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RESEARCH ARTICLE

Microcredential for Physics Majors

Microcredencial para estudiantes de física

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ABSTRACT

This article describes the benefits of using microcertifications to complement undergraduate physics courses. A microcertification program developed for the physics undergraduate program at University of Texas at El Paso is described, including modules created by the Data Science Community of Practice (DSCOP) group, part of the American Physical Society Data Science Group, on topics of data science, machine learning and artificial intelligence applied to physics topics.

KEYWORDS: microcertification; Physics degree plan; Data science; Machine learning; Artificial intelligence.

RESUMEN

Este artículo describe los beneficios del uso de microcertificaciones para complementar los cursos de licenciatura en física. Se describe un programa de microcertificación desarrollado para el programa de licenciatura en física en la Universidad de Texas en El Paso, incluyendo módulos creados por el grupo Data Science Community of Practice (DSCOP), parte del grupo de Ciencia de Datos de la American Physical Society, sobre temas de ciencia de datos, aprendizaje de máquina e inteligencia artificial aplicados a temas de física.

PALABRAS CLAVE: microcertificación; plan de estudios de física; ciencia de datos; aprendizaje de máquina; inteligencia artificial.

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I. INTRODUCTION

In an age where technology evolves at the speed of light, how can physics majors stay ahead, ensuring their education directly translates into career readiness and success? This seemingly innocuous question carries profound implications for the future of physics education. As the world around us becomes increasingly data-driven, a paradigm shift demands a re-evaluation of the traditional paths we have forged for aspiring physicists.

The author vividly recalls a conversation with a brilliant student who excelled in her physics coursework yet found herself at a crossroads upon graduation. Despite her passion for the subject and the countless hours dedicated to mastering its intricacies, she felt ill-equipped to navigate the modern job market, lacking the specialized skills, such as Python programming, data science, machine learning, and artificial intelligence, that could set her apart in an increasingly competitive landscape. Her experience is far from unique. In fact, it serves as a microcosm of a larger issue that has been brewing within the realm of physics education: the omission of crucial contemporary skills in standard curricula, leaving many graduates feeling underprepared for the demands of today's data-centric world.

For too long, physics educators have relied on the assumption that a solid foundation in physics principles alone will suffice. They have failed to recognize the rapidly evolving needs of industries that now prize specialized competencies in areas such as data science, Python programming, machine learning, and artificial intelligence. This oversight risks rendering graduates less competitive in a job market that demands a mastery of foundational knowledge and the ability to integrate and apply emerging technologies seamlessly.

Enter *microcredentials*—compact, focused certifications that empower students to acquire the highly sought-after skills that traditional physics programs often overlook. These versatile tools offer a novel solution to bridge the gap between theory and practice, equipping future physicists with the interdisciplinary problem-solving abilities that will set them apart in an increasingly data-driven world.

In 2021, recognizing the growing demand for short-term credentials among employers and education consumers, the University of Texas (UT) System launched its Texas Credentials for the Future initiative [1] to expand offerings across UT's academic institutions. Microcredentials embedded into bachelor's degree programs and undergraduate experiences at UT institutions help college graduates distinguish their education and talent with in-demand, industry-recognized skills. Similarly, these credentials are helping alumni and working adult professionals stay relevant in the workforce.

In the following pages, the transformative potential of microcredentials within the realm of physics education is explored, along with the benefits they offer, the practical implementation strategies, and real-world case studies that illuminate their tangible impact.

II. METHODOLOGY

A firm grasp of key terminology is crucial in the rapidly transforming world of education and career readiness. A microcredential is a compact, focused certification that recognizes an individual's proficiency in a specific skill or set of competencies. Unlike traditional degrees, which encompass a broad range of subjects, microcredentials offer a targeted, specialized pathway to acquire and validate expertise in areas of high demand.

