, sonido, mensajes, etc. Cuando un usuario selecciona una categoría, se muestran los bloques correspondientes. Además, el prototipo de alta fidelidad implementa un sistema de notificación para coordinar las propuestas de los usuarios dentro del grupo. Cuando un usuario propone un cambio en el script, se genera una notificación para todos los usuarios. Esta notificación debe ser aceptada o rechazada por el resto de los usuarios para que el cambio propuesto se aplique en el espacio colaborativo.

III. Conclusión

Este estudio propone el uso de mesas multitáctil como elemento de interfaz tangible principal para facilitar el aprendizaje colaborativo de la programación basada en bloques. Introduce un prototipo de alta fidelidad destinado a enseñar ScratchJr a niños. Se llevó a cabo un proceso de co-diseño que involucró a 23 estudiantes de diversas disciplinas en el aula para desarrollar varios prototipos de baja fidelidad. Estos prototipos fueron posteriormente analizados en cuanto a su usabilidad, culminando en el desarrollo de un prototipo de alta fidelidad. El prototipo tiene dos espacios principales: uno para trabajo colaborativo y otro para tareas individuales como la creación de scripts basado en bloques y personajes. Los siguientes pasos de este proyecto serán, en primer lugar, desarrollar un software que implemente el prototipo de alta fidelidad. Este prototipo será evaluado empíricamente con profesores en formación y niños. Finalmente, los resultados de esta evaluación empírica guiarán el desarrollo de una aplicación final.

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Implementação de um Learning Record Warehouse para diferentes especificações de interoperabilidade em um Learning Management System

Juary Costa Rocha
Centro de Desenvolvimento Tecnológico
Universidade Federal de Pelotas
Pelotas, Brasil
jcrocha@inf.ufpel.edu.br

Emilcy Juliana Hernández-Leal
Facultad de Ingenierías
Universidad de Medellín
Medellín, Colombia
ejhernandez@udemedellin.edu.co

Vinicius Ramos
Dept. de Engenharia do Conhecimento
Universidade Federal de Santa Catarina
Florianópolis, Brasil
v.ramos@ufsc.br

Roberto Munoz
Escuela de Ingeniería Informática
Universidad de Valparaíso
Valparaíso, Chile
roberto.munoz@uv.cl

Cristian Cechinel
Coord. Tec. da Informação e Comunicação (CIT)
Universidade Federal de Santa Catarina
Araranguá, Brasil
cristian.cechinel@ufsc.br

Tiago Thompsen Primo
Centro de Engenharias
Universidade Federal de Pelotas
Pelotas, Brasil
tiago.primo@inf.ufpel.edu.br

Emanuel Marques Queiroga
Diretoria de Tec. da Informação
Instituto Federal Sul-rio-grandense
Pelotas, Brasil
emanuelmqueiroga@gmail.com

I. Introdução

A interoperabilidade semântica desempenha um papel fundamental na eficácia dos sistemas de Análise de Aprendizagem, servindo como o canal pelo qual os dados de diversas fontes podem ser perfeitamente integrados e interpretados por um aplicativo central sem comprometer seu significado inerente.

II. Soluções Existentes para Interoperabilidade

Entre os vários mecanismos que facilitam a interoperabilidade no Learning Analytics, duas especificações se destacam: Caliper Analytics e Experience API (xAPI). Esses padrões fornecem as estruturas necessárias para harmonizar os fluxos de dados entre plataformas e aplicativos educacionais, possibilitando um ecossistema coeso para análise de dados e geração de insights.

O Caliper Analytics é uma especificação liderada pela 1EdTech, uma comunidade internacional de universidades e empresas que promove a padronização e as especificações internacionais em e-learning e ICT educacional. O Caliper Analytics adota o conceito de um evento, que aborda um contexto de uso com a seguinte estrutura: um ator, que pode ser um aluno, um professor ou qualquer agente educacional; uma ação (ou intervenção), que representa o que o ator está fazendo; e um objeto, que representa o material que o ator está usando [1].

xAPI, também conhecida como TinCan, é uma especificação técnica aberta para tecnologias educacionais que permite que o conteúdo de aprendizagem e os sistemas de aprendizagem se comuniquem entre si para registrar e rastrear experiências de aprendizagem. Ela especifica uma estrutura para a descrição de experiências de aprendizagem e define como essas descrições podem ser trocadas, sendo um dos primeiros serviços desenvolvidos com foco no compartilhamento de dados sobre experiências de aprendizagem [2], [3].

A xAPI teve sua primeira versão 1.0 lançada em 2013, enquanto o Caliper Analytics teve sua versão 1.0 lançada em outubro de 2015 [4]. De muitas maneiras, a xAPI e o Caliper executam funções semelhantes, fazendo uso de conceitos semelhantes. No entanto, eles são bastante diferentes em suas abordagens de desenvolvimento e governança. O Caliper foi criado por meio de um processo fechado em uma organização de membros, enquanto a xAPI surgiu de um processo aberto em que todas as partes interessadas são bem-vindas para contribuir. A propriedade intelectual do Caliper é detida pela 1EdTech, enquanto a xAPI, por outro lado, é disponibilizada gratuitamente para todos sob uma licença Apache 2. O Caliper se concentra principalmente nos casos de uso coletados das organizações membros da 1EdTech, ao mesmo tempo em que fornece extensões, enquanto a xAPI delega grande parte da responsabilidade de definir os vocabulários a serem usados na especificação para as comunidades, ao mesmo tempo em que desempenha um papel na garantia da funcionalidade principal.

III. Experimentos

O foco deste estudo está na implementação prática de um Learning Record Warehouse (LRW) adaptado para o armazenamento e o gerenciamento de registros do Moodle. Aproveitando alguns plugins disponiblizados pelo ambiente do Moodle que oferecem suporte a interoperabilidade de dados, Caliper Analytics e o xAPI, utiliza-se de um LRW como um repositório centralizado para a ingestão e o armazenamento de logs de atividades coletados do Moodle. Nesse contexto, o LRW não apenas permite agregar dados brutos provenientes de diferentes fontes, mas também preserva sua integridade semântica, garantindo que as nuances e o contexto dos registros originais sejam mantidos para análise posterior.

Os experimentos foram realizados no Moodle LMS, no qual foram instalados dois plug-ins que podem enviar registros de logs gerados no sistema. Um dos plugins envia os registros utilizando a especificação do Caliper Analyzer, enquanto o segundo os envia na especificação xAPI. Ambos os plugins são de código aberto e foram desenvolvidos para uso no Moodle. Para armazenar os registros, foi escolhido o OpenLRW, uma ferramenta produzida pela Apereo, que é de código aberto e desenvolvida em Java, com código disponível no GitHub. Em maio de 2016, o OpenLRW era compatível apenas com xAPI, no entanto, em outubro de 2016, ele também se tornou compatível com o Caliper.

Para instalar e configurar o OpenLRW, utilizou-se uma imagem do Docker do software e iniciou-se o serviço com a ajuda de um arquivo docker-compose.yml. Esse arquivo contém dois serviços: um banco de dados MongoDB na versão 3.9 e o próprio OpenLRW. Depois de executar o comando docker-compose up, o serviço fica disponível em um localhost. Para enviar eventos ao serviço, é necessário obter uma chave de acesso e o segredo correspondente, que serão usados como nome de usuário e senha no Moodle. Infelizmente, o OpenLRW não oferece uma API ou interface gráfica para obter essas credenciais diretamente. Portanto, é necessário conectar-se diretamente ao banco de dados MongoDB para recuperar as informações.

A compatibilidade do OpenLRW com os padrões Caliper Analytics e xAPI fez dele a escolha interessante para acomodar os diversos formatos de dados gerados pelos registros do Moodle. No entanto, apesar dos recursos de conversão incorporados do OpenLRW para dados que sejam compatíveis entre os diferentes formatos xAPI e Caliper Analyzer, durante o estudo encontraram-se alguns impedimentos, que demostraram lacunas na abordagem adotada pelo OpenLRW.

IV. Considerações Finais

Ao longo do processo de experimentação, alguns gargalos e desafios surgiram, indo desde a configuração do OpenLRW, até a perda de dados quando se enviam os dados em uma determinada especificação. Esses desafios se traduziram em uma investigação mais aprofundada e o refinamento da estratégia de implementação. Os obstáculos encontrados, embora não sejam intransponíveis, ressaltam as complexidades inerentes à obtenção de interoperabilidade de dados entre sistemas educacionais e de diferentes formatos. Ao enfrentar esses desafios, o estudo visa contribuir para o discurso em andamento sobre a interoperabilidade de dados na área de Learning Analytics, abrindo caminho para soluções mais robustas e dimensionáveis no futuro.

Em essência, a implementação de um LRW para os registros do Moodle usando o Caliper Analytics e as especificações xAPI representa um passo significativo para melhorar a interoperabilidade de dados e a utilidade dos sistemas de Learning Analytics. Embora o OpenLRW possa oferecer maior interoperabilidade ao permitir o uso de diferentes especificações, sua falta de atualizações e suporte pode comprometer a integridade e a eficácia da interoperabilidade a longo prazo. É necessário abordar essas limitações e buscar soluções que garantam a compatibilidade contínua com as especificações e os padrões mais recentes, como o xAPI, para promover a interoperabilidade robusta e confiável em sistemas de gerenciamento de aprendizagem como o Moodle.

Como trabalho futuro, pretende-se desenvolver um Learning Record Warehouse (LRW) que não dependa da conversão entre diferentes especificações, mas que armazene os dados no formato de entrada original. Para isso, planeja-se usar PostgreSQL, um banco de dados que oferece suporte nativo ao formato JSON. Este LWR será integrado a uma solução de análise de aprendizado baseada em nuvem para prever alunos em risco de reprovação e evasão escolar chamada LANSE [5].

Agradecimentos

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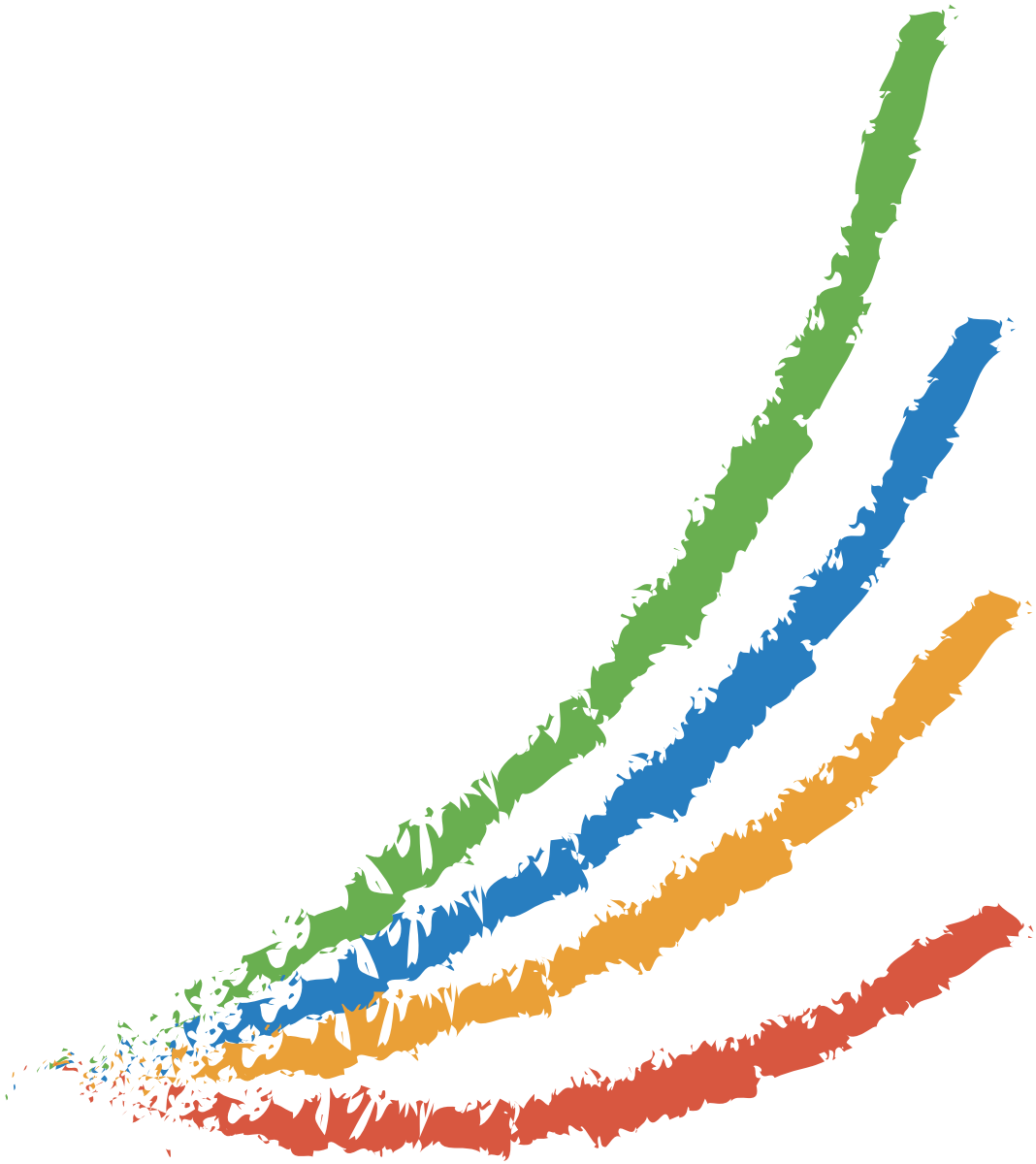
IA in Education and Learning Analytics



Opinión de los estudiantes sobre el uso de un Modelo Grande de Lenguaje en una asignatura de Bases de Datos

Students' opinion on using an LLM in a Database course

Manuel Palomo-Duarte
Departamento de Ingeniería Informática
Universidad de Cádiz
Puerto Real, Spain
manuel.palomo@uca.es

Rubén Baena-Pérez
Departamento de Ingeniería Informática, Universidad de Cádiz
Puerto Real, Spain
ruben.baena@uca.es

Antonio Balderas
Departamento de Ingeniería Informática, Universidad de Cádiz
Puerto Real, Spain
antonio.balderas@uca.es

Juan Antonio Caballero-Hernández
Departamento de Ingeniería Informática, Universidad de Cádiz
Puerto Real, Spain
juanantonio.caballero@uca.es

Andrés Muñoz
Departamento de Ingeniería Informática
Universidad de Cádiz
Puerto Real, Spain
andres.munoz@uca.es

Juan Manuel Dodero
Departamento de Ingeniería Informática
Universidad de Cádiz
Puerto Real, Spain
juanma.dodero@uca.es

***Resumen*—The use of assistants like ChatGPT or BingChat in educational settings presents opportunities and challenges, underscoring the importance of thoughtful and responsible integration. In this context, we present a study where students reviewed responses provided by BingChat to questions from a Database exam, followed by an evaluation of their experience using a Technology Acceptance Model questionnaire. Overall, the results reflected a positive attitude towards the tool and a certain correlation between academic performance and the perception of BingChat.**

***Resumen*— El uso de estos asistentes en entornos educativos como ChatGPT o BingChat presenta oportunidades y desafíos, lo que subraya la importancia de una integración reflexiva y responsable. Presentamos un estudio donde los estudiantes revisaron las respuestas proporcionadas por BingChat a un examen sobre Bases de Datos, seguido de la evaluación de su experiencia mediante un cuestionario Technology Acceptance Model. En general, los resultados reflejaron una actitud positiva hacia la herramienta y cierta correlación entre el desempeño académico y la percepción de BingChat.**

***Index Terms*—Generative Artificial Intelligence, Large Language Models, Technology Acceptance Model, Relational Databases.**

I. Introducción

ChatGPT y BingChat son asistentes conversacionales de IA generativos basados en Modelos Grandes de Lenguaje (LLM, del inglés *Large Language Model*). Su uso en entornos educativos ha tenido una adopción positiva [1]. Sin embargo, su fiabilidad ha planteado críticas sobre su integración en prácticas de enseñanza y evaluación [2], lo que enfatiza la necesidad de un uso responsable.

Este trabajo ha sido desarrollado en el contexto del proyecto CRÊPES (ref. PID2020-115844RB-I00), financiado por la Agencia Estatal de Investigación del Ministerio de Ciencia e Innovación de España con fondos ERDF.

II. Metodología

Se realizaron las siguientes fases (más detalle en [3]): primero se pidió a BingChat la solución de un problema práctica de examen. Después los estudiantes corrigieron en la respuesta de BingChat los errores detectados y por último rellenaron un cuestionario TAM.

III. Análisis de resultados por grupos

El cuestionario TAM y sus resultados se explicaron en [3]. Ahora se analizan las respuestas de los 55 estudiantes atendiendo a los resultados en el primer y tercer parcial de la asignatura, que son los más relacionados con la tarea (figuras 1 y 2 respectivamente). Se dividen los estudiantes en cuatro grupos: notable y sobresaliente (7 puntos o más), aprobado(entre 5 y 6,9 puntos), suspensos (entre 3,5 y 4,9 puntos) y abandonan (menos de 3,5 puntos).

Los estudiantes que abandonaron la evaluación continua de la asignatura en el primer parcial tienen un valor de $3,5$ en el ítem PU2 (BingChat me ha permitido mejorar la calidad de la solución del ejercicio), cuando el resto de grupos no llegan a 3. Parece que la herramienta ofrece un apoyo mucho más interesante ellos. Sin embargo, atendiendo a la nota del tercer parcial el grupo de notable/sobresaliente prácticamente iguala la nota del grupo de abandono.

De manera similar, en el ítem PU3 a los que abandonan en el primer parcial se unen a los suspensos con una media de 3,5 ambos (respecto al 3,3 del resto), afirmando que "BingChat

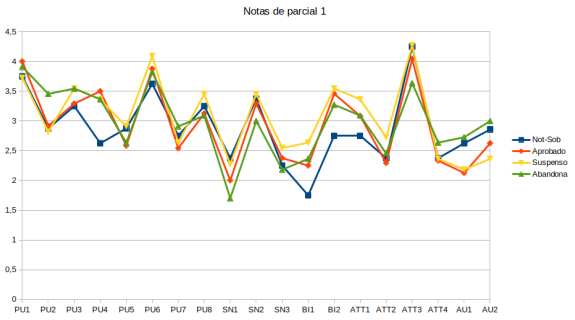


Figura 1. Medias según la nota del primer parcial.

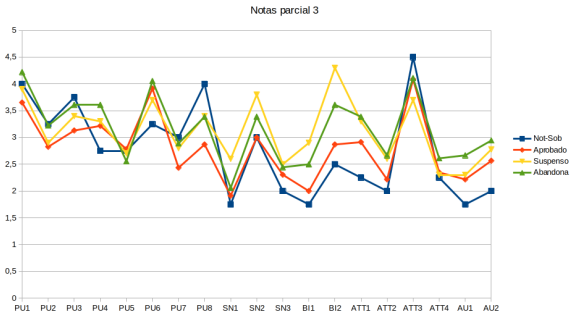


Figura 2. Medias según la nota del tercer parcial.

me ha permitido mejorar mi productividad en este ejercicio". Y curiosamente, en el ítem PU3 se une a estos dos grupos el grupo de aprobados en el primer parcial (todos con medias de $3,4$ o $3,5$) afirmando que "BingChat me ha permitido entender mejor lo que pedía el ejercicio", mientras que el grupo de notable/sobresalientes se mantienen en un valor medio $(2,6)$.

En el ítem PU4 (BingChat me ha permitido entender mejor lo que pedía el ejercicio) en las dos agrupaciones de notas los estudiantes de notable/sobresaliente declaran valores más bajos que el resto de grupos. Y atendiendo a notas del tercer parcial el orden es totalmente inverso: a menor nota en el parcial mayor valor en el ítem del TAM (es decir, más les ayudó BingChat a entender el ejercicio).

Destaca el resultado del ítem PU6 (La solución propuesta por BingChat es fácil de entender), que aunque tiene valores altos en todos los grupos (entre 3,6 de los notables/sobresalientes y 4,1 de los suspensos), presentan hasta medio punto de diferencia. Esta percepción se mantiene atendiendo a las notas del tercer parcial.

Para terminar con los ítem PU, hay que señalar que en PU8 (Las ventajas de usar BingChat al resolver este ejercicio son mayores que las desventajas) el grupo de notable/sobresaliente ha marcado un resultado mucho mayor que los demás grupos $(0,6$ respecto al siguiente).

Los estudiantes que abandonaron en el primer parcial tienen notas más bajas en SN1 (Mi profesor/a piensa que debemos usar BingChat en la asignatura) y SN2 (Mis compañeros/as piensan que debemos usar BingChat en la asignatura), con una diferencia de $0,3$ puntos con el siguiente grupo. Hay que recordar que son los que declaraban que más le ayudaba BingChat. Pero atendiendo a las notas del tercer parcial este comportamiento se invierte, y el grupo que abandona se muestra mucho más positivos en ambos ítems.

El grupo de mejores notas en el primera parcial con $0,4$ puntos por debajo en BI1 (Tengo intención de seguir usando BingChat en esta asignatura) y $0,5$ menos en BI2 (Suponiendo que el profesor nos dé acceso e instrucciones de cómo usar BingChat, tengo intención de utilizarla como una herramienta más en la asignatura). Parece que han detectado poca utilidad en la herramienta. Ese comportamiento se mantiene agrupando por notas del tercer examen parcial.

En Actitud hace el uso (ATT) destaca que en el ítem ATT3 (Revisar el ejercicio resuelto por BingChat ha sido entretenido) los estudiantes que abandonan tras el primer parcial declaran $0,7$ puntos menos que el siguiente grupo (aunque agrupando por el parcial tercero es el grupo de suspensos el más bajo). Mientras que en ATT4 (Pienso que BingChat es capaz de resolver el ejercicio mejor que yo) está como el grupo con puntuación más alta.

Por último, en cuanto al uso real (AU) los grupos extremos del primer parcial (estudiantes de notable/sobresaliente y los que abandonan) sacan una nota superior a los otros dos grupos. Pero hay que destacar que agrupando por la nota del tercer parcial los estudiantes de notable/sobresaliente declaran unas puntuaciones mucho más bajas ($0,4$ y $0,6$ en los ítems AU1 y AU2 respectivamente).

IV. Conclusiones y trabajo futuro

Se evidencia una cierta correlación entre el desempeño académico y la percepción de BingChat, ya que los estudiantes que suspendieron o abandonaron los parciales muestran una mayor aceptación de los resultados proporcionados por BingChat en comparación con aquellos que tuvieron un mejor desempeño en los parciales. Esto sugiere que los estudiantes con un rendimiento académico más bajo pueden percibir la herramienta como más útil o beneficiosa en su proceso de aprendizaje.

A la vista de los resultados obtenidos, se propone realizar un análisis más exhaustivo para el futuro y con una mayor población para identificar corroborar los aspectos apuntados en el estudio y realizar propuestas de actuación educativa.

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Employing UX techniques and AI tools to improve collaboration in Creative Technology courses

Félix Buendía-García
Computer Engineering department
Universitat Politècnica de València
Valencia, España
e-mail: fbuendia@disca.upv.es

***Abstract*— User experience methodologies have greatly influenced collaborative learning within various creative technology courses. Within the scope of the current project, a selection of these courses is leveraged to introduce Artificial Intelligence tools, empowering designers to enrich collaborative environments. An approach is outlined to foster a deeper comprehension of the significance of such tools through the lens of user experience design principles. Subsequently, collaborative learning experiences are devised to demonstrate the practical application of this approach in designing website elements and their consequential impacts. The primary contribution of this preliminary endeavor resides in proposing a systematic framework for integrating intelligent tools within collaborative learning design contexts.**

Keywords*— *User eXperience design methods, Artificial intelligence tools, Collaborative learning scenarios

I. INTRODUCTION

User eXperience (UX) methods have significantly impacted collaborative learning in creative technology courses, providing new opportunities for interaction, communication, and the sharing of ideas among students and instructors. That is the case of courses which are taught in the Design and Creative Technologies Bachelor's Degree at Universitat Politècnica de València. Moreover, AI (Artificial Intelligence) tools have burst into UX design processes [1] introducing novel technologies that can improve the way collaboration can be produced during the creation of digital projects. The current work is focused on the use of UX methods and AI tools to enhance collaborative scenarios in this kind of creative technology courses. These courses include the design of websites addressed to supporting the elaboration of digital artifacts within this context. Students in such courses belong to 3rd and 4th year, and they are organized in teams of 3-4 members facing different types of activities from preparatory meetings to explore or analyze a target Web project to more technical development tasks. A crucial question consists in examining the role of AI in a context of collaborative creative scenarios. Edgington [2] analyzed the combination of UX, Design and AI tools for enhancing design collaboration and creativity by embracing strengths of both humans and AI and achieving successful co-creation. A systematic literature review [1] about the use of AI in the UX design process has revealed multiple cases, which are classified according to different topics such as their impact in the digital design process or studies for understanding the context of use. Most of these UX design tasks were based on taking advantage of the potential of AI frameworks such as Chat GPT or similar ones to writing user stories or improving user interviews. Likewise, the interest in UX evaluation methods have shifted them to AI-powered applications. For example, eye-tracking software tools become very popular in UX design [3] and these tools have now evolved into a predictive perspective [4]. The remainder of this work is structured as follows. Section 2 describes the approach used to understand the role of UX methods and AI technologies in the previously referred courses. Section 3 provides some details about the collaborative experiences implemented in this context and their main results. A discussion of these results and the proposed approach is performed in section 4 and finally, some conclusions and further works are drawn.

II. APPROACH

The approach to review the use of UX methods and AI tools in a context of collaborative learning is based on the framework that organizes user-experience research methods in four main stages. Fig. 1 shows a workflow chart displaying some examples of UX methods according to this organization. First stage is referred to *Discover* methods that are addressed to achieving a better understanding of the target user needs. Within the current learning context, these needs make reference to the requirements of websites to be developed by students in Creative Technology courses. The second stage considers those *Exploration* methods, which can help website designers to obtain a more detailed view of the user needs through a customer journey map together with a description of the information architecture in a card sorting process. The third stage is related to the *Testing* of those artifacts that are generated during the website development such as a user interface prototype or its usability study. The final stage consists in *Listening* all the participants in the development process to evaluate gathered data through an analytics review or a search-log analysis.

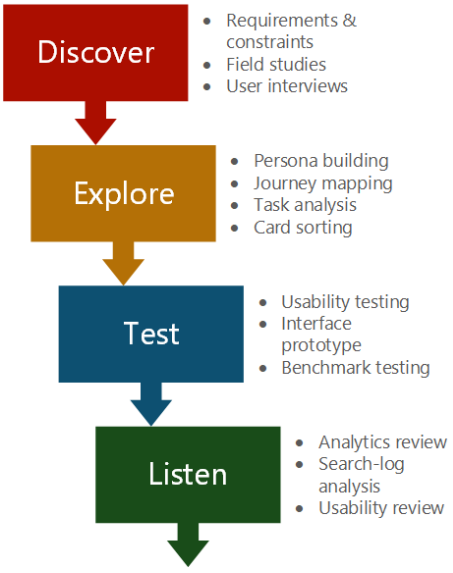

Fig. 1. Framework of UX methods and activities.

III. EXPERIENCES & RESULTS

The approach presented to review the application of UX methods and AI tools in collaborative scenarios was used in some experiences developed with students of Creative Technology courses. A first part of these approach-based experiences was focused on the collaboration among instructor and students who exchanged ideas about exploring the briefing contents to extract relevant concepts using AI tools. The next step leveraged the extracted concepts to carry out a collaborative *Carding Sort* task to allow students the classification of these concepts in several categories. Final results were evaluated to check the UX outcomes produced in a collaborative way.

IV. DISCUSSION

Previous sections have provided an initial understanding together with preliminary results about the impact of AI tools in some examples of design settings under UX principles. These settings were related to courses in Creative Technologies taught to students who combined basic technical knowledge in Web development along with their artistic background. These students are becoming increasingly aware of the possibilities offered by this kind of tools to help them to improve their design skills. They are conscious about the potential of technologies such as the Generative AI and other related tools in UX design aspects but, at the same time, students are feeling generally overwhelmed with the growing multiplicity of these technologies and their fast evolution. Moreover, it is clear that collaboration between human and AI is being consolidated but examining the role of AI tools to boost a collaborative learning scenario among UX design students is still a challenging issue.

First, it is important to understand how UX design has changed with the use of AI tools and the way these tools can help students in Creative Technologies disciplines. Stige et al. [1] already reviewed how AI could be actually used to support UX design processes and they observed its application through the several stages in these processes putting the focus on repetitive tasks that could be automated. For example, AI tools have demonstrated to be very useful in the generation of multimedia resources or the production of code during intermediate and last design stages. Nevertheless, initial stages dealing with the discovery of user needs or analyzing their context of use can also take advantage of AI techniques. In this sense, user needs gathered from a briefing statement can be "discussed" with an AI in order to obtain tentative questions to be used in further interviews with end-users or extract relevant concepts that feature the main information items of the designed product.

A second aspect to be considered within the context of the current work is the need to promote a collaborative strategy when using AI tools to support UX design. As mentioned before, there is a huge amount of these AI-powered tools, which can provide an invaluable help to the design of products such as user interface sketches or website prototypes. However, the shortage of environments and frameworks that can assist UX designers in the collaborative application of these tools is also evident. Finally, all these collaborative UX design tasks embracing the use of AI tools should be able to face a learning perspective in which the required academic work can be tracked and accounted. In this sense, a kind of formative assessment could be the right method to start a first instructional experience as it was shown in previous sections. This formative assessment would include resources such as concept maps, interactive quizzes, reflective journals or learning logs, which could be used to track and record the contributions of team members during the collaborative work.

CONCLUSIONS

The current work has presented an approach to guide the application of AI-powered tools within a context of collaborative UX design in Creative Technology courses. This approach has been based on a framework organization of four main stages coming from the initial discovery of target requirements to their final evaluation. Through these stages, several examples of AI tools and their application in specific UX tasks have been described. The impact of these tools in gathering potential user needs and their context of use has been observed to show how generative AI can contribute to achieving relevant UX design aspects. Moreover, the link between the collection of target requirements and their further processing by means of UX techniques such as *Card Sorting* has been highlighted remarking their application in a teamwork scenario. All these collected insights could be ultimately taken as inputs addressed to a final analysis in which evaluation and multimodal assessment methods would provide a meaningful perspective of the UX workflows and the produced outcomes. At this moment, only partial indicators such as topic agreement values or heatmap measurements have been proposed to analyze the results of UX design experiences but a more global idea is required.

The need for additional research in collaborative applications of AI tools in these UX design settings is also part of the future works to be undertaken. There are multiple platforms that allow users to share their projects when they are developing products or services under UX principles, although the incorporation of AI functionalities in these projects is usually carried out in an isolated way without a suitable connection among the component tasks. Besides, the lack of instructional initiatives that promote a sound collaboration among educational stakeholders in these UX settings has been detected and it could be part of a further investigation in the future.

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Evaluation of a predictive model for academic performance in a small-scale programming course

José Miguel Llanos Mosquera
Engineering Department
Corporación Universitaria del Huila - CORHUILA
Neiva (Huila), Colombia
jmllanosm@corhuila.edu.co

J. Ángel Velázquez Iturbide
Department of Informatics and Statistics
Universidad Rey Juan Carlos
Madrid, España
angel.velazquez@urjc.es

Maximiliano Paredes Velasco
Department of Informatics and Statistics
Universidad Rey Juan Carlos
Madrid, España
maximiliano.paredes@urjc.es

Víctor Andrés Bucheli Guerrero
School of Systems Engineering and Computer Science
Universidad del Valle
Cali (Valle del Cauca), Colombia
victor.bucheli@correounivalle.edu.co

***Abstract*—Programming courses often demonstrate poor academic performance. To address this challenge, one strategy involves developing predictive models to identify students facing difficulties and implementing early interventions during the course. The aim of this study is to evaluate the quality of an academic performance prediction model in a programming course with few students. The methodology employed both a predictive model and a questionnaire focusing on motivating learning strategies. Results show that the proposed model achieves 86% accuracy in its predictions, beginning from week 7 of the course.**

***Index Terms*—predictive model, academic performance, MSLQ, programming courses.**

I. Introduction

Computer programming courses equip students with the knowledge and skills essential for mastering programming [1]. However, these courses frequently encounter low performance rates, leading experts to propose that predicting performance throughout the course is essential to address this issue [2]. Furthermore, some advocate for early-stage predictions to assist instructors in providing timely support to students through interventions [3].

Early prediction of academic performance is garnering increasing attention from researchers and educators who seek the most appropriate characteristics and machine learning algorithms to leverage educational outcomes and devise interventions [4], [5]. Nonetheless, there is a need to develop and evaluate additional models that enable the prediction of student performance in programming courses right from the start. This approach empowers teachers to implement targeted actions to aid struggling students, address low academic performance, and effectively nurture the learning process [6], [7].

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This study tackles the following research question: *"What is the quality of the proposed predictive model for academic performance in a small-scale programming course?"* To address this inquiry, we employed a predictive model for academic performance along with the MSLQ Colombia questionnaire [8] in a programming course with a limited number of students.

II. Literature review

The literature review highlights that the most commonly utilized machine learning algorithms for predicting academic performance are classification and regression [2], [5]. For instance, In [9], performance is forecasted based on weekly assessments and programming exercises. In [10], academic and programming attributes are leveraged to forecast student performance from the third week of a programming course.

In the realm of regression algorithms, research like that of [11] uses the linear regression, to predict student performance and improve educational processes. Similarly, [12] introduces a model aimed at forecasting students' final grades in a CS1 programming course, leveraging grades from the initial phase of the course.

It is evident that while several prediction models have been developed, few have tackled the challenge of working with limited data. Hence, in this study, we draw upon the findings of [10], to formulate the proposed prediction model, which integrates the MSLQ Colombia questionnaire and the students' submitted practices.

III. Methodology

A. Participants

In this study, a group of 17 students enrolled in the "Programming and Computational Thinking I" course of the Master's Degree in Digital Competence and Computational Thinking at Universidad Rey Juan Carlos in Madrid (semester 2023/2024) was included [13]. However, only 11 students actively participated in the online course.

B. Data collected

The dataset gathered for predicting academic performance comprises 69 activity records submitted during the course and 504 records from the MSLQ Colombia questionnaire. The course activities consist of three practices, six self-study tests, and one assessment.

C. Prediction Model

To develop the proposed prediction model, we drew upon the work of [10], which outlines a model to forecast student performance with limited data. We followed the CRISP-DM methodology throughout the process, delineating phases such as data understanding, data preparation, modeling, and evaluation [14].

The initial phase, involved practices, self-study tests, and MSLQ questionnaire responses (pre-test and post-test), In the data preparation phase, we conducted preprocessing, and balancing the dataset. During the modeling phase, we implemented feature selection. We utilized 80% of dataset for training of model, the remaining 20% for testing . We evaluated the model using metrics such as precision, recall, and F1 score. The Random Forest algorithm emerged with the highest F1 scores, registering 0.86, 0.88, and 0.91 in weeks 3, 7, and 11, respectively.

IV. Results

A. MSLQ-Colombia questionnaire (pre-test and post-test)

We observed for the *task value* and *self-efficacy expectations for performance* subscales of the motivation scale, the *p-value* was less than 5%, indicating that the differences in values between the pre-test and post-test are statistically significant.

B. Model evaluation

To assess the prediction model, the final grade of each student was compared with the predicted value for weeks 3, 7, and 11. Out of the 21 predictions generated by the model, 16 were correct while the remaining 5 were incorrect. Consequently, the model attained an 86% accuracy rate in its predictions, with 6 out of 7 students having correct predictions from week 7 onwards (see figure 1).

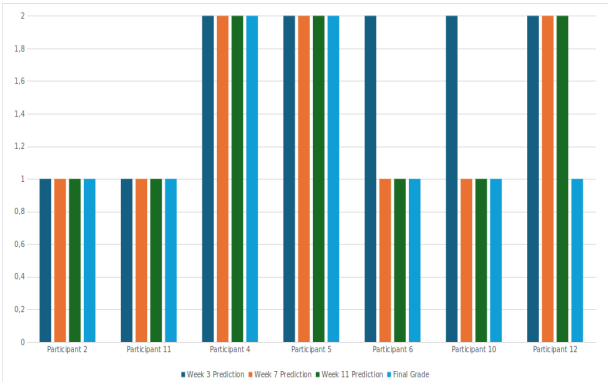

Fig. 1. Model evaluation

V. Conclusions

This study is grounded in [10], where we curated 36 items from the MSLQ Colombia questionnaire proposed by [8] alongside three practices to forecast academic performance during weeks 3, 7, and 11 of a programming course featuring a limited number of students. Findings were cross-referenced with [10], which suggests the feasibility of generating prediction models with sparse data and features to gauge academic performance in programming courses.

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VAAD: Visual Attention Analysis Dashboard Tool

Miriam Navarro*, Álvaro Becerra*, Roberto Daza*, Ruth Cobos*, Aythami Morales*, Julian Fierrez*
*School of Engineering, Universidad Autonoma de Madrid, Spain
{miriam.navarroclemente, alvaro.becerra, javier.irigoyen, roberto.daza, ruth.cobos, aythami.morales, julian.fierrez}@uam.es

***Abstract*—In this paper, we present an approach in the Multimodal Learning Analytics field. Within this approach, we have developed a tool to visualize and analyze eye movement data collected during learning sessions in online courses. The tool is named VAAD —an acronym for Visual Attention Analysis Dashboard—. These eye movement data have been gathered using an eye-tracker and subsequently processed and visualized for interpretation. The purpose of the tool is to conduct a descriptive analysis of the data by facilitating its visualization, enabling the identification of differences and learning patterns among various learner populations. Additionally, it integrates a predictive module capable of anticipating learner activities during a learning session. Consequently, VAAD holds the potential to offer valuable insights into online learning behaviors from both descriptive and predictive perspectives.**

***Index Terms*—biometrics, dashboard, eye-tracker, learning analytics, machine learning, multimodal learning, online learning**

I. Introduction

The popularity of Massive Open Online Courses (MOOCs) has grown in recent years due to their inclusivity and accessibility, offering a wide array of subject matter without requiring specific prerequisites for enrollment. This makes them a valuable source of knowledge and they are recognized by official educational institutions [1].

While the popularity of MOOCs grows, so do dropout rates, resulting in only a few learners completing these courses [2]. This has led to the creation of Learning Analytics (LA) tools, which provide valuable insights into online educational environments [3]. It is the case of Universidad Autónoma de Madrid (UAM), with the development of edX-LIMS [4], [5] or M2LADS [6].

However, in recent years, the field of Multimodal Learning Analytics (MMLA) has emerged, characterized by the use of biosensors to capture biometric data such as visual attention, heart rate, etc., that provide a comprehensive understanding of the learning process [7].

In this article, we focus on understanding visual attention captured from an eye-tracker via the edBB platform [8] and we present VAAD tool (Visual Attention Analysis Dashboard) that has been developed to visualize eye movement data collected during an online learning session (LS).

II. Context and Dataset

We conducted a study in the School of Engineering at UAM, monitoring 120 learners in our laboratory as they interacted with a MOOC during a 30-minute LS. This study has received approval from the university's ethics committee, and all biometric multimodal data are anonymized.

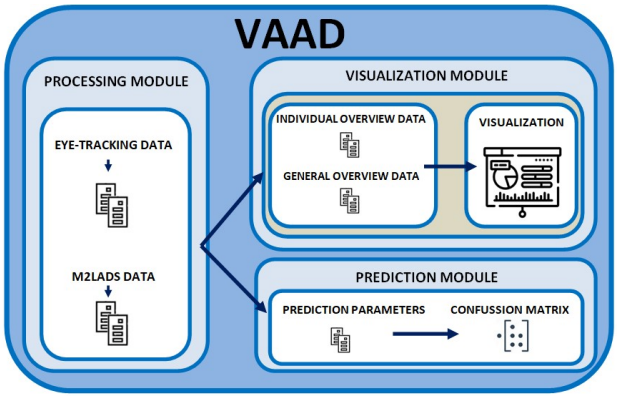

Fig. 1. VAAD Architecture/Modules

In this study, the monitored learners engaged in various activities such as watching videos, reading documents, and then completing assignments on the LS content.

Sensors including webcams, eye-trackers and EEG bands were used to obtain the multimodal data via the edBB platform, which were then synchronised by M2LADS [6]. VAAD manages all multimodal data linked to visual attention, which is why the eye-tracker remains the focal point.

A. Eye-tracking Data

The eye-tracker estimates a wide variety of multimodal data, such as gaze points, eye movement type, timestamps, etc.

B. M2LADS Data

Data regarding learner population and the LS are obtained from the M2LADS database. The processing module exclusively operates with data such as sex, group, activity identifiers, learning scores, etc. Before the monitorization, learners were categorized into three different groups of 40 learners.

III. Approach proposed

The VAAD tool is composed of three modules as seen in Fig. 1: a processing module that manages data from the eye-tracker and M2LADS, interconnected with the visualization and prediction modules.

A. Processing Data Module

VAAD focuses on capturing saccade and fixation event information provided by the eye-tracker, in addition to timestamps and event durations.

The processing module synchronizes the eye-tracking data with the M2LADS data, obtaining accurately tagged eye-tracking data with the corresponding activities within the MOOC for every frame captured.

From a general visualization perspective, four key parameters were determined for each learner: average saccades, average fixations, average saccade time, and average fixation time. These parameters were assessed for the overall session and for each activity individually. The culmination of this data processing is a final database that profiles each learner, including their respective group and sex, and provides details on the four aforementioned parameters.

Regarding the individual visual overview, data were generated for each available learner, which included information about their fixation events, their gaze point parameters for the X and Y coordinates and the activity within the MOOC.

Concerning the predictive analysis, data were utilized to collect metrics employed for prediction such as participant sex; number of saccades; average, maximum and minimum saccade velocity and its standard deviation, kurtosis and skew.

B. Visualization Module

The dashboards provide a deep understanding of global trends and individual learners' engagement during the LS.

The general session overview is presented through interactive box plot charts, providing a visual representation of the four key parameters mentioned earlier. These charts can be filtered by different demographic categories, such as groups or sex, as well as by specific activities within the MOOC, allowing for a detailed exploration of the data. Moreover, an ANOVA test is conducted for each of the four parameters, identifying significant variations among learners.

Another interactive chart presents individual learners' data through a heat map, providing a visual representation of their on-screen attention. Analysts can select a specific learner and choose different activities within the LS for visualization. This approach offers valuable insights into each learner's focus during different activities, assisting in the identification of engaging materials and assessing the impact of diverse learning sources on learners' performance.

C. Prediction Module

The goal of the prediction module is to determine the activity which the learner is doing between reading and video watching. We worked with learners 80 learners. Additionally, we excluded some data from the reading category to balance our training dataset (524 samples for each category).

We used the Random Forest algorithm and a neural network to test against the testing data. The neural network tested is a perceptron with one hidden layer (32 neurons and ReLU activation) and one output layer (sigmoid activation). The loss function chosen was Mean Squared Error (MSE) with Adam optimizer (default learning rate of 0.001).

The approach we adopted consisted of evaluating both methods using the Leave-One-Out Cross-Validation (LOOCV) technique. The results are presented in Table I.

TABLE I
RESULTS OF TESTING TWO ALGORITHMS WITH LOOCV

		Random Forest	**Neural Network**
Accuracy test		0.76	0.74
Video watching	Precision	0.76	0.74
	Recall	0.79	0.76
	F1-Score	0.77	0.75
Reading	Precision	0.78	0.75
	Recall	0.75	0.73
	F1-Score	0.76	0.74

IV. CONCLUSIONS

In this paper, we introduce VAAD (Visual Attention Analysis Dashboard), an innovative tool designed to visualize biometric data related to visual attention gathered from an online learning session. This tool offers valuable insights into learners' focus and engagement through the analysis and visualization of eye movement information. Moreover, the data managed by VAAD also offer the opportunity to detect the tasks performed by online learners.

This tool has the potential to significantly enhance the analysis of online learning behaviors and provide valuable insights for educational practitioners, and is currently being used by the MOOC instructors' team to gather information on learner visual behaviour while learning.