Microcredentials matter because, for centuries, academia has been structured around rigid degree programs. Nowadays, the rapid proliferation of new technologies and industries has given rise to a pressing need for highly specialized skills that traditional degree programs often struggle to keep pace with. In this landscape of accelerated change, the one-size-fits-all approach to education has revealed its limitations. Broad-based degrees, while invaluable in cultivating critical thinking and foundational knowledge, often fail to equip individuals with the targeted, market-ready skills that employers demand. This disconnect between academia and industry has left many graduates ill-prepared for the modern workforce while employers struggle to find candidates with the expertise to tackle emerging challenges [2].

Microcredentials—bite-sized, skill-specific certifications—offer a flexible alternative to traditional degrees, empowering learners to acquire highly targeted expertise that aligns with the specific demands of their chosen field or industry. The potential of microcredentials is exemplified by their successful implemen-

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tation in companies like Google, IBM, and Amazon, which have embraced microcredentials as a means of upskilling their workforce, enabling employees to rapidly acquire and validate new competencies in areas such as cloud computing, data analytics, and artificial intelligence [3].

Critics may argue that microcredentials lack the depth and rigor of traditional degrees, dismissing them as mere certifications with limited value. However, this perspective overlooks the teaching of skills demanded by the industry. Furthermore, the credibility of microcredentials is bolstered by their alignment with industry standards and the endorsement of respected institutions and professional organizations.

To facilitate this transition, educational institutions must adapt their offerings, integrating microcredentials into their curricula and fostering partnerships with industry leaders to ensure the relevance and quality of these specialized certifications. Employers, too, must recognize the value of microcredentials and create incentives for their workforce to embrace continuous upskilling, thereby cultivating a culture of innovation and adaptability. In the realm of physics, the embrace of microcredentials holds immense potential to bridge the gap between physics and fields like data analysis, machine learning, or AI. These focused learning pathways can equip physics graduates with the specialized skills and industry-aligned expertise to thrive in a rapidly evolving job market.

A. BLUEPRINT FOR INTEGRATION

This section provides a comprehensive blueprint for integrating microcredentials into existing physics curricula, bridging the gap between academic knowledge and industry-relevant skills. The result will be a curriculum that aligns with market needs, enhances student employability, and fosters a culture of continuous learning and professional development. The necessary knowledge is understanding an institution's existing physics curriculum, including program structure, course offerings, and learning outcomes. Also needed are insights into current industry trends, market demands, and emerging skills needed in physics-related fields; this can be obtained by establishing relationships with industry partners and professional organizations. It is useful to have access to microcredential platforms as well as support from faculty and administrators within the institution.

The steps involved are: first, to identify areas where students may need additional training or expertise; and second, to evaluate microcredential platforms and design a program to complement the existing curriculum, integrating microcredential pathways into degree programs, with proper monitoring of student engagement and learning outcomes.

B. POTENTIAL PITFALLS AND HOW TO AVOID THEM

Implementation may face obstacles such as a lack of buy-in or faculty or academic leadership resistance, which can impede progress. These challenges should be addressed through open dialogue, supported by data-driven evidence, and clear communication of the benefits involved. Additionally, ensuring alignment with industry needs is crucial to prevent microcredentials from becoming irrelevant or undervalued. Continuous engagement with industry partners and monitoring of market trends are essential strategies here. Moreover, to combat student disengagement or low completion rates, it's vital to integrate microcredentials into degree programs and emphasize their career benefits. Furthermore, careful attention must be paid to accreditation and compliance issues, ensuring proper integration and documentation of microcredentials with involvement from accreditation bodies and adherence to established guidelines.

C. POTENTIAL PROBLEMS AND SOLUTIONS

- Limited resources or funding for microcredential development and implementation: Explore partnerships with industry or external providers, leverage existing institutional resources, or seek grant opportunities.

- Faculty resistance or lack of incentives for participating in microcredential programs: Provide professional development opportunities, recognize contributions to microcredential efforts in promotion and tenure processes, and clearly communicate the benefits to students and the institution.