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Detecting Distractions in MOOC Learning Through Behavioral and Physiological Responses

Álvaro Becerra*, Javier Irigoyen*, Roberto Daza*, Ruth Cobos*, Aythami Morales*, Julian Fierrez*, Mutlu Cukurova†
*School of Engineering, Universidad Autonoma de Madrid, Spain
{alvaro.becerra, javier.irigoyen, roberto.daza, ruth.cobos, aythami.morales, julian.fierrez}@uam.es
†University College London, London, United Kingdom
{m.cukurova}@ucl.ac.uk

***Abstract*—In this article, we explore computer vision approaches to detect abnormal head pose during e-learning sessions and we introduce a study on the effects of mobile phone usage during these sessions. We utilize behavioral data collected from 120 learners monitored while participating in a MOOC learning sessions. Our study focuses on the influence of phone-usage events on behavior and physiological responses, specifically attention, heart rate, and meditation, before, during, and after phone usage. Additionally, we propose an approach for estimating head pose events using images taken by the webcam during the MOOC learning sessions to detect phone-usage events. Our hypothesis suggests that head posture undergoes significant changes when learners interact with a mobile phone, contrasting with the typical behavior seen when learners face a computer during e-learning sessions. We propose an approach designed to detect deviations in head posture from the average observed during a learner's session, operating as a semi-supervised method. This system flags events indicating alterations in head posture for subsequent human review and selection of mobile phone usage occurrences with a sensitivity over 90%.**

***Index Terms*—biometrics, head pose, machine learning, multimodal learning, online learning, phone usage**

I. Introduction

Online environments face new challenges in maintaining high-quality learning standards such as the lack of direct contact between teachers and learners [1] or an increased likelihood of distractions during sessions or and uncertainty regarding whether learners are paying attention to the content or experiencing difficulties [2], [3].

However, new e-learning platforms with biosensors [4] and Multimodal Learning Analytics (MMLA) tools aids in understanding learners' behavior and distractions [5], [6].

In this article, we focus on detecting phone usage distractions. The main contributions of this work are: *i*) An initial study on the effects of phone usage during e-learning on physiological responses, specifically attention, heart rate, and meditation, which were studied before, during, and after phone usage. *ii*) A feasibility phone-usage events detection through video-based head pose estimation applied to e-learning.

II. MultiModal Data Description

To study how phone usage could affect learners while learning in a MOOC, we monitored 120 learners (59 females) from the School of Engineering at Universidad Autónoma de Madrid (UAM) who attended our MMLA laboratory and interacted with the same MOOC subunit during a 30-minute LS. This study has been approved by the university's ethics committee, and all learner data are anonymized.

In this initial research, we focused on 40 learners who were required to keep their phones visible during the LS, and they were instructed to use them upon receiving a notification. Each learner received at least two messages, as all learners were targeted with two messages from the researchers, and we labeled the period during which they were answering those messages as a phone-controlled event.

All MMLA data were collected using the edBB platform [4]. It utilizes different sensors such as webcams, EEG band, smartwatches, etc. Thanks to the M2LADS system [7], all data captured from the LS were processed and synchronized to obtain information about the activity the learner was engaged in while each biometric value was being recorded.

III. Methods

A. Statistical Analysis

For each learner, we analyzed phone usage using EEG band NeuroSky meters to detect mental states, including attention and meditation (mental calmness), on a scale from 0 to 100, along with heart rate data from the smartwatch. Our focus was on phone-controlled events.

We extracted the data for attention, meditation, and heart rate 15 seconds before the learner started using the phone, during phone-controlled usage, and 15 seconds after ending usage. We compared mean differences using t-test among the 3 periods for all learners and dividing them by gender.

B. Head Pose Study

We propose an approach to detect abnormal head pose events during e-learning sessions using webcam images. Two state-of-the-art modules, developed on CNNs, were employed to extract head poses. It includes the following:

Face Detection module: The facial detection module utilized the state-of-the-art MediaPipe's BlazeFace (full-range) model [8] to detect 2D facial images.

Head Pose Module: Head pose estimation was conducted using 2D facial images obtained from the facial detection module. This module incorporates CNNs specifically designed

for real-time head pose estimation and calculates the vertical (pitch), horizontal (yaw), and longitudinal (roll) angles.

Approach for Abnormal Head Pose Detection: To detect abnormal head posture events from the LS, we adopted an offline processing strategy as follows: *i)* The Euler angles were calculated for each frame. *ii)* The mean (μ) and standard deviation (σ) across the entire session were determined for each Euler angle. *iii)* A sliding window methodology was adopted, through which the mean ($\overline{\theta}$) for each of the Euler angles was calculated within each temporal window w.

iv) A temporal window of w frames is flagged as an event if the average value of any Euler angle verified $|\theta_i - \mu_i| > n\sigma_i$.

v) All overlapping events are merged into a single one to ensure that the events are disjoint. Parameters n and w can be adjusted to enhance performance.

IV. Results

A. Statistical Analysis

For all learners, higher attention levels were found after using the phone than before ($t(65) = 2.21, p = 0.031, d = 0.29$). For all learners, lower heart rate levels were found before using the phone than during usage ($t(65) = 2.85, p = 0.006, d = 0.15$). Furthermore, this difference is particularly significant among men, who exhibited higher heart rate levels while using the phone and afterward compared to before usage ($t(37) = 2.62, p = 0.013, d = 0.17$, and $t(37) = 2.5, p = 0.017, d = 0.20$). For male learners, higher meditation levels were found during phone usage than after phone usage ($t(37) = 2.54, p = 0.015, d = 0.46$).

B. Head Pose Based Event Detection Approach for Phone Usage

The sensitivity of the approach was calculated across all 40 learners. Higher sensitivity rates are observed with lower values of n and w. For instance, a maximum sensitivity of 0.94 was achieved with $n = 1.5$ and $w = 1$. However, as n increases, indicating a more restrictive criterion for event detection, sensitivity decreases. Similarly, increasing w seems to reduce the approach's sensitivity.

The average number of predicted events was also determined for the corresponding settings of parameters n and w. This metric provides further insight into the approach's performance, showing the effect of parameter adjustments on the frequency of event prediction throughout the LS. The results demonstrate an expected inverse relationship between the number of events detected and the parameters n and w.

Ideally, settings should ensure robust sensitivity while keeping event predictions at manageable levels. Combining insights from both metrics a balance could be achieved at $n = 2$ and $w = 5$ for the case of controlled phone events. Under this configuration, the approach would achieve a sensitivity of 0.80 with an average of 29 predicted events per hour. In practice, this translates to roughly 4 minutes within a 30-minute LS where 80% of controlled phone events would be successfully captured, significantly optimizing the review process for supervisors overseeing the LS.

V. Conclusion

In our statistical analysis of attention, we noted a significant rise in attention levels among all learners following phone usage, compared to their attention levels before usage. Hence, we didn't find evidence suggesting that multitasking leads to decreased attention. Regarding to heart rate, we observed an increase in beats per minute during phone use compared to pre-usage levels. Notably, this disparity was more pronounced among men, who exhibited elevated heart rates both during and after phone usage compared to before. We theorize that this increase could be caused from the stress of responding to messages and the anticipation of receiving replies.

We also present an approach for detecting abnormal head pose events, with a feasibility study in an e-learning environment, focusing on phone usage events. Optimizing the approach's parameters for this task allows the identification of 80% of target events while saving the need to review 86% of the learning session. The results shown illustrate its potential as a tool for enhancing monitoring efficiency and time management. This approach could be also applied to other event types by readjusting its configuration.

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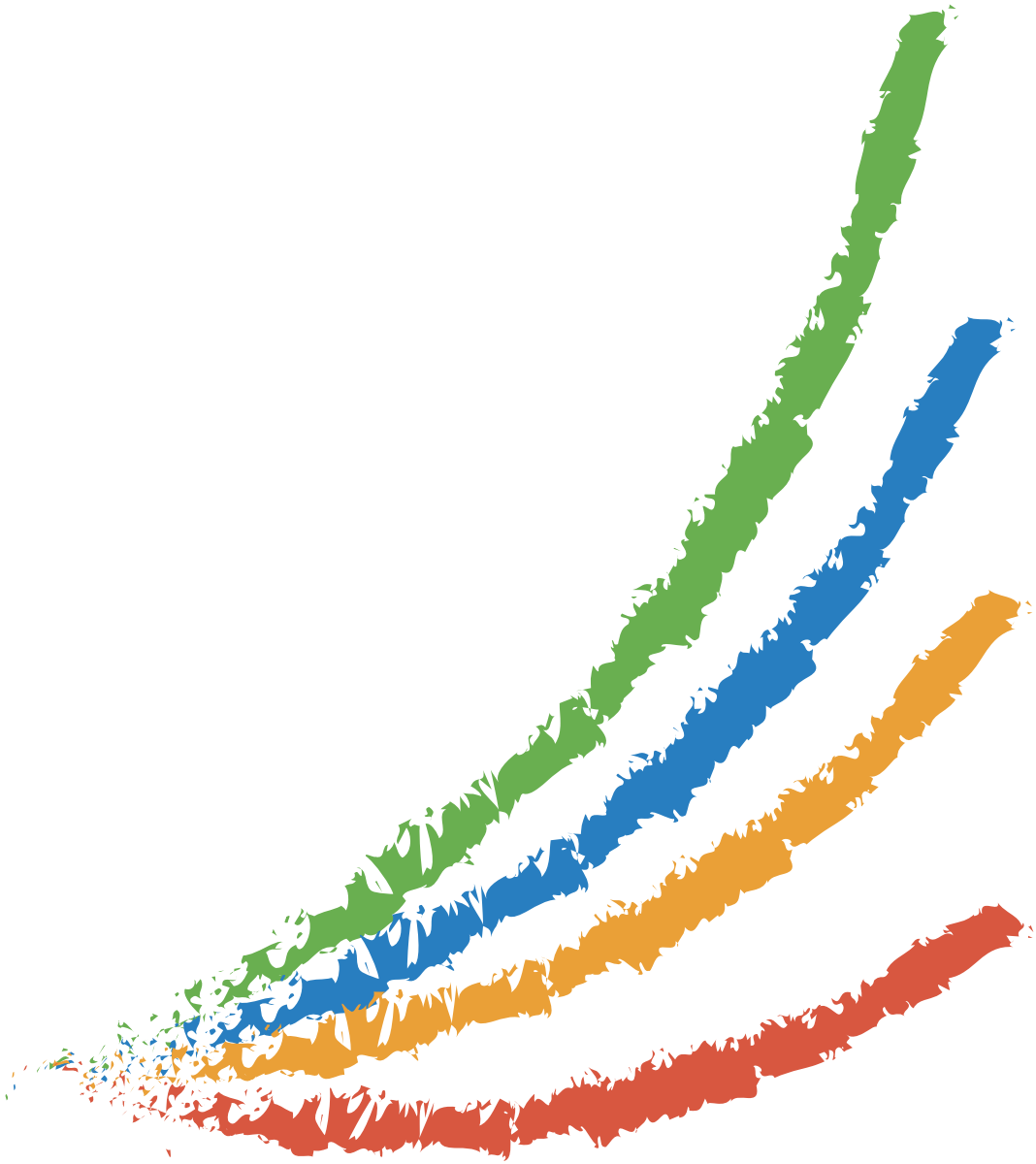
Projects and Inclusion



El Proyecto DACEM para la Mejora de Catálogos de Cursos en Instituciones de Educación Superior

Manuel Caeiro-Rodríguez
atlanTTic Research Center for Telecommunication Technologies
Universidade de Vigo
36310 Vigo, Spain
mcaeiro@det.uvigo.es

Fernando A. Mikic-Fonte
atlanTTic Research Center for Telecommunication Technologies
Universidade de Vigo
36310 Vigo, Spain
mikic@det.uvigo.es

Martín Llamas-Nistal
atlanTTic Research Center for Telecommunication Technologies
Universidade de Vigo
36310 Vigo, Spain
martin@det.uvigo.es

Adrián Lugilde-López
atlanTTic Research Center for Telecommunication Technologies
Universidade de Vigo
36310 Vigo, Spain
adrian.lugilde@det.uvigo.es

Martín Liz-Domínguez
atlanTTic Research Center for Telecommunication Technologies
Universidade de Vigo
36310 Vigo, Spain
mliz@det.uvigo.es

Nina Yarovenko-Kuzminykh
Universidade de Vigo
36310 Vigo, Spain
nina.yarovenko@uvigo.gal

***Resumen*—Este artículo presenta el trabajo en curso que se está realizando en el proyecto DACEM. El objetivo de este proyecto es mejorar los catálogos de cursos en las instituciones de educación superior Erasmus+. El programa Erasmus se puso en marcha hace 36 años para promover la movilidad de los estudiantes entre las instituciones europeas. Los catálogos de cursos son una herramienta clave para que los estudiantes busquen las oportunidades académicas que mejor se adapten a sus necesidades, y para que las instituciones puedan llegar a acuerdos bilaterales sobre programas compartidos. Sin embargo, a pesar del papel clave de este instrumento y de tantos años de experiencia y multitud de iniciativas relacionadas con los mismos, los catálogos de cursos siguen siendo un reto para las instituciones europeas de educación superior y la movilidad de los estudiantes. Este trabajo trata sobre los requisitos y los principales problemas que experimentan las instituciones y los estudiantes en relación con los catálogos de cursos. También se presenta el proyecto DACEM y sus propuestas para resolver algunos de los problemas actuales.**

Palabras clave—catálogo de cursos, Erasmus+, movilidad de estudiantes

I. Introducción

La movilidad de estudiantes en las Instituciones de Educación Superior (IES) es reconocida como una gran oportunidad para que los futuros graduados universitarios puedan desarrollar habilidades clave para su futuro profesional, especialmente cuando se trata de estancias realizadas en otro país. Los programas de movilidad internacional exponen a los estudiantes a diferentes puntos de vista, conocimientos, métodos de enseñanza y prácticas de trabajo que contribuyen al desarrollo de competencias transversales, comunicativas, lingüísticas e interculturales. La mayoría de los estudiantes que estudian en el extranjero regresan con una mejor comprensión de sí mismos y de sus valores, así como con una visión más amplia del mundo y confianza en su adaptabilidad a nuevos entornos [1].

En el contexto europeo, el programa Erasmus se puso en marcha en 1987, bajo el acrónimo *European Region Action Scheme for the Mobility of University Students*, como una iniciativa de intercambio que ofrecía a los estudiantes universitarios la posibilidad de aprender y enriquecer sus estudios en otras instituciones europeas de educación superior. Desde el principio, el programa Erasmus se basó en un conjunto de principios básicos y herramientas necesarias para la realización de las movilidades previstas:

- El Catálogo de Cursos (CC). Se trata de un elemento esencial para que tanto las instituciones de origen como las de acogida analicen sus respectivas ofertas académicas y la posible equivalencia de estudios.
- El *Bilateral Institutional Agreement*. Requiere conocer de antemano la disponibilidad de cursos o módulos que podrían ser realizados por los estudiantes en un semestre determinado.
- El *Learning Agreement*. Contrato de estudios a firmar antes del inicio de la movilidad tanto por el estudiante como por las instituciones de origen y de acogida.

El CC desempeña un papel central en el programa de movilidad Erasmus+. Es una pieza clave para que los estudiantes decidan el destino más adecuado para continuar sus estudios y preparar sus contratos de estudios antes de iniciar su movilidad. Por este motivo, el programa Erasmus+ ha formulado algunas recomendaciones y directrices al respecto.

Además, el CC también puede desempeñar un papel principal en el contexto de las Alianzas Universitarias Europeas (EUA). La idea de una "exposición conjunta de cursos" tiene como objetivo la implementación de una visión común y centralizada de los programas académicos ofrecidos por varias IES, es decir, un CC común. Esto puede incluir programas conjuntos, pero también cursos ofrecidos en las IES de cada alianza como parte de los planes de estudio regulares, así como cursos desarrollados específicamente por la alianza con fines de cooperación. El reto es cómo proporcionar una pantalla tan común, ya sea apoyando la interoperabilidad entre los CC existentes o desarrollando una solución centralizada.

II. Situación actual de los catálogos de cursos

El Erasmus Charter for Higher Education (ECHE) ha desarrollado un marco de calidad para las actividades de cooperación, tanto europeas como internacionales, que las instituciones de educación superior pueden llevar a cabo en el marco de Erasmus+. Sobre la base de la Guía de seguimiento de la ECHE publicada en febrero de 2023 [2], las instituciones de educación superior deberían haber completado la aplicación de la administración electrónica en 2023 y las agencias nacionales deberían evaluar los esfuerzos para lograrlo. A pesar de este planteamiento, actualmente a principios de 2024, la mayoría de las instituciones de educación superior en Europa no cuentan con CC adecuados que cumplan con los requisitos y recomendaciones del programa Erasmus+. La digitalización de los CC ha sido un tema complejo en las últimas décadas, no solo porque están profundamente arraigados en las culturas académicas y, a veces, altamente descentralizadas de las IES europeas, sino también porque plantea una serie de desafíos técnicos para implementar modelos de datos sostenibles, población y mantenimiento, y servicios interoperables que faciliten el uso de los datos almacenados por otras herramientas.

La inclusión de los CC en los sitios web de las IES, tal y como exige ECTS Users' Guide, es uno de los principales retos para muchas instituciones en la actualidad. En la mayoría de casos no están disponibles de manera accesible y traducidos al inglés, ni en un formato legible por ordenador o utilizando estándares que faciliten la interoperabilidad, características clave para proporcionar soluciones integradas adecuadas a las necesidades de las IES y los estudiantes. De hecho, a pesar de que algunas instituciones de educación superior invierten una cantidad sustancial de fondos en el desarrollo de CC, existe poca evidencia de que la mayoría de estas instituciones de educación superior hayan digitalizado completamente su CC. En consecuencia, todo el potencial de la transformación digital se ve obstaculizado por la falta de CC verdaderamente digitalizados.

Los retos a los que se enfrentan las instituciones de educación superior Erasmus+ en relación con los CC se reflejan claramente como un problema principal en las encuestas completadas por los estudiantes Erasmus: "*La información sobre las instituciones de educación superior a menudo no está debidamente actualizada*", "*los derechos de los estudiantes con respecto al mecanismo de evaluación... qué pasa si no apruebas los exámenes*", "*¿qué pasa con los plazos de inscripción a los cursos*?", etc. El programa Erasmus+ ha pasado por diferentes fases, pero estos problemas persisten en el tiempo y se traducen en niveles de reconocimiento inferiores a los deseables. Los datos de la encuesta de la Red Europea de Estudiantes (ESN) de 2021 muestran menos del 80% de reconocimiento pleno de los logros académicos en el extranjero, lejos del objetivo de reconocimiento automático establecido en el contexto del Espacio Europeo de Educación.

Otra cuestión importante con respecto a los CC existentes es la interoperabilidad [3]. Hoy en día, las IES tienen sus propias soluciones de CC, integradas con software diverso utilizado para soportar los procesos educativos y administrativos dentro de las propias instituciones. Dado que las estructuras y los procesos de cada IES son diferentes, los flujos de trabajo entre las instituciones y las interacciones con los usuarios finales son complicados, si no imposibles, en la mayoría de los casos. En este punto, la estandarización y la interoperabilidad están llamadas a desempeñar un papel clave. El objetivo es permitir que las partes se comuniquen entre sí y compartan información, manteniendo al mismo tiempo sus propias estructuras y soluciones. Las soluciones exploradas por las instituciones de educación superior que participan en las EUA, que cuentan con el apoyo de la Comisión Europea a través de la iniciativa Universidades Europeas, deben analizarse con miras a una mejor interoperabilidad.

III. El Proyecto DACEM

El proyecto DACEM Erasmus+, recientemente aprobado, tiene como objetivo resolver los problemas existentes en relación con los CC de las IES para proporcionar y mantener actualizada la información sobre sus cursos e instituciones de forma accesible, completa, coherente e interoperable.

Este proyecto tiene como objetivo proporcionar un software de código abierto y una plataforma en la nube para CC en línea siguiendo el ECTS Users' Guide. Esto permitirá a las instituciones europeas de educación superior poner a disposición la información sobre los cursos de manera accesible, completa, coherente, oportuna e interoperable, apoyando a los estudiantes en su búsqueda de opciones de movilidad. El programa informático proporcionado pretende contribuir a la integración con las herramientas existentes disponibles en el contexto de las iniciativas EWP (*Erasmus Without Papers)* y OLA (*Online Learning Agreement*). Para ello, la solución aportada tiene como objetivo implementar la especificación OCCAPI (desarrollada por la EUF para facilitar la interoperabilidad de los CC) con el fin de permitir que otros sistemas accedan a la información.

Las principales actividades del proyecto DACEM son la realización de una revisión exhaustiva de la situación actual de los CC existentes, un análisis de las necesidades de los usuarios finales y las partes interesadas, y la adopción de nuevas tecnologías para desarrollar una solución de CC de código abierto y una plataforma en la nube. El desarrollo de software seguirá una metodología ágil con sprints cortos y resultados incrementales. Después de cada sprint, los resultados del software se entregarán a los usuarios finales para probar la funcionalidad y proporcionar comentarios. Se realizará una validación final con pruebas en escenarios reales.

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An online pilot course to foster inclusive museums education

Covadonga Rodrigo
ETS Ingeniería Informática
Universidad Nacional de Educación a Distancia (UNED)
Madrid, Spain
ORCID: 0000-0001-8135-3163

Francisco Iniesto
ETS Ingeniería Informática
Universidad Nacional de Educación a Distancia (UNED)
Madrid, Spain
ORCID: 0000-0003-3946-3056

Halldora Arnardóttir
Faculty of Sociology, Anthropology and Folkloristics
Háskóli Íslands
Reykjavík, Iceland
halldorarnar@hi.is

Ángeles Sánchez-Elvira
Facultad de Psicología
Universidad Nacional de Educación a Distancia (UNED)
Madrid, Spain
ORCID: 0000-0002-3007-3935

Ana Garcia-Serrano
ETS Ingeniería Informática
Universidad Nacional de Educación a Distancia (UNED)
Madrid, Spain
ORCID: 0000-0003-0975-7205

Sigurjón Hafsteinsson
Faculty of Sociology, Anthropology and Folkloristics
Háskóli Íslands
Reykjavík, Iceland
sbh@hi.is

ABSTRACT

Museums must transform themselves if they are to remain relevant to 21st-century audiences and must focus themselves on developing their audiences as regular users, committed to participation and collaboration, bring on-site, online, and mobile provision and, through social media, build meaningful relationships with their users. An engaging museum must have a clear vision of the future that stimulates and inspires the public it serves, playing an active role in promoting tolerance and understanding within and between communities, including disfavored groups. In this sense, a growing body of research into the social role and impact of museums suggests that engagement with the concepts of social inclusion and exclusion will require museums - and the profession and sector as a whole - to radically rethink their purposes and goals and to renegotiate their relationship to, and role within, society. Creating a new system of social inclusion (especially for groups with protected characteristics) based on the Art-Health-Wellness link may prove to be a good practice from which health and social care institutions, cultural organizations and educational institutions across Europe can draw inspiration.

The Inclusive Memory (IM) project (2021-2024) aims at promoting the building of a common shared social memory realized through a museum-based social inclusive system, through the link Art-Health-Wellbeing. The core idea of the project stems from the potential benefits of the cooperation between HEIs, Health and Social care Institutions and Museums, as a strategic partnership to advance museum education as well as in museum experience to support the design, realization, monitoring and evaluation of art-based activities and actions specifically addressed to people with social care and health problems. Through the reversed community approach, the Inclusive Memory project tends to stimulate processes of rebuilding troubled communities through the collaboration of academics, people working professionally in health and social care as well as artists and people working in cultural organizations. The project challenges habitual thinking and asks for new collaborations to be formed across conventional boundaries.

The IM project wants to promote an innovative strategy for social inclusion, derived from the creation of a new teaching methodology, and the use of digital tools and based on the development of transverse competences in both university teachers and museum and health professionals. The project is based on the concept which sees museums as teaching and learning environments, and Universities as active social actors, both strengthening their role of cultural integration facilitators. The methodology applied in the IM project is based on the logic of converting the theoretical concept of Museums as inclusive spaces for Health and Wellbeing development into a practical protocol of teaching scenarios adapted to specific local communities' needs and newly created open resources (Open Educational Resources-OERs and Massive Open Online Courses -MOOCs), testing the protocol and resources into ready-to-use courses, and using the test outcomes to enrich the theoretical basis.

On a methodological level, the project adopts a Design Based Research methodology, first described by, who conceptualized it as a cyclic process for didactic product creation. The model is developed as a process of diverse stages, known by the acronym ADDIE: Analysis, Design, Development, Implementation, and Evaluation. Moreover, the Asset Based Community Development (ABCD) approach is used for the development of art-based activities for Health and Wellbeing promotion within partners' local communities. ABCD's premise is that communities can drive the development process themselves by identifying and mobilizing existing, but often unrecognized assets.

A. Pilot course instructional design

The IM pilot course is based on the social model of disability and the design 4all approach. The pilot course is filled to the brim with practical examples, in the form of an open online course. In online learning, learners should be continually influenced by information, social interaction, and learning experiences, providing them with the knowledge to come up with new ideas to develop. The instructional design is based on Gagne's events of instruction as in other previous authors' work. Regarding the context of the training, the selected learning styles for the IM pilot course are visual-Spatial (doing puzzles, drag and drop, and view 360º image), interpersonal (interacting with others), intrapersonal (concentrating on user's feelings, intuition, and motivation), linguistic (making up stories). Authors focus on empowering learners in MOOC environments for fostering critical thinking and collaboration, developing competency-based outcomes,

encouraging peer assistance and assessment through social appraisal, providing strategies and tools for self-regulation, and finally using a variety of media to create and publish learning resources and outputs.

B. Content syllabus

In this project, partners with humanistic expertise are guided and supported by the partner with long experience in educational technology to design the course structure and design and develop the educational resources as follows:

- The division of the course syllabus into N modules (each with an overall learner workload of 1-2 ECTS).
- Multilingualism is achieved in educational resources by video subtitling.
- Short introductory videos in each module.
- The use of a self–paced methodology.
- The establishment of interactive user forums to help the learners and tutors develop an international community.
- The presence of automated feedback through objectives and online assessments, e.g. quizzes and exams.
- A final task that implies personal internal reflection and a wrap-up activity to gather all the knowledge achieved on a practical basis.

The course structure is divided into five units, depending on duration and specific objectives. Each module has typically between 4 to 8 videos with associated activities and evaluations. All units have practical activities, accumulating a learner workload of 25 hours (1 ECTS). Learners develop peer-to-peer and tutor-learner interaction through dedicated forums, addressing questions and sharing ideas with the course team.

C. Open Educational Resources Development

Many audiovisuals have been prepared in English, the conducting language of the project. Accessible videos with an approximate duration of 5 minutes are linked to a YouTube channel offering direct translation and subtitling for all the languages of the project: Catalan, Greek, Icelandic, Italian, Spanish, and Portuguese.

In addition to this, some interactive H5P resources have been included to motivate learners' interaction and engagement in the Inclusive Memory Pilot Course. There is an easy-to-use plugin to add these components to the Moodle platform. Specifically for this project, we have selected the following types:

- Image 360º: spread out on a large table, the resource show 6 different artefacts built specifically for visually impaired people as part of the MUSACCES project[1]: 3D reproductions, paintings in Braille, relief reproductions based in fuser technology and puzzles. For each artefact, a stop point is created with a brief explanation. Image was created with an Insta360 One X2-5.7K camera.
- Drag and drop: several images are distributed so that the users must match with each corresponding dropzones (specific technologies).
- Image hot spots: one resource has been created regarding the use of Virtual Reality means, each hotspot reveals texts, images or videos when clicked.

[1] http://www.musacces.es/

The control of the assessment involves the use of a flexible certification model, which allows learners to demonstrate their achievements by taking a standardized test-like evaluation and uploading tasks (empathy map, design of accessible activity).

D. Pilot Course Delivery and Initial Results

The course while writing this paper is being run from February 5th and will end April 30th, 2024. Currently, there are 590 enrolled learners of which 354 are active (participating in forums, delivering the practical activities, and participating in the assessment). Of those 200 answered the pre-course survey indicating a predominantly participation of female learners (87%) and between 20 and 30 years old (52%). Most of the professional backgrounds of the participants include either professionals or learners from art and humanistic studies, but some of them are museum and cultural managers, science communicators, journalists, nurses, archaeologists, designers, and psychologists.

In a multiple-answer response as indicated in Table I, learners consider the course will help them to apply inclusive approaches in museums (65%), improve their practice (59%) and to better evaluate their competences.

TABLE I. EXPECTATIONS FROM THE COURSE

Expectations	**Responses**
The course will support me in applying inclusive approaches in museums.	130 (65 %)
The course will help me improve my practice.	118 (59 %)
The course will help me better evaluate my competences.	89 (44.5 %)
The course will help encourage me to use innovative technologies in museums.	77 (38.5 %)
The course will help me motivate other practitioners.	40 (20 %)
I do not have any expectations.	6 (3 %)

TABLE II. EVALUATION OF THE EXPERIENCE

	SD	**D**	**N**	**A**	**SA**
I enjoyed participating	0	3 (7 %)	5 (11%	27 (60%)	10 (22%)
Enjoyed working with other learners	1 (2 %)	3 (7 %)	26 (58%)	11 (24%)	4 (9 %)

Note: SD: Strongly Disagree, D: Disagree, N: Neutral, A: Agree and SA: Strongly Agree

So far 43 learners have responded to the post-course survey showing as indicated in Table II that mostly enjoyed the experience but did not show the same emphasis on working with other learners, probably because of the self-paced design.

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KEYWORDS: social inclusion, museum education, museum learning, digital & transversal competences.

Enhancing Museum Accessibility with Adaptive Digital Tools

Gabriel Guerrero-Contreras*
Dept. of Computer Science and Engineering
University of Cadiz
Av. Universidad de Cádiz, 10
Puerto Real, 11519, Cádiz, Spain
gabriel.guerrero@uca.es

Sara Balderas-Díaz
Dept. of Computer Science and Engineering
University of Cadiz
Av. Universidad de Cádiz, 10
Puerto Real, 11519, Cádiz, Spain
sara.balderas@uca.es

Silvia Toribio-Camuñas
Dept. of Translation and Interpreting
University of Granada
C. Puentezuelas, nº 55
Granada, 18071, Spain
storibio@ugr.es

María Luisa Rodríguez-Almendros
Dept. of Software Engineering
University of Granada
C. Periodista Daniel Saucedo Aranda, s/n
Granada, 18071, Spain
mlra@ugr.es

María Visitación Hurtado-Torres
Dept. of Software Engineering
University of Granada
C. Periodista Daniel Saucedo Aranda, s/n
Granada, 18071, Spain
mhurtado@ugr.es

***Abstract*—The AL-MUSACTRA platform is a digital tool that enhances museum accessibility via mobile devices, catering to diverse physical and cognitive needs. Built on Drupal 8, it supports audio descriptions, sign language videos, and simplified texts, adhering to web accessibility standards. The platform offers a flexible content management system, automatically matching resources to user accessibility profiles. Promoting collaboration between cultural institutions, it provides a unified, customizable space for cultural content.**

***Index Terms*—digital accessibility, inclusive design, sustainable development, user engagement, content management systems**

I. Introduction

Access to leisure and culture is recognized as a fundamental right by international conventions, including the Convention on the Rights of Persons with Disabilities [1], which urges member states to enable participation in cultural life. This aligns with the Sustainable Development Goals, specifically SDG 11 [2], which promotes inclusive cities that provide access to cultural and natural heritage for all residents. Incorporating these elements into urban planning ensures that everyone, regardless of physical or cognitive abilities, can engage in meaningful cultural experiences. This approach emphasizes the importance of creating accessible environments, which enhance the quality of life for individuals with disabilities and foster a sense of community. In Spain, significant strides have been made in the field of Translation and Interpreting to enhance accessibility for the blind and deaf communities. Researchers and practitioners have developed methods and practices to ensure that cultural content is accessible to individuals with sensory impairments [3], [4]. These efforts include the implementation of audio descriptions, sign language interpretation, and simplified texts, which cater to the diverse needs of users with disabilities.

* Corresponding author

II. Related Work and Background

Accessibility in cultural heritage is an intersection of multiple disciplines, including disability studies, information technology, cultural studies, and urban planning. Ferri [5] examines the role of digitization and web accessibility within the EU's disability policy, emphasizing the European Disability Strategy's role in promoting digital access to cultural resources. Marin et al. [6] introduce an evaluation tool for assessing the physical accessibility of cultural heritage buildings to guide necessary improvements. Giaconi et al. [7] conducted a pilot study in Italy on cultural accessibility for people with intellectual disabilities, stressing the importance of simple guidelines and inclusive practices. Kwak et al. [8] review the need for specialized information services within cultural and art complexes for various disabilities, advocating for active support and tailored facilities.

III. AL-MUSACTRA Platform

In this work, we present the AL-MUSACTRA platform, a digital tool designed to enhance museum accessibility via mobile devices. This platform aims to broaden cultural access for both on-site and remote users by employing adaptive tools such as audio descriptions, sign language videos, and simplified texts. By addressing diverse physical or cognitive needs, AL-MUSACTRA ensures that all users can engage with cultural content. Additionally, the platform fosters collaboration between cultural institutions and creative industries to standardize content formats and accessibility plans.

Built on Drupal 8, the platform adheres to web accessibility standards such as the *Web Content Accessibility Guidelines*

(WCAG) and the *Authoring Tool Accessibility Guidelines* (ATAG). Drupal's features, including semantic HTML5 and ARIA roles, support keyboard navigation, making it suitable for a diverse audience. Its open-source nature under the *GNU General Public License* also aligns with AL-MUSACTRA's mission of making cultural heritage universally accessible.

The AL-MUSACTRA platform is designed to facilitate interaction for two main user types: content editors and end users. Content editors are responsible for creating and managing content, ensuring that resources are up-to-date and well-organized. End users, who may have diverse accessibility needs, access this content.

It incorporates hierarchically structured content types to organize cultural heritage resources effectively. *Museums* are represented with attributes such as contact information, description, and address. *Collections* group related objects under thematic or historical categories, providing context for the artifacts. *Objects* represent individual artifacts within collections, with attributes like narrative descriptions and images. *Resources* encompass additional multimedia or informational assets related to objects, categorized by taxonomy and available in multiple languages to support diverse accessibility needs.

The modular design enhances flexibility and scalability, allowing for independent management and seamless integration of new or updated content. This ensures the platform can dynamically respond to the unique needs of different user profiles without disrupting the overall architecture or coherence of the content ecosystem.

The platform leverages taxonomies within the Drupal content management system to categorize resources, correlating them with diverse user profiles. This adaptable approach allows for the seamless introduction of new resource categories and disability profiles without structural modifications. The system matches resources to user profiles using two taxonomies: `ResourceCategory` and `UserProfile`. Users are associated with specific profiles based on their accessibility needs, and resources are categorized accordingly. This interconnectivity enables the platform to automatically present the most relevant and accessible resources to each user, utilizing Drupal's views to fetch and display personalized content.

The platform offers a variety of resources, such as audio descriptions, sign language guides, easy-to-read texts, and subtitled videos, catering to users with visual, auditory, and cognitive disabilities.

Key Drupal modules have been implemented to enhance accessibility, performance, and user experience. The `Language` and `Interface Translation` modules make content globally accessible, supporting multilingual interaction. Performance benefits from the `BigPipe` module, which enhances page load times by streaming dynamic content incrementally.

The `Easy Read Pager`[1] is a custom module developed specifically for the AL-MUSACTRA platform. Designed for users with cognitive disabilities, it presents text in a manageable paginated format within the same window, reducing cognitive load and enhancing comprehension. This module is available under the GNU General Public License version 3 and integrated with Drupal's `Field Formatter API` to provide accessible pagination through configurable settings and Twig templates, enhancing the web interface's navigability and operability.

[1]https://github.com/gjguerrero/Easy-Read-Pager

IV. Conclusions

In conclusion, the AL-MUSACTRA platform exemplifies a comprehensive approach to making cultural heritage accessible to all. This approach addresses a crucial research gap by offering museums an individualized and customizable space within a unified framework. It integrates information and resources from all participating institutions, promoting cultural accessibility and collaboration. By integrating advanced accessibility features and adhering to international web standards ensures that users with diverse needs can fully engage with cultural content. The platform is available at tracce.ugr.es/almusactra and features over 120 objects, underscoring its commitment to inclusivity and cultural engagement. Future efforts will focus on incorporating user feedback, fostering interdisciplinary collaboration, and expanding the platform's global reach to further enhance accessibility to cultural heritage.

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Adaptive Content and Accessible on the Responsive and Usable LECTPAT Platform

Sara Balderas-Díaz*
Dept. of Computer Science and Eng.
University of Cadiz
Av. Universidad de Cádiz, 10
Puerto Real, 11519, Cádiz, Spain
sara.balderas@uca.es

Gabriel Guerrero-Contreras
Dept. of Computer Science and Eng.
University of Cadiz
Av. Universidad de Cádiz, 10
Puerto Real, 11519, Cádiz, Spain
gabriel.guerrero@uca.es

Marina Ramírez-Vela
School of Engineering
University of Cadiz
Av. Universidad de Cádiz, 10
Puerto Real, 11519, Cádiz, Spain
marina.ramirezvela@alum.uca.es

Silvia Toribio-Camuñas
Dept. of Translation and Interpreting
University of Granada
C. Puentezuelas, nº 55
Granada, 18071, Spain
storibio@ugr.es

Nuria Cabezas Gay
Dept. of Translation and Interpreting
International University of Valencia
C. del Pintor Sorolla, nº 21
València, 46002, Spain
nuria.cabezas@professor.universidadviu.com

Ana Medina Reguera
Dept. of Philology and Translation
University of Pablo de Olavide
Ctra. de Utrera, km 1
Sevilla, 41013, Spain
ammedreg@upo.es

***Abstract*—The LECTPAT project addresses the critical need for inclusive educational tools, leveraging easy-to-read pictographic systems to make complex cultural heritage content accessible to individuals with learning difficulties. The platform's multimodal online dictionary features detailed definitions, pictograms, and multimedia elements to enhance comprehension. LECTPAT aligns with the United Nations' SDG goals, aiming to diminish educational inequalities.**

***Index Terms*—accessibility, multimodal online dictionary, cultural heritage**

I. Introduction

The World Health Organization reports that around 1.3 billion people, or 16% of the global population, currently live with significant disabilities [1]. This highlights the critical need for innovative, inclusive solutions, especially in education and cultural engagement. The LECTPAT project [2] emerges as a groundbreaking initiative in this area, leveraging easy-to-read (E2R) pictographic systems and visual elements to make information universally accessible, particularly addressing the needs of individuals with learning difficulties in accessing complex cultural heritage content [3]. The LECTPAT project aligns with the United Nations' Sustainable Development Goals, particularly SDG 4, which promotes inclusive and equitable quality education and lifelong learning opportunities for all. Furthermore, through its innovative tools, LECTPAT aims to diminish educational inequalities, thereby ensuring that everyone has the opportunity to gain knowledge and appreciate cultural heritage, in line with SDG 10's objectives [4].

II. Related Work

Recent research has emphasized the importance of creating inclusive environments, especially for individuals with learning difficulties and cognitive disabilities. Efforts in this area include analyzing language usage in accessible tourism to progress heritage inclusivity and developing a classification system for disabilities [5]. Additionally, tools like the one introduced in [6] simplify complex Spanish vocabulary, enhancing cognitive accessibility through synonyms, definitions, and pictograms while the PRA2 platform further supports sensory and cognitively impaired with customized online questionnaires to improve the accessibility of audiovisual content [7]. These initiatives represent a broad effort to create more inclusive environments via innovative and interdisciplinary approaches. Online resources such as *Diccionario Fácil*[1] and *OpenThesaurus*[2] address specific needs by providing simplified language aids and extensive synonym databases. Meanwhile, the *Real Academia Española (RAE)*[3] offers deep insights into Spanish language and grammar, and *ARASAAC*[4] provides pictographic aids for those with communication impairments. However, many platforms still miss features like multimedia integration, extended definitions, and advanced search, which would further improve learning and accessibility. Traditional online dictionaries often fail to meet specific accessibility needs, highlighting the importance of making dictionaries both comprehensive and user-friendly to truly boost educational outcomes.

III. Development of the LECTPAT Platform

In this work, we present the LECTPAT platform, a multimodal online dictionary designed to be comprehensive, user-friendly, and easily navigable.

* Corresponding author

[1]https://www.diccionariofacil.org/
[2]https://www.openthesaurus.de/
[3]https://www.rae.es/
[4]https://arasaac.org/

The platform aims to make complex cultural heritage more accessible, especially for individuals with learning and cognitive disabilities or those not fluent in the text's original language. LECTPAT enhances term searchability and comprehension through detailed definitions, pictograms, and multimedia elements, providing a richer educational experience. The platform incorporates a visual search engine that sorts terms alphabetically and supports both complete and partial term searches. Users can suggest new terms, ensuring the platform remains dynamic and responsive. User comprehension is enhanced by providing terms with multiple distinct definitions, supported by dynamic labels such as "Field," 'Semantic Role', and 'Conceptual Category', supporting up to five levels of specificity. The interface displays primary definitions prominently and offers additional content through a "Learn More" option. The platform adjusts content visibility and auditory playback according to user roles, ensuring a personalized educational journey. Different roles within the platform allow access to specific content and functionalities, from simplified access for Visitor Users to full control for Root Users, who can manage users, terms, definitions, tags, and categories, and gather feedback through an integrated questionnaire. Root Users also have advanced management and security capabilities.

Built on Node.js, the platform supports scalable web applications, integrating Express for web frameworks, MySQL2 for database interactions, and CORS for resource sharing. Security features include Validator and Bcrypt for input validation and password hashing, respectively, with JSON Web Tokens (JWT) handling authentication and Nodemailer supporting email functions. Multer manages file uploads. The platform employs a Model-View-Controller (MVC) architecture, emphasizing models and controllers to streamline development and ensure efficient data management with MySQL. Web content accessibility is assessed using the Web Accessibility Evaluation Tool (WAVE)[5] by WebAIM, against the Web Content Accessibility Guidelines (WCAG) 2.1, Level AA standards. This benchmark focuses on text alternatives, content structure, keyboard accessibility, navigation, color contrast, form labeling, ARIA roles, and compatibility with assistive technologies.

Accessibility evaluations prioritize essential platform pages like the homepage, header, navigation menus, contact page, list of terms, and term definition pages. For example, the homepage features a search bar with a screen-reader-friendly setup, while the contact page's font colors were adjusted to improve contrast and readability. The term definition page's headings are structured to enhance content hierarchy and accessibility. Moreover, the header and navigation menu were modified to meet contrast requirements, changing the menu text color to raw sienna (#7A4E00) to achieve a 7:1 contrast ratio, improving visibility for users with low vision. The logo's alternative text was set to "LECTPAT Logo - A Complete Digital Dictionary" to provide meaningful context for screen readers. Additionally, the menu items were made keyboard accessible by incorporating the `tabindex` attribute. The search bar on the homepage included a hidden label for screen reader users, ensuring the input field is properly identified and accessible. The contact page's initial vivid blue font color was changed to deep teal (#005E80) to enhance text readability against a white background, achieving a contrast ratio of 7:1. Furthermore, all form elements on the contact page were associated with explicit `<label>` elements, improving form usability and compliance with accessibility standards. In the list of terms, an ordered list (`<ol>`) was used to display terms alphabetically, emphasizing the sequential nature of the list. The term definition page utilized a hierarchical heading structure, with `<h1>`, `<h2>`, and `<h3>` tags, to facilitate navigation and comprehension for users of assistive technologies.

[5]Web Accessibility Evaluation Tool homepage: https://wave.webaim.org/

IV. Conclusions and Future Work

These measures ensure the platform is universally accessible, particularly benefiting users with disabilities. LECTPAT significantly addresses educational disparities by providing inclusive access to knowledge and cultural resources. This represents a vital advancement in educational equality and accessibility. In the near future, an impact analysis will be carried out to assess the effects of accessibility improvements on user experience, focusing on metrics such as bounce rates and session durations. Additionally, enhancements will prioritize direct user feedback and comprehensive accessibility evaluations across all platform pages, including editor pages, to enhance user experience and inclusivity.