- Difficulty in integrating microcredentials into existing degree programs due to curricular constraints or accreditation requirements: Work closely with curriculum committees to develop creative solutions, such as modular or stackable microcredential pathways, hybrid delivery models, or interdisciplinary collaborations.

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- Limited awareness or recognition of microcredentials among students or employers: Implement marketing and communication campaigns to promote the value and benefits of microcredentials, leverage industry partnerships and endorsements, and actively engage in advocacy efforts to raise awareness and recognition.

D. CHECKING FOR SUCCESSFUL COMPLETION

- Analyze student enrollment, completion rates, and learning outcomes for microcredential programs to evaluate their effectiveness and impact.

- Seek feedback from industry partners and employers regarding the relevance and value of the microcredentials offered by your institution.

- Monitor graduate employment rates, career trajectories, and alumni feedback to assess the impact of microcredentials on employability and career advancement.

- Regularly review and update microcredential offerings based on evolving industry needs, emerging trends, and stakeholder feedback to ensure continued alignment and success.

III. RESULTS AND DISCUSSION

The University of Texas at El Paso (UTEP), located along the U.S.-Mexico, has long been at the forefront of innovative educational practices. With a student population that is predominantly Hispanic and first-generation, UTEP recognized the need to bridge the gap between academic knowledge and industry-relevant skills, positioning its graduates for success in the evolving job market.

UTEP faced the challenge of ensuring that its physics graduates were equipped with not only theoretical knowledge, but also practical skills and competencies valued by employers. The traditional curriculum, while rigorous in academic content, often fell short in addressing the industry's specific needs, leaving graduates ill-prepared for the challenges of the workforce.

The background of the effort was, first, the creation of the UTEP Microcertification program headed by UTEP's Vice Provost for Curriculum Effectiveness and Improvement, and second, the author's participation in the first meeting of the Data Science Community of Practice (DSCOP) [4], part of the Group of Data Science of the American Physical Society, at the University of Maryland in College Park in August 2022.

A program was developed to integrate microcredentials into the physics curriculum, collaborating closely with fellow faculty members, administrators, and industry partners. A team of UTEP physics faculty embarked on a comprehensive effort to incorporate microcredentials into the physics curriculum by conducting a skill gap analysis to identify areas where students needed additional training or expertise. Through the participation of industry partners (Intel, Raytheon, Oak Ridge National Laboratory) and professional organizations (American Physical Society, Society of Hispanic Professional Engineers, MAES: Latinos in Science and Engineering, National Society of Hispanic Physicists), faculty gained insights into the specific skills and competencies sought after by employers.

One key strategy was the development of microcredential programs tailored to address these identified skill gaps. These programs focused on areas such as data analysis, Python programming, machine learning, and artificial intelligence, which complemented the core physics curriculum. The microcredentials were designed to be modular and stackable, allowing students to build upon their knowledge and skills incrementally during their studies.

A certification program was proposed at the University of Texas at El Paso to upskill physics majors in data science, Python, machine learning, and artificial intelligence. The constraints at UTEP are i) a rigid degree plan and ii) the need for low-cost solutions, which translates into the impossibility of adding extra courses to the degree plan or charging extra tuition for a possible certification program. The plan proposed thus partitioned the topics into small modules that were to be incorporated into the existing physics courses during the nine semesters of the career.

A. THE PLAN

The prospective learners for this microcredential are physics majors at all levels, ranging from freshmen to graduate students; their participation will be voluntary. The microcredential program was designed to help stu-

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dents demonstrate their skills in data science, Python, machine learning, and artificial intelligence as applied to physics, providing a valuable asset for prospective employers. Prerequisite knowledge includes the standard mathematics and physics competencies expected of physics majors at different levels.

The microcredential program focused on developing proficiency with Anaconda, Jupyter, Python, data cleaning, mathematical calculations, plotting, fitting, various models of machine learning, and AI through OpenAI.

Partnerships with companies such as Intel, Microsoft, and Raytheon, and national laboratories, such as Oak Ridge National Laboratory, were initiated. Additionally, an existing small grant from Microsoft supported the initial effort.