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Inspirando vocaciones STEM en estudiantes Indígenas

Erika García-Silva
GRIAL Research Group
Research Institute for Educational Sciences, Universidad de Salamanca,
Salamanca, Spain
erika.garcia@usal.es

Alicia García-Holgado
GRIAL Research Group
Research Institute for Educational Sciences, Universidad de Salamanca,
Salamanca, Spain
aliciagh@usal.es

Lucía García-Holgado
GRIAL Research Group
Research Institute for Educational Sciences, Universidad de Salamanca,
Salamanca, Spain
luciagh@usal.es

Nastaran Shoeibi
GRIAL Research Group
Research Institute for Educational Sciences, Universidad de Salamanca,
Salamanca, Spain
nastaran@usal.es

Sonia Verdugo-Castro
GRIAL Research Group
Research Institute for Educational Sciences, Universidad de Salamanca,
Salamanca, Spain
soniavercas@usal.es

***Resumen*— El proyecto "Retos Indigenius: Inspirando Futuros STEM" está alineado con los Objetivos de Desarrollo Sostenible (ODS), particularmente con el objetivo de promover la educación de calidad (ODS 4), la igualdad de género (ODS 5) y la reducción de desigualdades (ODS 10) de la Agenda 2030. Su objetivo principal es inspirar a jóvenes indígenas a explorar carreras en ciencia, tecnología, ingeniería y matemáticas (STEM), promoviendo oportunidades iguales y empoderando a las mujeres. Utiliza retos prácticos y charlas inspiradoras para fomentar el interés en las áreas STEM, promueve el pensamiento crítico y la diversidad e inclusión en la educación.**

Palabras clave—Retos-Indigenius, educación, STEM, Indígenas

I. Introducción

A pesar de los múltiples esfuerzos que se realiza a nivel mundial para mejorar las oportunidades educativas, los estudiantes indígenas siguen estando significativamente infrarrepresentados en las áreas STEM (Ciencias, Tecnología, Ingeniería y Matemáticas, en inglés, Science, Technology, Engineering and Mathematics)[1], [2], [3]. En este marco , nace el proyecto Retos Indigenius, que tiene como objetivo llevar conocimientos de ciencia, tecnología, ingeniería y matemáticas a niños y jóvenes en zonas marginadas, ya sean comunidades indígenas o rurales, mediante charlas y retos STEM.

II. Método e implementación

El proyecto utiliza un innovador marco de Aprendizaje Basado en Retos (ABR) que involucra activamente a los estudiantes a la resolución de diversos desafíos relacionados a las áreas STEM, incentivando su compromiso y mejorando los resultados de aprendizaje. El Aprendizaje Basado en Retos (ABR) es una metodología activa que capacita a los estudiantes para dirigir su propio proceso de aprendizaje, fomentando una actitud reflexiva y comprometida hacia la comunidad. Además de promover el trabajo colaborativo, busca aumentar la autoestima y la confianza, mejorar el razonamiento lógico-matemático y estimular la creatividad e imaginación de los estudiantes [4],[5]. Este enfoque educativo se complementa con charlas inspiradoras de profesionales STEM que comparten sus experiencias e ideas, motivando aún más a los jóvenes [6].

A. Actividades Clave

En el el contexto del proyecto Retos Indigenius, se diseñaron una serie de actividades claves.

Por un lado, se encuetran los Retos STEM, que han sido propuestas por profesoras universitarias en el campo de la Ingeniería y Arquitectura en la Universidad de Salamanca, así como por profesionales en estas áreas en el marco de la iniciativa "Ingeniería con perspectiva de género" (35/7ACT/21) financiada por el Instituto de la Mujer, una organización independiente adscrita al Ministerio de Sanidad, Servicios Sociales e Igualdad [7], [8].

Por otra parte, se encuentran las charlas inspiradoras, que son sesiones realizadas por profesionales exitosos en campos STEM que pueden servir como fuentes de inspiración para los participantes del proyecto, tanto mujeres como hombres.

III. Resultados e impacto

Los primeros hallazgos del proyecto reflejan un entusiasmo significativo entre los profesores/as, así como en los estudiantes por integrar estas iniciativas en sus instituciones educativas.

El compromiso continuo con actividades en áreas STEM es altamente demandado, siendo estas bien recibidas y profundamente agradecidas por la comunidad. Además, desde el proyecto se impulsa la igualdad de género al animar a las niñas indígenas a explorar campos STEM, desafiando roles y expectativas de género arraigadas.

IV. Conclusión

El proyecto Retos Indigenius, está comprometida con reducir la disparidad en la educación STEM al presentar retos innovadores y accesibles para involucrar a los jóvenes a través de enfoques de aprendizaje basado en retos.

Estos desafíos están diseñados para despertar la curiosidad y promover la exploración activa en campos STEM. A través de la participación, los estudiantes no solo adquieren conocimientos en ciencia, tecnología, ingeniería y matemáticas, sino que también cultivan habilidades vitales como el pensamiento crítico, la colaboración y la resolución de problemas.

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Proyecto ROBOSTEAMSEN: Capacitación de docentes de educación especial en el uso de la robótica para fomentar STEAM y desarrollar el pensamiento computacional

Miguel Á. Conde
Dept. of Mechanics, Computer Science and Aerospace Engineering
Universidad de León
León, Spain
mcong@unileon.es

Francisco J. Rodríguez-Sedano
Dept. Electrical, Systems and Automation Engineering
Universidad de León
León, Spain
fjrods@unileon.es

Francisco J. García-Peñalvo
Dpto. de Informática y Automática - IUCE
Universidad de Salamanca
Salamanca, España
fgarcia@usal.es

Jose Gonçalves
Research Centre in Digitalization and Intelligent Robotics (CeDRI)
Instituto Politécnico de Bragança
Bragança, Portugal
goncalves@ipb.pt

Ilkka Jormanainen
School of Computing
University of Eastern Finland
Joensuu, Finland
ilkka.jormanainen@uef.fi

Andrea Anzanello
Dept of Project Management
Pixel
Florence, Italy
andrea.anzanello@pixel-online.net

Jonny Filipe Ribeiro Alves
Colegio Intérnato Dos Carvalhos
Carvalhos, Portugal
jonny.alves@cic.pt

Raquel Fernández Hernández
Colegio de Educación Especial Ntra. Sra. del Sagrado Corazón de León
León, Spain
rfernandezhe@educa.jcyl.es

Alina-Andreia Ailincai
EuroEd Primary School
Lasi, Romania
alina.ailincai@euroed.ro

***Abstract*— En la sociedad actual, que los profesionales desarrollen las llamadas competencias del siglo XXI es esencial, y las disciplinas STEAM son efectivas para fomentar su adquisición. Sin embargo, educar en STEAM a estudiantes con discapacidades intelectuales o del desarrollo (IDD) presenta importantes desafíos. La iniciativa RoboSTEAMSEN apoya a los educadores de estudiantes con IDD proporcionando metodologías y herramientas especializadas para promover educación en STEAM a través de la robótica y el aprendizaje activo. Los objetivos principales del proyecto incluyen comprender las necesidades de los estudiantes con IDD, adaptar los métodos educativos en consecuencia y establecer programas de capacitación para la instrucción personalizada. Además, busca crear una comunidad de práctica respaldada por un ecosistema tecnológico para compartir estrategias exitosas de en la docencia en STEAM. Los resultados esperados son una mejora en la educación en STEAM para los estudiantes con IDD, lograda a través de una serie de productos como una taxonomía de recursos, modelos de aprendizaje personalizados, guías de instrucción y un ecosistema tecnológico para apoyar una comunidad de práctica.**

Keywords—Profesores de Educación Especial, Robótica, Metodologías Activas de Aprendizaje, Educación en STEAM.

I. Introduction

En nuestra cambiante sociedad actual las instituciones y las empresas deben adaptarse para satisfacer las necesidades en continua evolución de los usuarios y esto supone contar con profesionales bien preparados para afrontar estos desafíos. Es crucial que dichos profesionales desarrollen las denominadas competencias del siglo XXI desde una edad temprana [1].

Históricamente, el desarrollo de estas competencias se ha asociado con disciplinas como la Ciencia, Tecnología, Ingeniería, Artes y Matemáticas, que se conocen por el acrónimo anglosajón STEAM (*Science, Technology, Engineering, Arts and Maths*). Diversas experiencias demuestran que estas disciplinas no solo mejoran el desempeño de los trabajadores, sino que también pueden verse asociadas a la capacidad de innovación de los países [2]. Esto subraya la importancia de fomentar el interés en STEAM entre los jóvenes e integrar sus principios en los actuales planes de estudio. Diversas iniciativas, como TACCLE3 [3] y RoboSTEAM [4], han explorado estas áreas, mientras que otras, como W-STEM [5] y CreaSTEAM [6], han profundizado en el potencial de STEAM para la educación inclusiva de colectivos específicos.

Sin embargo, los colectivos de personas discapacitadas no pueden quedarse al margen. El acceso a las disciplinas STEAM para las personas con discapacidad a menudo es difícil debido a varios factores: el hecho de que no se les considere hábiles en STEAM, un currículo STEAM poco adaptado y las limitaciones que enfrentan los educadores para apoyar proporcionar un aprendizaje inclusivo en ese contexto [7, 8]. Se necesitan, por tanto, nuevos enfoques, herramientas, metodologías y propuestas para abordar este problema. La robótica, por ejemplo, se ha mostrado como una herramienta prometedora en disciplinas STEAM [9] y ha demostrado éxito en la enseñanza de estudiantes con necesidades educativas especiales, particularmente para mejorar las habilidades sociales y las funciones ejecutivas [10]. No obstante, el elemento crucial no es simplemente el uso de la robótica, sino su adaptación para personas con diversas dificultades [11]. Esto implica facilitar a los expertos y educadores recursos robóticos especializados, metodologías y herramientas adaptadas para diversas discapacidades.

Dadas estas circunstancias el proyecto ROBOSTEAMSEN, va a promover el uso de la robótica y metodologías activas de aprendizaje para mejorar el acceso a la educación en STEAM a personas con discapacidades

intelectuales y del desarrollo (IDD). RoboSTEAMSEN está planteado para asistir a los profesores de estudiantes con IDD, proporcionándoles herramientas y estrategias especializadas para atender diferentes discapacidades. Esto supone comprender las IDD comunes y las características de los estudiantes con IDD una personalización del aprendizaje adaptada a las capacidades del discente [12].

El resto de este artículo presenta los objetivos del proyecto, los paquetes de trabajo y el consorcio

II. OBJETIVOS

ROBOSTEAMSEN tiene como objetivo principal: la definición de una base de conocimiento para la educación de profesores de educación especial, en la impartición de disciplinas STEAM y en el desarrollo del pensamiento computacional para estudiantes con IDD, mediante el uso de robótica y metodologías activas de aprendizaje.

La consecución de este objetivo va a requerir: conocer los retos asociados a la educación STEAM para estudiantes con discapacidad; investigar acerca de cómo adaptar las tecnologías y metodologías para ellos; desarrollar guías y formar profesorado acerca de cómo aplicar estos planteamientos en la docencia en STEAM de estudiantes con IDD; fomentar una colaboración entre todos los actores involucrados en el contexto del proyecto para garantizar su éxito una vez finalice el mismo.

III. CONSORCIO

El consorcio está compuesto por ocho organizaciones que representan las áreas de interés del proyecto (más concretamente los ámbitos robóticos y educativos) y las áreas de aplicación (representados por colegios). Más concretamente se tienen cuatro universidades: Universidad de León y Universidad de Salamanca en España, Instituto Politécnico de Bragança en Portugal, y la University of Eastern Finland en Finlandia; dos colegios: El Colegio Internato dos Carvalhos en Portugal y el Colegio de educación primaria EuroEd en Rumania; un centro de educación especial español: el CEE Nuestra Señora del Sagrado Corazón (SCO) y; un socio del ámbito técnico y de gestión como es la empresa

IV. PAQUETES DE TRABAJO

El Proyecto se divide en los siguientes 5 paquetes de trabajo (PT):

- PT1. Gestión del proyecto. Esencial para la consecución del mismo, incluye tareas relativas a la coordinación del proyecto, distribución y planificación de tareas, evaluación de la calidad, gestión del riesgo, gestión presupuestaria, etc.
- PT2. Adaptación de recursos, metodologías y herramientas por IDD. Paquete diseñado para equipar a los profesores con el conocimiento necesario para integrar robótica y metodologías activas de aprendizaje en la docencia para estudiantes con diferentes IDDs.
- PT3. Enseñar a los profesores a utilizar los recursos generados en el paquete anterior de cara a que ellos puedan aplicarlo al fomento de las disciplinas STEAM en estudiantes con IDDs.
- PT4. Ecosistema tecnológico y Comunidad de práctica. Paquete centrado en aspectos fundamentales de diseminación y sostenibilidad que tiene como objetivo establecer una comunidad de práctica soportada por un ecosistema tecnológico donde se pueda acceder a los recursos y contenidos generados.
- PT5. Diseminación y explotación. Se centra en asegurar que los resultados se conozcan y utilicen no solo durante la vida del proyecto sino una vez este finalice.

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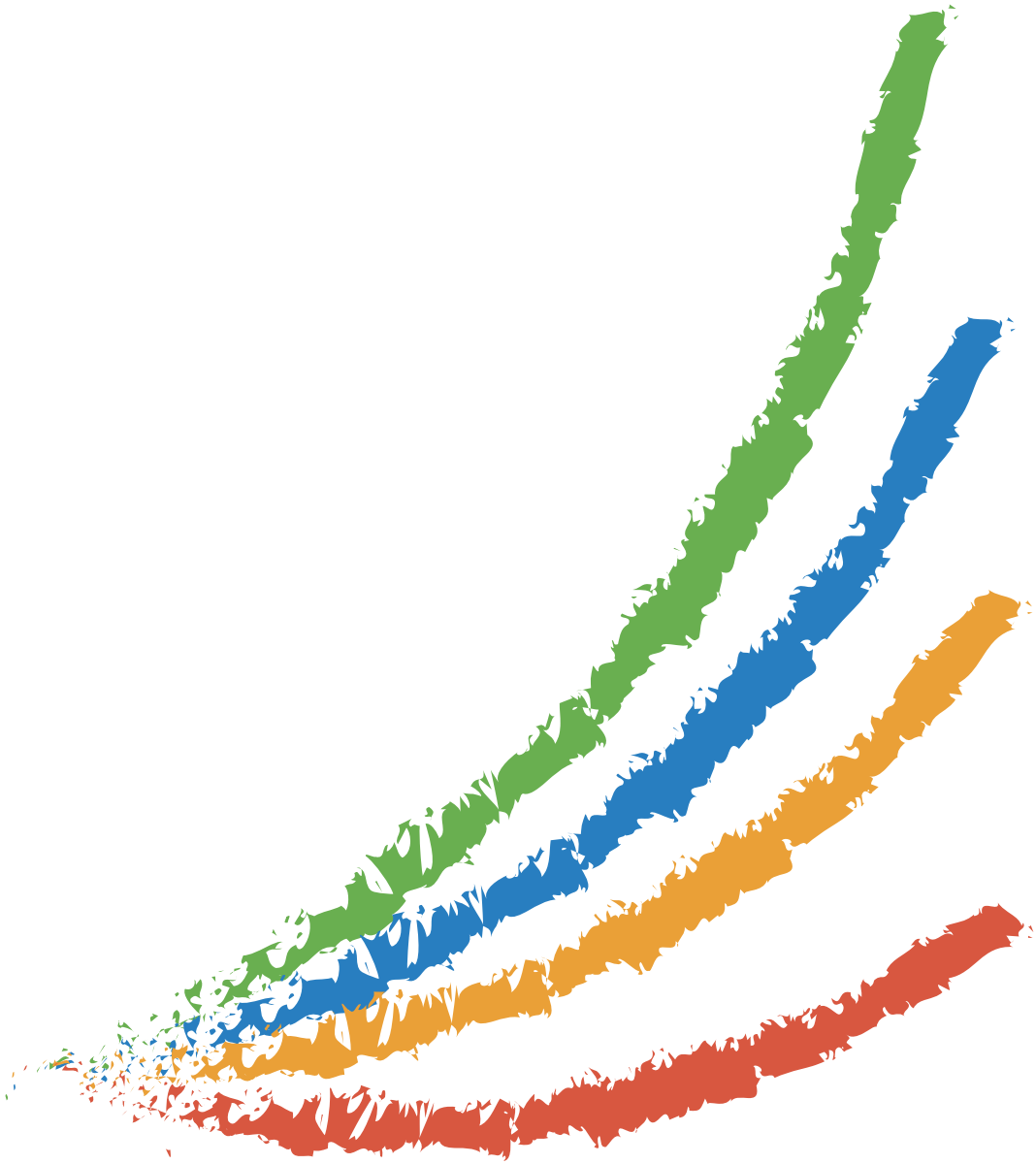
STEAM, Computational Thinking and Teacher training



Materiales Educativos para la Formación del Profesorado en el Lenguaje ScratchJr: Reglas de Comportamiento y Patrones de Programación

J. Ángel Velázquez-Iturbide
Escuela Técnica Superior de Ingeniería Informática
Universidad Rey Juan Carlos
Móstoles, Madrid, España
angel.velazquez@urjc.es

***Resumen*—Los materiales disponibles para el aprendizaje de la programación basada en bloques suelen promover un aprendizaje más intuitivo que profundo. En esta comunicación se presentan dos materiales diseñados para mejorar el aprendizaje del lenguaje ScratchJr. Por un lado, se presenta la semántica operacional del lenguaje en forma de reglas de comportamiento. Por otro, se presentan patrones de programación para facilitar la codificación de las acciones de los personajes. Ambos materiales se han evaluado con profesores preuniversitarios noveles en programación y con profesores universitarios de programación, habiendo sido valorados muy favorablemente y habiendo permitido mejorar su formulación.**

Palabras clave—lenguajes basados en bloques, ScratchJr, formación del profesorado, semántica operacional, reglas de comportamiento, patrones de programación

I. Introducción

En la última década se ha asentado la programación basada en bloques como un paradigma fundamental para la enseñanza de la programación [1] en etapas preuniversitarias. La programación basada en bloques elimina algunas dificultades de su aprendizaje, como memorizar el léxico y la sintaxis del lenguaje. Sin embargo, persisten otras dificultades, como comprender la dinámica de la ejecución de los programas. De hecho, no se ha propuesto ningún modelo explícito de la dinámica operacional de ningún lenguaje de bloques [2].

Asimismo, uno de los problemas principales para la introducción generalizada de la informática en el currículo escolar es la falta de profesorado preparado. El trabajo que aquí se presenta se inscribe dentro de un proyecto de investigación sobre el aprendizaje de la programación basada en bloques, principalmente por profesores de etapas preuniversitarias. En esta comunicación presentamos dos materiales educativos diseñados para aprender ScratchJr.

Por un lado, presentamos materiales para aprender el comportamiento en tiempo de ejecución de los programas ScratchJr. En la comunicación, presentamos una especificación del comportamiento de ScratchJr mediante reglas de comportamiento [3].

Por otro lado, presentamos patrones de programación [4] para facilitar la codificación de movimientos y de control de los personajes. Los patrones representan formas de codificar tareas de programación frecuentes y que ayudan a la comprensión de las instrucciones del lenguaje.

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II. Reglas de Comportamiento

En educación, el profesor debe utilizar un modelo conceptual del comportamiento de los programas para explicárselo a los alumnos. Se ha propuesto el uso de reglas de comportamiento para especificar dicho modelo [3]. Dichas reglas declaran el efecto que produce la ejecución de las construcciones del lenguaje de programación.

Se ha descrito el lenguaje ScratchJr mediante un total de 27 reglas de comportamiento. Las reglas se estructuran en cinco conjuntos de reglas que permiten una presentación progresiva del lenguaje:

1. Programas y bloques (4 reglas).
2. Escenario y movimientos (6 reglas).
3. Apariencia y sonido (7 reglas).
4. Paralelismo y eventos (6 reglas).
5. Control y terminadores (4 reglas).

La mayoría de las reglas constan de varias subreglas. Además, los conjuntos de reglas terminan con ejemplos que ilustran los comportamientos enunciados. El conjunto completo de reglas está disponible en un informe técnico [6].

La Fig. 1 muestra un ejemplo de regla de comportamiento, la regla 9, que describe el bloque "Saltar" (conjunto de reglas 2). La regla contiene dos subreglas.

§9 El bloque "Saltar" hace que el personaje suba primero y baje después un cierto número de celdas, simulando un salto.

§9.1 Si el salto es de un número negativo de pasos, primero baja y después sube.

§9.2 El escenario no se comporta de forma circular con el bloque "Saltar". Con un número positivo, si al subir llega al borde superior (de altura 15), no avanza más. Después baja tantas casillas como indica su número (sin sobrepasar el borde inferior). Con un número negativo, si al bajar llega al borde inferior, tampoco avanza más. Después sube tantas casillas como indica su número (sin sobrepasar el borde superior).

Fig. 1. Regla de comportamiento del bloque "Saltar"

III. Patrones de Programación

Cuando alguien aprende una materia nueva, utiliza estrategias generales para resolver problemas. Según avanza su aprendizaje, va construyendo esquemas cognitivos más eficientes [5]. Estos esquemas se concretan en programación mediante patrones.

Un patrón de programación es un esquema de código que ayuda a comprender y usar ciertas construcciones del lenguaje [4]. Presentamos patrones de programación para ScratchJr. Se han obtenido tres categorías de patrones:

- Efectos especiales (3 patrones): "Bamboleo", "Resaltado" e "Inclinación".
- Patrones de movimiento (2 patrones): "Entrar en algún sitio" y "Movimiento compuesto".
- Patrones de control (5 patrones): "Sincronización de dos personajes mediante el reloj", "Sincronización de dos personajes mediante un mensaje", "Sincronización de dos personajes mediante choque", "Parar a un personaje" y "Parar a varios personajes".

Las dos primeras categorías corresponden a patrones de efectos multimedia. Casi todos los patrones se acompañan de ejemplos. El conjunto completo de patrones se encuentra en un informe técnico [7].

La Fig. 2 muestra un ejemplo de patrón de movimiento, el patrón "Movimiento compuesto".

El personaje se mueve como resultado de realizar en paralelo los movimientos más sencillos de los dos guiones. Un guion realiza un movimiento continuo, normalmente en horizontal, mientras que el otro guion realiza otro movimiento distinto. El patrón consta de dos guiones correspondientes a un mismo personaje:

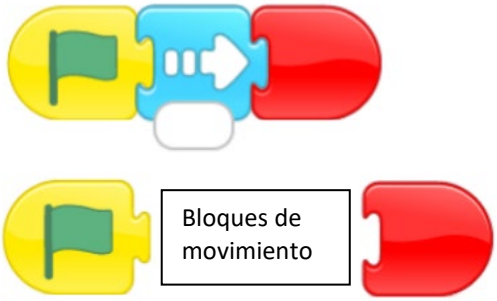

Fig. 2. Patrón "Movimiento compuesto"

La Fig. 3 muestra un ejemplo de aplicación del patrón.

Eleva un balón de fútbol, que después sigue rondando:

Fig. 3. Un ejemplo del patrón "Movimiento compuesto"

IV. Evaluación

Se realizó una primera evaluación en la asignatura "Programación y Pensamiento Computacional I" del Máster Universitario en Competencia Digital Docente y Pensamiento Computacional de la Universidad Rey Juan Carlos. Se evaluaron tanto las reglas de comportamiento como los patrones de programación. Su aceptación fue muy positiva, pero la lectura de sus comentarios deja la duda de si algunos alumnos confunden los apuntes y el documento de reglas de comportamiento.

También se realizó una evaluación con 6 profesores de la Universidad Rey Juan Carlos que habían impartido o tenían previsto impartir la asignatura "Informática y Competencia Digital Docente" del Grado en Educación Infantil.

Se organizó una única sesión, que comenzó con una introducción a los objetivos de la investigación, continuó con la evaluación de los patrones y siguió con la evaluación de las reglas de comportamiento. Para cada parte, se dio acceso a los materiales a evaluar y a un formulario de Microsoft Forms.

Cada cuestionario constaba de varias secciones, presentadas en páginas sucesivas y que correspondían a la organización del material educativo correspondiente. Es decir, los patrones se presentaban según los tres tipos de patrones y las reglas de comportamiento por conjuntos de reglas. Las valoraciones numéricas se realizaron sobre una escala de Likert de cinco valores (1= poco, 5=mucho). También se incluían campos de texto para comentarios libres.

Los resultados numéricos obtenidos sobre la utilidad de las reglas fueron muy altos. Los seis profesores valoraron unánimemente 12 de los 22 ítems con 5, siendo las demás calificaciones cuatros y un tres. La mayor parte de los comentarios fueron elogios de los ejemplos y sugerencias.

Los resultados numéricos obtenidos sobre la claridad y utilidad de los patrones de programación también fueron altos, con casi todos los valores medios por encima de 4'5.

V. Conclusiones

Hemos presentado dos materiales docentes para la enseñanza del lenguaje ScratchJr. Actualmente se están utilizando en la asignatura de máster mencionada. Las reglas de comportamiento tienen como destinatario principal los formadores de profesores noveles en programación, mientras que los patrones de programación están pensados principalmente para que éstos aprendan a programar. Las evaluaciones realizadas han dado un alto grado de aceptación y han permitido mejorar los materiales.

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Teacher's Data Literacy Assessment Tool

Belén Donate-Beby
Informatic and Automatic Departament
University of Salamanca
Salamanca, Spain
belendonate@usal.es

Francisco José García-Peñalvo
Informatic and Automatic Department
University of Salamanca
Salamanca, Spain
fgarcia@usal.es

Daniel Amo-Filva
Computer Engineering Department
La Salle, University Ramón Llull.
Barcelona, Spain
daniel.amo@salle.url.edu

I. INTRODUCTION

In an era dominated by digitalization, integrating advanced technologies into teaching-learning practices poses a significant challenge across all educational levels [1]. Educators often face barriers to effectively utilizing data and integrating Information and Communications Technology (ICT) due to a lack of confidence, competence, and access to these technologies [2]. The emergence of Artificial Intelligence (AI) further accentuates this technological adoption lag, yet it also offers immense opportunities for teachers and educational institutions [3]. Specifically, AI and data literacy are intertwined critical concepts essential for achieving goals in the educational environment in the comprehension of AI tools functioning [4].

The European Digital Competence Framework underscores the importance of developing digital competencies, including data literacy, to navigate the complexities introduced by AI and big data in education [5]. Effective data management requires critical collection, analysis, and application of data, which is essential for Data-Driven Decision-Making (DDDM) and is aimed at improving teaching and student outcomes [6], [11]. Consequently, there is a growing need for educators and administrators to receive training and tools to enhance data literacy skills and leverage AI effectively [7]. To address this need, this paper introduces a self-assessment questionnaire designed to evaluate data literacy competencies among teachers.

This work outlines the questionnaire's development and validation methodology, presents validation results, and discusses the findings' implications for enhancing data literacy among educators.

II. METHODOLOGY

The study employed a Sequential Exploratory Design (DEXPLOS) [8] to develop the questionnaire [9]. We conducted a comprehensive review of existing research and frameworks on data literacy from various sources. We selected models from Maybee and Zilinski [10], Mandinach & Jimerson [11], Buckingham Shum [12], and Raffaghelli [13] to guide the questionnaire design. We ensured that every question was unambiguous and closely linked to these areas, relying on Ridsdale et al. [14] for structuring and tailoring conceptual and core competencies across five key areas. Thus, Redecker and Punie's framework [15] has been take for emphasizing European digital teaching competencies requirements. From this review, they identified four primary domains of data literacy competencies: problem identification, data utilization, transformation of data into information, and evaluation of results. Subsequently, we formulated 26 questions based on these identified domains. To ensure the questionnaire's validity and refinement, feedback was sought from 20 teachers and 10 postgraduate students.

For the questionnaire design we followed the expert judgments and feedback, the researchers stabilized questionnaire items and made necessary improvements. We opted for the 6-Point Likert Scale due to its effectiveness in measuring constructs promoting the comprehension and interpretation of the questionnaire [16]. Afterwards, we analyzed responses from 66 primary and secondary education teachers. Then, we conducted an Exploratory Factor Analysis (EFA) [17] to reorganize questionnaire items into three competency dimensions: Comprehensive Educational Analytics Area, Educational Problem-Solving Through Data Area, and Promoting Meta-Learning Students through Data and Ethical Implications Area. Each statement was statistically reviewed for internal consistency and reliability, leading to the exclusion of two items (24 statements).

III. RESULTS

The study presents a self-assessment questionnaire comprising 24 items categorized into three dimensions, which is available in [18]. Regarding the questionnaire distribution, the resultant dimensions measure conceptual and core competencies [11]. These authors outline the difference in the tasks' difficulty: while core competencies involve data practical skills, conceptual competencies encompass an understanding of data.

Thus, the dimensions extracted from the EFA [17] are described below: (1) Comprehensive Educational Analytics: evaluates practical data management competencies essential for Data-Driven Decision-Making in the educational sector. It assesses the ability to handle data effectively and convert it into actionable insights; (2) Educational Problem-Solving Through Data: This dimension focuses on addressing educational challenges using data. It evaluates conceptual competencies related to knowledge and core competencies related to practical problem-solving abilities [14]; (3) Promoting Meta-Learning Students through Data and Ethical Implications: assesses conceptual competencies related to data ethics, critical thinking, and the role of data culture in transforming information. It also evaluates specific knowledge about handling student data, such as understanding privacy policies and facilitating data visualization tools for student self-assessment.

IV. DISCUSSION

With its global and granular insights, the questionnaire is accompanied by guidelines for meticulous interpretation and pragmatic application. The guidelines provided for the questionnaire administration underscore the importance of contextualizing competencies within a framework that acknowledges the centrality of comprehension in fostering core competencies: (1) The Comprehensive Educational Analytics dimension evaluates educators' adeptness in managing data to inform pedagogical decisions, emphasizing the pivotal role of Data-Driven Decision-Making and the conversion of data into actionable insights. (2) The Educational Problem-Solving Through Data dimension scrutinizes educators' proficiency in identifying and resolving educational challenges through judicious data utilization, thereby revealing potential gaps in both knowledge and application. (3) The Promoting Meta-Learning Students through Data and Ethical Implications dimension delves into the ethical dimensions of data management, urging educators to grapple with the legal and ethical ramifications of student data utilization. It combines theoretical underpinnings with practical pedagogical strategies, thus fostering a holistic approach to data-driven educational practices.

With its guidelines, this tool empowers educators to navigate the complexities of data-driven education effectively, enhancing both their professional development and student outcomes.

CONCLUSIONS

In conclusion, this validated questionnaire offers a robust framework for assessing data literacy skills among educators, providing valuable insights for both practitioners and researchers. The accompanying guidelines enhance educators' understanding of their results, empowering them to develop data literacy skills to optimize teaching practices and support student learning effectively. Ethical considerations underscore the responsible use of data in education, while the focus on promoting student self-assessment fosters a more personalized learning experience [19].

The questionnaire's global evaluation potential allows future research to establish a worldwide observatory on teacher data literacy. Likewise, research lines should employ the questionnaire to identify gaps in data management practices and enhance understanding of teaching barriers.

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Una estrategia de tutorización para entornos CSCL basada en Modelos Lineales Generalizados

Camilo Palazuelos
Universidad de Cantabria
Santander, España
camilo.palazuelos@unican.es

Rafael Duque
Universidad de Cantabria
Santander, España
rafael.duque@unican.es

Crescencio Bravo
Universidad de Castilla-La Mancha
Ciudad Real, España
crescencio.bravo@uclm.es

***Index Terms*—CSCL; análisis de la colaboración; modelos lineales generalizados; tutorización inteligente.**

I. Resumen

Los entornos CSCL (Computer-Supported Collaborative Learning) se han convertido en herramientas fundamentales para facilitar el aprendizaje en grupo en dominios complejos. La Programación, en particular, es un campo donde estos entornos juegan un papel crucial al permitir que los estudiantes colaboren en la resolución de problemas informáticos. En este contexto, los entornos CSCL proporcionan una infraestructura tecnológica que fomenta la interacción entre los estudiantes y facilita el intercambio de ideas y conocimientos.

La Programación es una habilidad cada vez más demandada debido al uso generalizado de las tecnologías de la información en todos los ámbitos de la vida [1]. Los programadores son profesionales altamente cualificados que diseñan, desarrollan, prueban y mantienen software que utilizamos a diario, desde aplicaciones de mensajería hasta plataformas de comercio electrónico. Por lo tanto, es fundamental dotar a los estudiantes de las habilidades necesarias para sobresalir en este campo en constante evolución.

El objetivo principal de este trabajo es diseñar y evaluar un método innovador aplicable a entornos CSCL para proporcionar apoyo y orientación a los estudiantes durante el proceso colaborativo de resolución de problemas de Programación. Este método se centra en anticipar y presentar a los estudiantes predicciones tempranas sobre sus resultados y el progreso de su trabajo colaborativo.

En esencia, el método propuesto utiliza Modelos Lineales Generalizados (MLG) [2] como marco analítico para predecir y mostrar valores de indicadores clave que evalúan tanto el proceso colaborativo como los resultados del trabajo de los estudiantes. Al proporcionar a los estudiantes información predictiva, se les capacita para tomar decisiones informadas y ajustar su trabajo con el objetivo de mejorar su desempeño y maximizar la calidad de la solución final.

El método propuesto procesa un repositorio de log que contiene información sobre las acciones que ejecutan los usuarios de un sistema CSCL. Los mencionados usuarios están organizados en grupos y realizan diversas acciones para resolver un problema del ámbito de la Programación. Estas acciones se agrupan en intervalos de tiempo para facilitar su análisis.

El método calcula diversas métricas, como el número de veces que ciertos pares de acciones han ocurrido dentro de cada intervalo de tiempo para cada grupo de usuarios. Luego, se emplea MLG para predecir la calidad de las soluciones basándose en la evolución de estas acciones a lo largo del tiempo. El enfoque de regresión lineal busca pronosticar el comportamiento futuro del grupo, y luego se aplica una regresión logística para relacionar estas predicciones con indicadores que evalúan la calidad de las soluciones.

Para validar y poner a prueba este método, se utilizó el sistema COLLECE como plataforma experimental [3]. COLLECE es un entorno de desarrollo colaborativo que permite a los usuarios editar, compilar y ejecutar programas de forma distribuida y síncrona. Este sistema ha sido utilizado como prototipo de investigación en diversos contextos educativos y profesionales, proporcionando un espacio compartido donde los estudiantes pueden abordar tareas de Programación y colaborar de manera efectiva.

Además de facilitar la Programación colaborativa, COLLECE incluye un módulo de análisis avanzado capaz de registrar y sintetizar la actividad de resolución de problemas, generando indicadores de análisis que caracterizan diferentes aspectos del proceso colaborativo y la calidad de las soluciones propuestas [4]. Para evaluar la efectividad de nuestro método, se recopilaron datos de registro de 106 grupos que utilizaron COLLECE para resolver uno de entre nueve problemas disponibles, evaluando las soluciones propuestas mediante 19 indicadores específicos.

La Tabla I presenta las áreas bajo la curva ROC resultantes de la validación cruzada Leave-One-Out (LOO) al final del experimento y a los 30, 45 y 60 minutos después del inicio del experimento. Para cada uno de estos tres puntos temporales, se distinguen dos posibles análisis: (i) considerando tanto los grupos que han terminado como los que no (* en la Tabla I), y (ii) considerando solo los grupos que aún no han terminado la tarea (** en la Tabla I). Los indicadores (consultar [4] para una descripción detallada de ellos), que se dividen en tres categorías que evalúan aspectos de usuario, aspectos de grupo y aspectos de solución, se encuentran en los tercios superior, medio e inferior de la Tabla I, respectivamente.

Los resultados obtenidos muestran la eficacia del método

TABLA I
RESULTADOS DEL EXPERIMENTO.

Indicador	T	60 min (*)	60 min (**)	45 min (*)	45 min (**)	30 min (*)	30 min (**)
Trabajo	**0.9232**	**0.8364**	**0.7356**	**0.8039**	**0.7607**	**0.7386**	**0.7333**
Actitud	**0.8527**	**0.7640**	**0.7119**	**0.7129**	**0.7026**	**0.7508**	**0.7631**
Discusión	**0.8260**	0.6719	0.5897	**0.7365**	**0.7599**	0.6729	0.6667
Modelado	0.6921	0.6844	0.6067	0.6608	0.6303	0.5316	0.5113
Velocidad	0.6477	**0.7071**	**0.7811**	0.5979	0.5807	0.5326	0.5360
Participación	0.6127	0.5733	0.5438	0.6073	0.5429	0.5670	0.5542
Comunicación	**0.9360**	**0.9197**	**0.8894**	**0.8796**	**0.8657**	**0.8166**	**0.8191**
Experimentación	**0.8388**	**0.7730**	**0.7444**	0.6991	**0.7106**	0.5768	0.5507
Colaboración	**0.8372**	**0.8256**	**0.8241**	**0.8244**	**0.8438**	**0.7948**	**0.7888**
Trabajo	**0.8331**	**0.8095**	**0.8189**	**0.8302**	**0.8432**	**0.7722**	**0.7818**
Coordinación	**0.8106**	**0.7929**	**0.8318**	**0.8239**	**0.8678**	**0.8176**	**0.8328**
Velocidad	0.5627	0.5170	0.6389	0.5348	0.5120	0.5065	0.5554
Dificultad	**0.7750**	**0.7314**	0.6917	**0.7562**	**0.7451**	0.6552	0.6217
Calidad	**0.7112**	0.6767	**0.7253**	0.6146	0.6143	0.6045	0.5703
Correcto	0.6670	0.5940	0.6984	0.5694	0.5815	0.5894	0.5689
Bien formado	0.6420	0.5591	0.5722	0.6874	0.5556	0.5120	0.5301
Validez	0.6223	0.5124	0.5187	0.5963	0.5044	0.5043	0.5094
Grado de experimentación	0.6136	0.6174	0.5657	0.6187	0.5966	0.5234	0.5246
Coste	0.5743	0.5435	0.6345	0.5815	0.5509	0.5232	0.5138

propuesto para predecir adecuadamente la mayoría de los indicadores relacionados con el trabajo en grupo y la interacción entre los miembros. Estos hallazgos respaldan la aplicación de modelos analíticos avanzados para intervenir y mejorar procesos colaborativos de aprendizaje y resolución de problemas en entornos educativos. Este enfoque no solo permite identificar oportunidades de mejora en tiempo real, sino que también proporciona una base sólida para desarrollar estrategias de tutorización personalizadas que impulsen el éxito académico y profesional de los estudiantes en el campo de la Programación y la Informática, contribuyendo así a satisfacer la creciente demanda de habilidades digitales en la sociedad contemporánea.

Una de las fortalezas clave del método propuesto es su capacidad para ser generalizado a otros dominios y entornos educativos más allá de la Programación. Si bien inicialmente se diseñó para abordar problemas de Programación en entornos CSCL, el método podría adaptarse para aplicarse en contextos de aprendizaje que implican la construcción de documentos, artefactos o la resolución de problemas en otras disciplinas.

Para lograr esta generalización, es esencial identificar y definir un conjunto adecuado de indicadores de análisis que sean relevantes para el proceso de trabajo y el producto final en el contexto educativo específico. Además, se requiere una infraestructura tecnológica que permita recopilar datos de actividad de los estudiantes y calcular los indicadores necesarios para alimentar el modelo predictivo del método.

Como parte de las futuras investigaciones, se planea explorar mecanismos automatizados de intervención basados en el método propuesto. La idea es desarrollar software de soporte que pueda detectar automáticamente situaciones problemáticas durante el proceso colaborativo de los estudiantes y proporcionar intervenciones específicas para corregir desviaciones y mejorar el proceso de aprendizaje.

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Cataloguing Learning Resources that promote Computational Thinking, a systematic approach

1st Cristiana Araújo
ALGORITMI Research Centre/LASI, University of Minho
Braga, Portugal
decristianaaraujo@hotmail.com

2nd Pedro Rangel Henriques
ALGORITMI Research Centre/LASI, University of Minho
Braga, Portugal
prh@di.uminho.pt

3rd João José Cerqueira
Life and Health Sciences Research Institute (ICVS), University of Minho
Braga, Portugal
jcerqueira@med.uminho.pt

ABSTRACT

Jeannette Wing [1] came up with the concept of Computational Thinking (CT), in 2006, and defined it as being: "a method of solving problems, designing systems and understanding human behavior, based on fundamental concepts of Computer Science". For Wing, CT is a crucial approach that cuts across any field, not just for Computer Scientists. Over the years, several definitions have emerged in the literature [2]–[5].

For us, CT is *a reasoning process characterized by a set of skills and practices (attitudes) that allow to find an effective and efficient way to solve a given problem, prone to be executed by a computer*. This definition includes, but is not limited to, the following skills: abstraction (identifying what is important and remove unnecessary details) [6]–[8]; algorithmic thinking (ordering a set of instructions or rules for doing something) [6]–[8]; decomposition (breaking a problem into less complex steps to reduce its difficulty) [6]–[8]; patterns recognition (identifying similarities or characteristics between problems and solving the problem using solutions previously defined in other problems and based on experiences) [7], [8]; analysis (identify and understand the different elements of a problem) [9], [10]; logical reasoning (deduction (conclude something from information that already exists), induction (affirm a generalized truth based on the observation of some elements), abduction (look for new ideas and knowledge that can validate something)) [7], [8], [11]; and evaluation (ensure that the solution is adequate to solve the problem, checking the limit cases) [6]–[8].

These skills are supported and enhanced by practices or attitudes, namely: adapting (adjust the strategy/resolution to each situation) [9], [10]; collaborating (working as a team) [7], [8]; creating (design and make with creativity) [8]; debugging (finding and fixing errors) [8]; optimizing (restructure for a more efficient solution) [9], [10]; persevering (continue and never give up, even when the problem is more complex to solve) [7], [8]; planning (define long-term objectives and the means to achieve them) [9], [10]; and tinkering (change and see what happens – cause and effect experiments) [8].

To develop CT skills from a young age, it is necessary to use appropriate Learning Resources (LR). There are many LR available, online and in books, to promote CT. However, in addition to being dispersed, it is also difficult to quickly understand which CT skills each of them develop, and even to what years of schooling they can be applied. In this paper, we aim to present an approach to categorize these LRs. This categorization will help the teacher to more quickly and efficiently find an LR to train one or more specific CT skills for a given school year. Furthermore, this categorization will make it possible to build an LR catalog in order to concentrate all LR in one place. To implement the LR categorization approach, we will use the OntoCnE Ontology. We started building OntoCnE some time ago with the aim of understanding how to promote the development of CT in children. We believe that developing CT skills will help students reduce the difficulties they have in learning to solve problems using a computer, thus reducing the known failure rate in Computer Programming (CP) courses [12], [13].

OntoCnE is composed of 4 layers. Layer 1 describes CT and relate it with CP allowing an understanding of how and why to develop CT. Figure 1 displays a fragment of OntoCnE Layer 1.

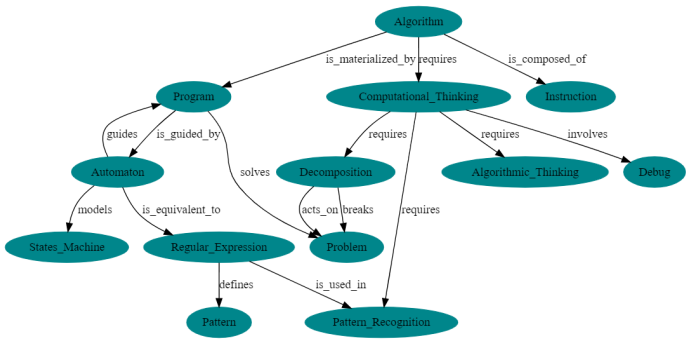

Fig. 1: OntoCnE – Layer 1 (fragment).

Layer 2 defines which concepts should be worked at each

scholar year and how deep to introduce them. Figure 2 displays a fragment of OntoCnE connecting Layers 1 and 2 illustrating the main idea of our work. In this figure, Layer 1 is represented in turquoise and Layer 2 in red. Concepts are represented in ellipses as in the previous layer and individuals are represented in rectangles.

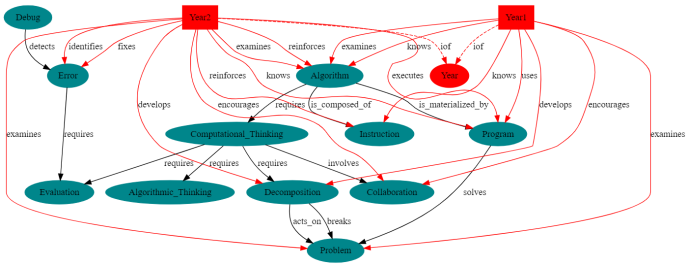

Fig. 2: OntoCnE – Layer 1 and Layer 2 (fragment).

Layer 3 defines the skills developed by each resource and the appropriate ages. Figure 3 shows a fragment of the 3 layers of OntoCnE. In this figure, Layer 3 is represented in orange.

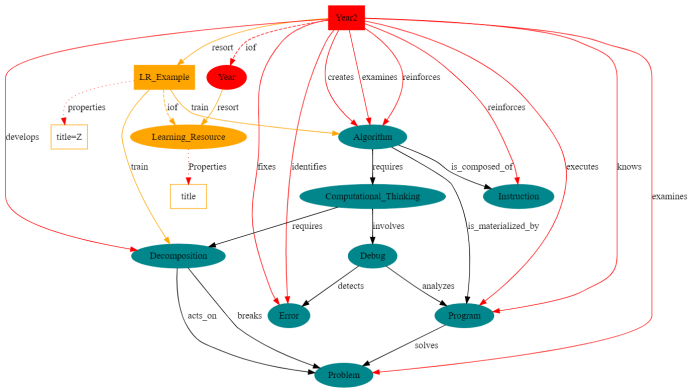

Fig. 3: OntoCnE – Layer 1, Layer 2, and Layer 3 (fragment).

Layer 4 describes a set of Neuroeduction Guidelines relating them with the learning process and linking with the resources. Figure 4 shows a fragment of OntoCnE with the 4 Layers connected. Layer 4 is represented in green.

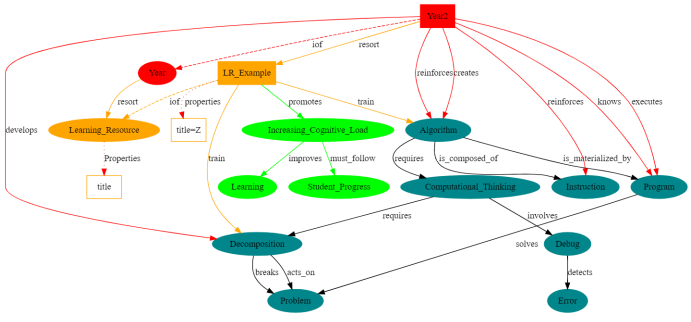

Fig. 4: OntoCnE – Layer 1, Layer 2, Layer 3, and Layer 4 (fragment).

Layers 3 and 4 are crucial to perform LR categorization. Layer 3 characterizes LR in order to select them for concrete training (example, development of *Pattern Recognition* in *4th year)*. Layer 4 assists the teacher in selecting a concrete LR that aids training based on one or more specific Neuroeducation Guidelines (e.g., developing *Pattern Recognition* in *4th grade* with *Increased Cognitive Load*). This categorization allows the teacher to select the most appropriate and efficient LR in developing one or more CT skills.

As future work, we intend to continue to characterize more LR to enrich our catalog. We also intend to design an educational program to promote Computational Thinking at school, based on Layers 1 and 2, to be applied in Years 1 to 9. Furthermore, design and conduct experiments is necessary to validate this approach, focusing teachers feedback. Their opinion is crucial to improve our proposal.

The paper is organized into 4 sections. Section 2 discusses OntoCnE and its 4-layer structure. In Section 3 we present the characterization of concrete LRs – *Pokemon* and *Mática* – to illustrate our proposal. Section 4 presents conclusions and future work.

***Index Terms*—Computational Thinking, Ontology, OntoCnE, Learning Resources, Neuroeducation**

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Evaluando la usabilidad de EvalCOMIX-FLOASS: un entorno virtual para la evaluación colaborativa de competencias y resultados de aprendizaje

Nuria Hurtado Rodríguez
Departamento de Ingeniería Informática
Universidad de Cádiz
Puerto Real, España
nuria.hurtado@uca.es

José Luis Isla Montes
Departamento de Ingeniería Informática
Universidad de Cádiz
Puerto Real, España
joseluis.isla@uca.es

Antonio Balderas
Departamento de Ingeniería Informática
Universidad de Cádiz
Puerto Real, España
antonio.balderas@uca.es

***Resumen*— EvalCOMIX-FLOASS es un entorno virtual de aprendizaje integrado en Moodle que permite la evaluación de resultados de aprendizaje. Para ello, permite la creación de diversos instrumentos de evaluación y la integración de diferentes estrategias de evaluación. Con el objetivo de impulsar la transferencia tecnológica y mejorar la interacción del usuario con la herramienta, se ha llevado a cabo una completa evaluación de la usabilidad. Los hallazgos destacan la relevancia de realizar evaluaciones de usabilidad en el contexto de las herramientas educativas.**

Keywords*— *Análisis de usabilidad, Evaluación, Evaluación de los resultados del aprendizaje.

I. Introducción

EvalCOMIX-FLOASS es un entorno virtual de aprendizaje, implementado como un servicio web integrado en Moodle, que facilita la creación de diversos instrumentos de evaluación y su uso en procesos de evaluación participativa, como pueden ser la autoevaluación y la evaluación entre iguales. Dicho entorno permite evaluar los resultados de aprendizaje, así como conocer en qué medida se alcanzan las competencias relacionadas.

Desde su nacimiento en el año 2000, EvalCOMIX-FLOASS ha evolucionado notablemente, consolidándose como un valioso recurso para la comunidad educativa [1, 2, 3, 4, 5]. No obstante, hasta el momento no se había evaluado formalmente su usabilidad. La investigación centrada en la usabilidad de las herramientas de e-learning tiende a recibir menos atención en comparación con la investigación que se enfoca en la eficacia de estas herramientas para mejorar los resultados del aprendizaje [6]. Sin embargo, la usabilidad de una herramienta educativa es un aspecto crítico que impacta directamente en la eficacia y la experiencia del estudiante y del docente [7].

Uno de los objetivos del proyecto ValeFLOASS [1] es impulsar la transferencia tecnológica del entorno EvalCOMIX-FLOASS y lograr alcanzar el nivel TRL8 (Technology Readiness Level 8) de madurez tecnológica [8]. Para ello, entre otras tareas, se hace necesario realizar una evaluación de la usabilidad de la herramienta.

En este trabajo se presenta la evaluación de usabilidad llevada a cabo con el entorno EvalCOMIX-FLOASS.

II. Evaluación de la usabilidad de EvalCOMIX-FLOASS

La usabilidad se define en la norma ISO 9241-11:2018 como la medida en que un producto puede ser utilizado por usuarios específicos para lograr objetivos específicos con eficacia, eficiencia y satisfacción en un contexto de uso especificado [9].

La evaluación de la usabilidad permite comprobar la extensión de la funcionalidad, conocer el efecto de la interfaz en el usuario e identificar cualquier problema específico con el sistema [10].

Para realizar la evaluación de la usabilidad de EvalCOMIX-FLOASS se utilizaron dos métodos: uno sin usuarios y otro con usuarios. Para la evaluación sin la participación de usuarios se usó el método conocido como "Evaluación Heurística" [11, 12]. Este consiste en analizar la conformidad de la interfaz con unos principios reconocidos de usabilidad (heurísticas), mediante la inspección por parte de varios evaluadores expertos de forma independiente. La evaluación con usuarios consistió en probar el sistema con usuarios representativos realizando las tareas para las que está concebido el sistema. Durante la interacción, los usuarios expresaron en voz alta y libremente sus pensamientos u opiniones acerca de cualquier aspecto del sistema.

La evaluación heurística permite detectar problemas funcionales o de consistencia que son más difíciles de detectar en una evaluación con usuarios. La evaluación con usuarios, sin embargo, es esencial para conocer aquellos aspectos que generan confusión en los usuarios durante la interacción y que pueden pasar desapercibidos en una inspección de expertos.

Para la evaluación heurística, se preparó una plantilla con la que cada evaluador/a pudo recoger la información necesaria durante la sesión de evaluación. Así, se recopiló información sobre el contexto en el que se encuentra la funcionalidad evaluada, la descripción de cada uno de los problemas que encontrados, una posible alternativa de solución para cada problema, una indicación de los principios heurísticos de Nielsen [13] incumplidos, así como la clasificación de cada problema en cuanto a su frecuencia, impacto y gravedad.

Respecto a la evaluación con usuarios, éstos comenzaron la sesión rellenando un pre-test para la recopilación de información sociodemográfica de los participantes. Posteriormente, trataron de realizar las tareas planificadas

[1] Proyecto ValeFLOASS - Valorización del entorno e-FLOASS para el seguimiento y evaluación de los resultados de aprendizaje en el sistema educativo (Ref. PDC2022-133050-I00). Mecanismo de Recuperación y Resiliencia de la Unión Europea (MRR), Ministerio de Ciencia e Innovación.

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ayudados de un documento guía con información del escenario y las tareas a realizar. La interacción fue supervisada por un/a observador/a que tomó nota en una plantilla sobre la realización de cada tarea, el tiempo empleado en completarla y comentarios relacionados con lo que pudo observar a través de lo que expresó el usuario, tanto verbalmente como con su actitud. Por último, los usuarios completaron un post-test para conocer su grado de satisfacción a través de preguntas centradas, especialmente, en evaluar la usabilidad subjetiva y la percepción que ha tenido el usuario de la herramienta.

Tanto para la evaluación heurística como para la evaluación con usuarios se tuvieron en cuenta las tareas propias de cada uno de los perfiles posibles: estudiante y docente. Así, para la evaluación heurística, los dos expertos en usabilidad participantes inspeccionaron el entorno asumiendo un rol diferente en cada sesión. En cuanto a la evaluación con usuarios, ésta se llevó a cabo con 25 estudiantes matriculados en el "Máster en Investigación Educativa para el Desarrollo Profesional del Docente" de la Universidad de Cádiz. Por otro lado, se reclutaron 5 docentes de la Universidad de Cádiz. Ninguno de los usuarios tenía experiencia previa en el uso del entorno EvalCOMIX-FLOASS.

La evaluación heurística permitió identificar un total de 90 problemas de usabilidad: 22 en el perfil estudiante y 68 en el perfil docente. Para todos y cada uno de los problemas identificados se aportó una solución de diseño. Cada uno de los problemas fue clasificado en función del principio o conjunto de principios heurísticos infringidos. Además, se asignaron unos valores de frecuencia con la que cada problema sucede, su impacto y prioridad para solucionarlo teniendo en cuenta su gravedad.

Respecto a la evaluación con usuarios, los resultados del post-test para el perfil estudiante mostraron una evaluación muy positiva en cuanto a usabilidad y experiencia de usuario se refiere. En una escala Likert 5, la mayoría se ubicaron en el rango “De acuerdo” (4 puntos) y “Muy de acuerdo” (5 puntos). No obstante, a pesar de los buenos resultados arrojados por este perfil, los estudiantes comentaron en el post-test algunos aspectos que influyeron negativamente en su experiencia de uso. La mayoría de los problemas reportados ya fueron detectados por los evaluadores expertos durante las sesiones de evaluación heurística.

En el caso del perfil docente los resultados no fueron tan satisfactorios. Si bien es cierto que los ítems del instrumento de medición fueron diferentes, ya que se evaluaban tareas distintas, algunos de éstos no llegaron a entrar en el rango “De acuerdo” (4 puntos) y “Muy de acuerdo” (5 puntos).

Para el profesorado participante, por lo general, la herramienta no pareció manifiestamente fácil de usar. En especial, tuvieron dificultad para crear el instrumento de evaluación y modificar los porcentajes de las puntuaciones asociadas. Así mismo, tuvieron ciertos problemas para usar el instrumento en la evaluación y comprender el informe generado en relación con el nivel de desarrollo de los resultados de aprendizaje y competencias trabajadas.

III. Conclusiones

La evaluación de usabilidad llevada a cabo ha sido satisfactoria, enfatizando la relevancia de este tipo de evaluaciones en el contexto de los entornos tecnológicos y educativos. Es esencial resaltar que, a pesar de la trayectoria consolidada del entorno y su amplia adopción por parte del profesorado, la evaluación de usabilidad con docentes y estudiantes que se enfrentaron por primera vez a la herramienta reveló problemas que anteriormente no habían sido considerados.

A partir de los resultados obtenidos se propondrán alternativas de mejora que permitirán, sin duda, evolucionar el diseño de la interacción con el usuario en las sucesivas versiones del entorno EvalCOMIX-FLOASS.

Asimismo, la realización de esta evaluación nos permite vislumbrar el camino hacia la madurez tecnológica del entorno EvalCOMIX-FLOASS, aspirando a alcanzar el nivel TRL8. La retroalimentación recopilada servirá como base para iteraciones futuras, orientadas a la implementación de mejoras concretas que respondan directamente a las necesidades y expectativas de los usuarios. Este enfoque es esencial para avanzar hacia un nivel de madurez tecnológica que garantice la robustez, fiabilidad y aceptación generalizada de la herramienta en el entorno educativo.

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Desafios e perspectivas da aprendizagem inicial de programação no contexto moçambicano

Geraldo Carlos Nhadumbuque
Dpt. Of Informatics Engeneering
Universidade Pedagógica de Maputo
Maputo, Mozambique,
gcarlos@up.ac.mz

Anabela Gomes
Polytechnic Institute of Coimbra, ISEC
CISUC - University of Coimbra
Coimbra, Portugal
anabela@isec.pt

Maria José Marcelino
Dept. of Informatics Engineering
CISUC – University of Coimbra
Coimbra, Portugal
zemar@dei.uc.pt

I. INTRODUÇÃO

A aquisição de competências na fase inicial de aprendizagem da programação é caracterizada por obstáculos para a maioria dos estudantes no ensino superior [1]. Esta é uma problemática que se verifica globalmente, e a maioria dos estudos existentes na literatura estão concentrados no contexto, europeu, americano e asiático. No contexto africano há poucas pesquisas que debruçam acerca dessas matérias, e no contexto moçambicano não foram encontrados evidências de estudos similares. Investigar esta matéria no contexto em alusão é fundamental pois, os contextos de ensino e aprendizagem exercem uma certa influência na forma como os alunos enfrentam as dinâmicas do processo de ensino e aprendizagem.

Pretendemos estudar como a programação em ambiente de programação simplificada pode ser um precursor da aprendizagem na fase inicial de aprendizagem no contexto em estudo.

Numa primeira fase do estudo, procuramos compreender as preferências de aprendizagem dos estudantes no contexto em estudo. Para tal, validamos e aplicamos o questionário Felder-Solomon Index of Learning Styles para identificar as preferências de aprendizagem dos estudantes, em cursos de Ciência da Computação. Os resultados indicam que a maioria dos alunos se enquadram na categoria "preferência equilibrada", ou seja, são equilibrados em termos de estilos de aprendizagem e não têm uma preferência definida, mas se verifica uma menoria com ligeira tendência para o estilo visual, activo, sensorial e sequencial [2].

Para compreender esta questão, é crucial estudar as principais dificuldades, barreiras e estratégias de ensino. Este estudo surge como um passo importante na identificação de características essenciais que poderão fazer parte de uma nova ferramenta adaptada ao contexto moçambicano, visando compreender as dificuldades, barreiras e estratégias adotadas para superá-las.

II. METODOLOGIA

O estudo apresenta um enfoque qualitativo baseado numa abordagem fenomenológica, em que as dificuldades e estratégias de superação adotadas na aprendizagem de programação constituem o principal fenômeno em estudo. No processo de coleta de dados baseou-se em entrevistas semiestruturadas com participação voluntária de professores e alunos. Seis professores de duas universidades moçambicanas e 16 estudantes de cursos das áreas de computação. As entrevistas foram realizadas remotamente ou presencialmente e tiveram como objetivo identificar os desafios, conteúdos, estratégias, atividades, ferramentas e avaliações mais comuns. Para análise de dados privilegiou-se a técnica de análise de conteúdo.

III. RESULTADOS

Conforme ilustra a tabela I, os resultados indicam uma série de dificuldades.

TABLE I. DIFFICULTIES

Dificuldades	Docentes	Estudantes
Sintaxe	2	4
Lógica	3	4
Estrutura de repetição	2	8
Estrutura de decisão	2	3
Debugging do código	1	3
Escrita de código legível	2	0
Habilidades matemáticas	1	2

Essas dificuldades, estão relacionadas a problemas de compreensão de sintaxe, lógica de programação, escrita de código legível, bem como uso de comandos básicos de entrada e saída e dificuldades na escrita de código legível e uso de estrutura de repetição. O uso de estrutura de repetição é referida como uma questão problemática por vários autores [3]–[6]. Para superar esses desafios, diversas estratégias e ferramentas de ensino são adotadas, incluindo o uso do ChatGPT para geração de código-fonte, colaboração com pares e consulta a diversos recursos e fontes educacionais. A tabela I mostra o resumo das dificuldades apontadas indicando igualmente a frequência com que foram referenciados por alunos

A. Ferramentas e estratégias

As estrategias e recursos visam tornar a aprendizagem de programação mais acessível na fase inicial de aprendizagem [7]. Os professores citam diversas ferramentas e estratégias no ensino de programação, que são usadas tanto por docentes bem como por estudantes. A tabela II ilustra essas estratégias, e elas incluem o recurso a exercícios práticos e definição de datas limites de submissão, a resolução de tarefas e exercícios em grupos e a partilha de soluções de exercícios propostos. As estratégias e métodos referenciados exclusivamente por docentes são, a tomada de notas ou apontamentos para sistematizar o conteúdo no caderno, encorajamento para resolução de exercícios individualmente, Fornecimento de feedback construtivo e encorajador nos exercicios resolvidos, o uso de redes sociais como facebook e WhatsApp, o uso de sala de aulas invertidas, criação de vídeos de resumo das aulas anteriores para submissão, análise de programas feitos e uso de exemplos baseados em exercícios resolvidos. As estratégias referidas pelos estudantes incluem a partilha do código ou soluções de

exercícios, a aprendizagem por erros e a obtenção de respostas usando ChatGPT.

TABLE II. STRATEGIES

Strategies	Teacher	Students
Tomada de notas	1	
Atribuição de Exercícios Práticos e Prazos de Entrega	1	1
Incentivo à resolução individual de problemas	3	
Abordagem Prática Diferenciada e Suporte Individualizado	1	
Fornecimento de feedback construtivo e encorajador	1	
Uso de redes sociais para compartilhar códigos e fornecer sugestões	2	
Grupo de estudos	6	9
Abordagem de sala de aula invertida	1	
Criação de Vídeos por estudantes	2	
Projetos Práticos e Exemplos	3	
Análise de Programas feitos	1	
Partilha de código		2
Aprender com os erros		2
Obtenção de respostas via ChatGPT		3
Exemplos e exercicios resolvidos	3	1

As ferramentas de aprendizagem de programação mencionadas incluem um ambiente textual e visual para facilitar a interação. E numa primeira fase do ensino os docentes têm recorrido ao ambiente textual como a de Turbo C, para desestimular o copy paste do código e permitir que estes digitem o código como forma de facilitar a retenção da sintaxe.

IV. CONSIDERAÇÕES E TRABALHOS FUTUROS

Além disso, este estudo permitiu identificar um conjunto de aspectos muito importantes a integrar na ferramenta a desenvolver, uma vez que a população em causa enfrenta um conjunto de problemas mais diversos dos habitualmente reportados na literatura. Por exemplo, nos contextos europeu e americano, a maioria dos estudantes ingressa no ensino superior com conhecimentos básicos de programação, enquanto em Moçambique, a maioria dos estudantes começa a programar apenas no ensino superior. Esse aspecto influenciou negativamente o domínio da sintaxe e a ocorrência de erros de digitação e sintaxe. Nesse cenário, a ferramenta proposta sugere um ambiente de aprendizagem diversificado com recursos de arrastar e soltar como estratégia para minimizar esse tipo de erro e diversas atividades de aprendizagem.

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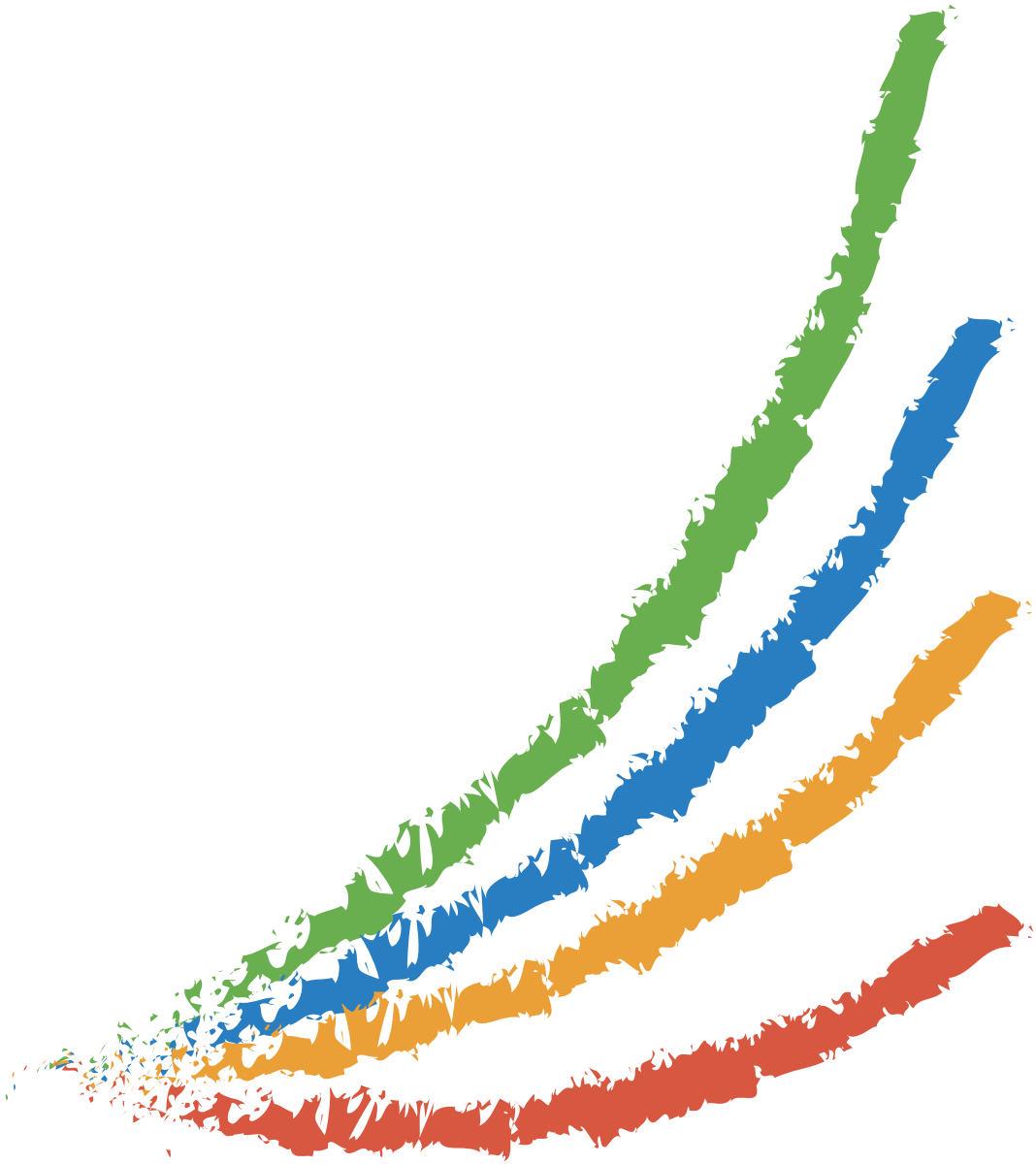

Virtual Learning Environment to Promote Motivation for Students New to Programming

Rosemary Borges de Almeida
CISUC-Department of Informatics Engineering,
University of Coimbra,
Pólo II, 3030-290, Coimbra, Portugal
rosemaryalmeida@dei.uc.pt

***Abstract*—Initial programming education is an academic field with a particularly high dropout and failure rate, and it is a subject that continues to generate much debate. The challenge of offering this subject through distance learning adds to the complexity. Students need to adapt to this mode of teaching and learning. Several studies suggest that students must develop appropriate cognitive and non-cognitive skills for effective learning. However, there is an urgent need to investigate further the impact of non-cognitive skills on student performance. In particular, motivation plays an important role in student success. In this sense, considering the specificities of learning programming in distance education, this research aims to understand the factors that can stimulate student motivation for initial programming learning and develop a virtual learning environment that promotes student motivation to learn to program and evaluate the environment.**

***Index Terms*—Motivation, Learning Programming, Distance Education, Virtual Learning Environment.**

I. Introduction

Learning programming is a topic of great relevance for courses in the field of Computing and has gained prominence due to the growing demand for people with programming skills at different levels and academic areas [1], [2]. Overcoming pedagogical obstacles and employing methods that improve students' skills and boost their performance are increasingly investigated, and necessary [2], [3]. This is even more relevant when it comes to distance education environments since, for beginning students, the practical application of theoretical concepts and interaction with other students and teachers may be limited compared to face-to-face [4].

Low student motivation is a topic of growing interest in educational research in various fields. Therefore, investigations seek to understand how to stimulate and maintain students' motivation [5], [6]. This knowledge has been applied in designing and developing technological solutions that promote student motivation and support teachers' work, including in virtual learning environments [7], [8].

Thus, this project aims to propose and investigate resources that can increase the motivation of adult students in their initial programming learning in a computer-assisted learning environment. The elements of this environment will be analyzed to understand how they influence student motivation, especially intrinsic motivation, and how this can impact success in learning programming.

II. Thesis proposal

This proposal aims to develop a computational environment with the potential to promote student motivation for initial programming learning.

A. Problem Definition

The challenges that college students face when first learning to program are exacerbated in a distance learning environment, especially for those without prior experience. The limited interaction with instructors and peers in this environment can hinder the practical application of theoretical concepts, while cognitive and non-cognitive issues such as motivation and technological challenges significantly impact student engagement.

B. Scientific Objectives

The macro objective will involve the development of a computer-assisted learning environment designed to promote the teaching of programming, considering elements that contribute to generating, maintaining, or increasing student motivation. This environment will seek to incorporate technologies and resources that have shown potential in making the learning process more engaging and dynamic.

To achieve the main objective, the following specific objectives were identified:

a) Understand factors that can stimulate the motivation of adult students for the initial learning of programming;
b) Build a virtual learning environment that stimulates students' motivation to learn programming;
c) Evaluate the environment to identify whether its functionalities help in the motivation of students in programming studies.

C. Research Questions

The following research questions were designed to achieve the objectives of this research:

RQ1: What are the factors that play a fundamental role in stimulating the motivation of adult students during the process of learning programming in the context of Distance Education?
RQ2: What are the resources that a Virtual Learning Environment should provide to stimulate students' motivation

in introductory programming courses for adults in the context of Distance Education?

RQ3: What changes are observed in relation to the learning outcomes, motivation, and attitudes of students towards the use of this Virtual Learning Environment as the course progresses?

RQ4: What is the relationship between the motivation factors addressed in this study and academic performance in learning programming in the context of Distance Education?

Some studies point to the influence of motivation on programming learning, but further investigations are still needed for a better understanding, especially in the context of distance education for adults.

III. Methodology

The Design-Based Research (DBR) methodology will help address the outlined objectives and answer the research questions. By using DBR in projects validated in real environments, research objectives can be aligned incrementally, aligning theory and practice [9]. Given the characteristics, the DBR is relevant to this research, as understanding students' motivation can help investigate and design decisions about the learning environment for distance learning students.

IV. Current work

From the results obtained in the Systematic Mapping Study and conversations with students who completed introductory programming courses in the distance-learning mode, we identified numerous challenges and needs faced by students, particularly adults. A recurring theme is acknowledging technology as an intrinsic motivator, given its capacity to offer enriching experiences such as challenge, curiosity, novelty, and enjoyment [10].

A. Virtual Learning Environment

For this research, the Moodle Virtual Learning Environment was selected, owing to its existing functionalities and the potential to integrate new ones. In previous studies, the Moodle Virtual Learning Environment has been a focal point in research related to the Theory of Self-Determination, with interventions conducted in courses spanning various learning domains [11], [12]. The findings from these investigations indicate a positive connection between the use of this platform's tools and the enhancement of students' motivation. This further supports the possibility that such an approach could also produce positive outcomes in the specific area of programming education.

B. The Structure of the Proposal

To execute this proposal, we'll utilize the standard features of the Moodle installation, along with specific modifications and the inclusion of an external plugin. While Moodle inherently offers resources for courses, such as diverse media distribution and communication tools, this work will primarily concentrate on the design, implementation, and refinement of functionalities inspired by the Theory of Self-Determination.

A new plugin will have the capability to manage programming tasks, allow code execution, and implement the well-known collaborative technique called 'Peer Review.' Regarding the assessment of activities to be managed by this plugin, in addition to peer assessment inspired by the 'Peer Review' technique, the plugin will automatically conduct checks using test cases and enable manual grading by the instructor. Furthermore, the instructor will have the option to link competencies to the activities managed by this plugin, allowing students to track their progress.

V. Expected results

It is expected to increase students' motivation by providing an environment that offers tools that allow them to meet their autonomy needs, feel competent during learning, and maintain social bonds through sharing and mutual help, with a focus on coding practices, according to the theory of self-determination.

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A two spirals model to promote programming learning

Adorilson Bezerra de Araújo
CISUC, Department of Computer Engineering
University of Coimbra
Coimbra, Portugal
adorilsonararujo@dei.uc.pt

***Abstract*—Learning programming involves complex tasks requiring problem-solving skills, logical thinking, and creativity, posing particular challenges for beginners due to the abstract nature of programming concepts. This research aims to design, implement, and evaluate an interactive web-based environment for learning programming that integrates scaffolding strategies to enhance engagement and alleviate frustrations. It proposes a new learning model alternating between block-based and text-based programming, tailored to individual student performance and game challenge levels. The research will address key questions about the characteristics of effective web programming environments, student utilization of scaffolding, and its impact on academic performance in real classroom settings.**

***Index Terms*—high school, scaffolding, learning programming, teaching programming, career and technical education**

I. Introduction

Learning programming entails complex tasks requiring problem-solving skills, logical thinking, and creativity, with the abstract nature of programming concepts posing particular challenges for beginners [1]–[5]. Moreover, the plethora of online resources for learning coding can overwhelm students [6], requering educators to curate suitable materials. Understanding students' motivations for enrolling in programming courses is crucial, especially in career and technical education (CTE) [7] schools that integrate CTE with regular secondary education, catering to those seeking vocational training and those aiming for higher education. Scaffolding, a pedagogical approach, aids in knowledge retention and application, with practices such as fill-the-blank exercises enhancing engagement and alleviating frustrations in coding tasks [8], [9]. This proposal seeks to design, implement, and evaluate an interactive web-based environment for learning programming that integrates scaffolding strategies, focusing on its characteristics, students' utilization of scaffolding, and its impact on academic performance.

II. Background

Scaffolding provides targeted support that is precisely aligned with learners' current understanding, effectively balancing challenges and preventing student frustration. Originally a social process [10], scaffolding now includes aids in instructional materials or technology tools [11] to guide students through complex problems. It's often operationalized through structuring tasks into manageable steps and providing prompts to aid completion. Support fading is crucial, ensuring eventual independence [12], but incorporating it into instructional materials poses challenges. Puntambekar [13] distinguishes between scaffolding, a gradual withdrawal of support, and scaffolds, specific tools aiding task completion. Despite being recognized as a teaching strategy, scaffolding has been minimally researched, with only 5 out of 120 studies addressing it [14]. Future research is recommended concerning visual aids and block-based languages' transition to text-based languages. Another study demonstrated the effectiveness of various exercises in addressing different learning profiles. Exercises such as skeleton and code baseline are more suitable for novice students, while traditional code-from-scratch approaches are more suited to more advanced students [15].

Allan et al. and Lee et al. [16], [17] explored strategies for cultivating computational thinking (CT) in middle and high school students, advocating for rich computational environments and proposing the Use-Modify-Create (UMC) framework for learning to program, emphasizing an evolving process of CT development. Predict-Run-Investigate-Modify-Make (PRIMM) [18], another approach, integrates methodologies such as UMC along with other teaching strategies, aiming to tackle novices' inclination to write programs without understanding them by employing guided analysis of sample code. Although UMC and PRIMM are technology-independent methodologies, UMC primarily uses block-based programming (BBP) to teach children. On the other hand, PRIMM focuses on textual-based programming (TBP), specifically Python, to teach teenagers. However, there aren't tools to support professors and students through the UMC and PRIMM's phases.

III. Research Objectives and Questions

We propose a new learning model based on UMC and PRIMM and a web environment to support it. The Figure 1 shows this new two-spiral model. In the first spiral, we alternate between BBP and TBP. The main aim is to take advantage of BBP while introducing the TBP interface as soon as possible. Before TBP is introduced, and students must have completed correlated activities with BBP. Consequently, any new knowledge will be added incrementally, following a spiral approach. Furthermore, each activity will follow the

principles of UMC and PRIMM. The second spiral comprises TBP activities that must adhere to the PRIMM approach.

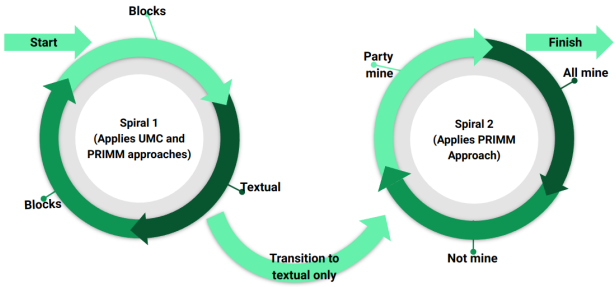

Fig. 1. A scaffolding two spirals model with blocks and textual-based programming

We are going to use Python and the Free Python Games [19], a collection of games created following some PRIMM principles. This new environment is adaptable. It adjusts the display of games based on each student's previous performance and the challenge level of the game. The system uses these parameters to determine which games to show a student and which parts of the game's source code to reveal or assign as exercises. The source code can be fully or partially implemented. The system will decide which sections serve as examples and which are left for the student to complete.

Annotations in source code determine the display of source code elements such as lines, functions, and classes. They categorise these elements as always shown, never shown, or conditionally shown based on student performance. The system evaluates performance by considering the initial grade provided by the teacher, speed and accuracy in previous exercises, and requests for assistance. The challenge level of the game can be system-calculated or teacher-assigned, ensuring exercises are appropriately tailored to the student's skill level.

A. Research Questions

The study will be guided by the following research questions:

RQ1: What characteristics should have a web programming environment using a model of scaffolding strategies to promote learning programming?

RQ2: How do students use the available scaffolding while studying programming?

RQ3: What is the relationship between scaffolding strategies and academic performance in learning programming?

IV. Conclusion

Scaffolding strategies have been the subject of significant research in educational settings. However, there is a clear need for further studies on their application in teaching programming, particularly at the high school level. Using the Design Based Research (DBR) methodology [20], we will design and evaluate a web environment that incorporates scaffolding strategies to enhance the learning of programming for youth in CTE schools.

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Uso de un chatbot con IA generativa para medición e intervención en SRL

Nina Yarovenko-Kuzminykh
Universidade de Vigo
36310 Vigo, Spain
nina.yarovenko@uvigo.gal

Manuel Caeiro-Rodríguez
atlanTTic Research Center for Telecommunication Technologies
Universidade de Vigo
36310 Vigo, Spain
mcaeiro@det.uvigo.es

Fernando-Ariel Mikic-Fonte
atlanTTic Research Center for Telecommunication Technologies
Universidade de Vigo
36310 Vigo, Spain
mikic@det.uvigo.es

Martín Llamas-Nistal
atlanTTic Research Center for Telecommunication Technologies
Universidade de Vigo
36310 Vigo, Spain
martin@det.uvigo.es

***Resumen*—Este artículo representa una propuesta de proyecto de tesis de investigación para una sesión de trabajos de doctorado. En los últimos años identificar a los estudiantes con riesgo de abandono o no superar el primer año de estudios universitarios de grado se ha convertido en un tema crucial. Para abordar el problema, esta investigación se centra en el desarrollo de las habilidades de aprendizaje autorregulado (SRL – *Self-Regulated Learning*) de los estudiantes. Se propone la realización y testeo de una herramienta de diagnóstico y apoyo que ayude a medir y resolver las debilidades de los estudiantes en el proceso de aprendizaje. La propuesta pretende explotar las capacidades de los agentes conversacionales actuales con tecnologías de inteligencia artificial (IA) generativa para abordar la medición y el desarrollo de las habilidades SRL de una manera más eficaz y eficiente.**

Palabras Clave*—*education, dropout, self-regulated learning, chatbot, generative artificial intelligence, conversational agents

I. INTRODUCCIÓN

Cada verano, los aspirantes a estudiantes universitarios aguardan impacientes sus calificaciones para el deseado ingreso a la universidad. Sin embargo, la alegría de la admisión pronto da paso a la decepción. Según las estadísticas en España [1], en menos de un año, el 6% de los estudiantes simplemente abandonan la universidad, o cambian de profesión, o deciden pasar un año de vacaciones después del instituto, o trabajan en un campo completamente diferente a la especialidad previamente elegida. ¿Por qué se está desvaneciendo la brillante imagen de la educación superior? ¿Cuál es el motivo del repentino cambio en los pensamientos de los jóvenes? ¿Se trata realmente de la volubilidad de la juventud moderna, que ha crecido en condiciones familiares cómodas, que no está acostumbrada a sufrir y luchar por sus sueños y prefiere simplemente darse por vencida ante las primeras dificultades? ¿O las raíces del problema son mucho más profundas de lo que parece a primera vista y sólo estamos viendo la cima del iceberg?

Esta situación global se puede observar perfectamente en un caso particular, como el de la Universidad de Vigo. Durante los últimos años en la Escuela de Ingeniería de Telecomunicación de la Universidad de Vigo se ha observado que un alto porcentaje del total de estudiantes matriculados presentaban un rendimiento bajo y reducían su motivación, incluso en primer curso de grado, lo que les llevó al fracaso en los exámenes y al abandono temprano (Tabla I) [2]. Esto tiene implicaciones negativas principalmente para el estudiante como persona, pero también para las instituciones educativas, que pueden adquirir una reputación negativa.

Para combatir los problemas anteriores ligados al fracaso y abandono escolar se ha planteado el Aprendizaje Autorregulado (SRL: *Self-Regulated Learning*). Se trata de una aproximación que pone en el estudiante la responsabilidad de su propio aprendizaje y que señala la importancia del desarrollo de ciertas competencias, habilidades y estrategias clave para el éxito académico.

TABLA I. TASAS DE ABANDONO DEL GRADO EN INGENIERÍA DE TECNOLOGÍAS DE TELECOMUNICACIÓN

Año académico	**2018-2019**	**2019-2020**	**2020-2021**	**2021-2022**
Tasa abandono (VERIFICA)	42,21%	49,68%	47,33%	51.02%
Tasa abandono (CURSA)	28%	32,43%	28,24%	25.49%

La idea principal de esta propuesta es desarrollar un agente conversacional, un chatbot, que permita, por una parte, evaluar el nivel de desarrollo de SRL en los estudiantes y, por otra, intervenir para mejorar el mismo. Se pretende utilizar el chatbot para mantener conversaciones agradables con el alumno, parecidas a las de un tutor, mentor o compañero, y a partir de ellas inferir en que grado es capaz de poner en juego las competencias, habilidades y estrategias que se plantean en el SRL. La tesis evaluará las capacidades de los actuales agentes conversacionales basados en la inteligencia artificial (IA) generativa para desarrollar esta aproximación con estudiantes de primer año de universidad, evaluando su capacidad para reducir el abandono y fracaso escolar.

II. FUNDAMENTOS

La base de conocimiento sobre los chatbots de IA generativa se está expandiendo de forma extraordinaria en todo el mundo. Casi todos los días, la IA está presente en las noticias y debates estimulando la atención social constante. También en el ámbito educativo se está promoviendo el uso de sistemas de IA generativa para múltiples propósitos, entre otros mantener conversaciones con los estudiantes simulando papeles de consejeros, tutores o mentores.

En relación con la utilización del SRL para resolver los problemas de fracaso o abandono escolar, en la literatura se pueden encontrarse numerosos trabajos en los que se han explorado distintas aproximaciones, desde el uso de cuestionarios hasta la aplicación de analítica de aprendizaje [3] [4] [5]. Sin embargo, ninguna de las aproximaciones ha proporcionado resultados claramente satisfactorios y, por el contrario, se han identificado desafíos sin resolver (Tabla II).

TABLA II. DESAFÍOS EXISTENTES EN LA MEDICIÓN Y PROMOCIÓN DE SRL [6]

Desafío	Descripción
Uso de las herramientas/métodos tradicionales en e-learning	Los instrumentos tradicionales, como cuestionarios y entrevistas, se basan en rasgos y están orientados al usuario; Los alumnos responden a los elementos de SRL dependiendo de cómo se perciben a sí mismos, lo que lleva a que los alumnos sobreestimen su uso de las habilidades de SRL. Las herramientas también se implementan fuera del entorno de aprendizaje antes o después de un episodio de aprendizaje y, por lo tanto, no pueden medir el SRL durante un episodio de aprendizaje real cuando los estudiantes emplean las habilidades.
Las herramientas y métodos tradicionales son intrusivos	Los alumnos normalmente son conscientes de que se está midiendo SRL y, por lo tanto, afectan su compromiso y desempeño.
Existencia de muchos modelos y muchos constructos a medir.	No existe un modelo generalizado que describa o conceptualice todos los constructos de SRL. Además, cada uno de los modelos existentes se basa en diferentes aspectos del aprendizaje.
Falta de herramienta(s) tanto para mediciones como para intervenciones de SRL .	¿Qué sigue después de establecer el nivel de SRL? Hasta ahora hemos tenido herramientas separadas para medir y promover SRL. Los autores ahora recomiendan una herramienta para ambos.
Falta de un marco que describa/guíe cómo establecer los niveles de SRL de los estudiantes y describa en qué nivel comenzar y detener la emisión de andamios dentro de un sistema de aprendizaje electrónico.	Los modelos teóricos existentes sólo proporcionan marcos que describen las diferentes fases, procesos y constructos a medir. Cuando se trata de medición y provisión real de andamios, no existe un marco definido a seguir como guía.

III. PROPUESTA

En línea con los desafíos anteriores, se identificó que un problema principal en las aproximaciones SRL es la baja participación de los estudiantes. Esto puede ser debido al elevado número de preguntas incluidas en los cuestionarios sobre SRL [7]. Frente al uso de cuestionarios grandes, en este trabajo se plantea la utilización de chatbots, que simulando personajes de interés para los estudiantes, puedan mantener conversaciones con los estudiantes y extraer de forma indirecta respuesta a las preguntas clave sobre SRL.

En lugar de utilizar preguntas directas del cuestionario, el investigador pretende crear una especie de "relación" entre el estudiante y el chatbot, y desarrollar escenarios de comportamiento que se parezcan más a la comunicación entre dos amigos, o con un mentor o tutor, que a una persona y un robot. El lenguaje de comunicación también debe tener una connotación "amigable" y "juvenil". Además, una de las características especiales adicionales del sistema de apoyo desarrollado podría ser la posibilidad de que el estudiante elija libremente el rol de acompañante.

El chatbot, al comunicarse con los estudiantes, recopilará información sobre sus capacidades de aprendizaje autorregulado con ayuda de preguntas indirectas. Además, este "compañero virtual" tendría indicadores modelo de estrategias de autorregulación, lo que le permitiría dar a sus interlocutores recomendaciones adecuadas y exitosas para mejorar la calidad de la autorregulación, dependiendo de las debilidades particulares que él mismo detecte durante una conversación, sustituyendo de esta manera el rol de mentor.

La hipótesis de este trabajo se puede formular con la pregunta "¿Puede una herramienta de IA generativa como agente conversacional mejorar el rendimiento de las soluciones SRL de medición e intervención existentes?"

Además, siguiendo la hipótesis sería interesante descubrir respuestas a las siguientes preguntas de investigación:

1) Satisfacción de los estudiantes: ¿Les gustará esta nueva forma de comunicación?

2) Fiabilidad de la medición: ¿Es más fiable este tipo de recogida de datos?

Resumiendo todo lo anterior, la propuesta presentada podría ser una buena aproximación para superar dificultades como la falta de herramientas tanto para las mediciones como para las intervenciones de SRL o la intrusión de las herramientas y métodos tradicionales de SRL.

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