To ensure transparency, the program was designed to have a web page detailing benefits, requirements, and prerequisites. Similarly, such information will be disseminated through printed and emailed infographics.

Each participant will be given a personal web page on the UTEP website, accessible via password, where details of the modules taken and a portfolio of their activities will be documented and can be shared with potential employers.

To earn the microcredential, students must complete all modules throughout their undergraduate years. The participant's web page will show evidence of completion, displaying the completed modules and activities.

The micro certification coordinator will grade each module as it is finished, assessing knowledge, skills, and achievements. Planning assessments to be developed or utilized will also validate learner skills and competencies. Subsequently, the micro certification coordinator will grade modules.

End-of-module surveys will be utilized to gather student feedback and iterate on the module designs.

A microcredential team will include selected physics faculty, an administrator, and an industry representative. The physics faculty members will support the scientific content, while the remaining university staff will assist with program approval at the university level. The industry representative will ensure the program's relevance.

The course delivery methods include several options, such as online, face-to-face, or a hybrid approach, where modules are primarily delivered online.

The microcredential will be awarded upon completing all modules, with assessment criteria based on each participant's progress. The issuer of the badge/credential will be the micro-certification office established by the Dean of Extended University in conjunction with the office of the Vice Provost for Curriculum Effectiveness & Improvement.

B. MODULES

The microcredential program will integrate elements of cohort-based learning, self-paced instruction with instructor support, and self-paced learning without direct instructor involvement. The program structure includes 15 modules, detailed in Table 1. These modules, some adapted from the DSECOP modules [5], align with course content, and are intended to be completed throughout the semester, separate from classroom and instructor interaction. The microcertification coordinator will conduct module assessment, with results recorded on the students' web profiles.

TABLE 1
Modules and Corresponding Classes

Physics class	Modules and tentative topics
Introduction to Mechanics	1: Introduction to Data Science [6] 2: Newton's Laws 3: Simple Harmonic Motion
Introduction to Electromagnetisms	4: Coulomb Forces 5: Circuits [7] 6: Magnetism
Modern Physics	7: Photoelectric Effect 8: Schrödinger Equation 9: Hydrogen Atom
Electromagnetics	10: Optics [8] 11: Antennas 12: Magnetisms-Ising Lattice [9]
Quantum Mechanics	13: Schrödinger Equation [10] 14: Spectroscopy [11] 15: Schrödinger Equation [12]

C. MODULES FOR INTRODUCTION TO MECHANICS COURSE

At present, a version of the physics microcredential program is being implemented. Modules for Introduction to Mechanics activities were developed and deployed into a class with 120 students in the Fall 2022 semester

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at UTEP, consisting of engineering and science majors. The students did not receive any microcredentials at this time and were required to work on the activities as part of their grades. In particular, the students had 1-hour weekly workshops led by teaching assistants in which they were provided code in a Jupyter Notebook and asked to run or manipulate it to answer relevant physics questions. Coding was not a prerequisite for the class, so students did not have to write their own code, just reason about the operations being performed.

The weekly workshops kept up with concepts being introduced in lectures and leveraged code from previous sessions that the students were already familiar with. The first few weeks introduced concepts from kinematics, which eventually resulted in the implementation of simple molecular dynamics. When Newton's Laws were covered, the acceleration could then be computed from a physical event such as a spring or friction. When the concepts of work and energy were covered, the acceleration was computed from the potential energy curve. The molecular dynamics code investigated systems of interest, such as the harmonic, damped harmonic, and quartic oscillators. The students were also exposed to code that performed Monte Carlo integration, numerical differentiation, and integration, and their numerical answers were compared to analytical solutions. The modules are freely available online [13]. Figure 1 shows a sample problem, including a brief Jupiter notebook example.

The students provided feedback on the individual exercises, which were incorporated into a second and third iteration in Spring 2023 and Fall 2023. A teaching assistant was hired in Spring 2023 to work on clarifying the assignments and the code.

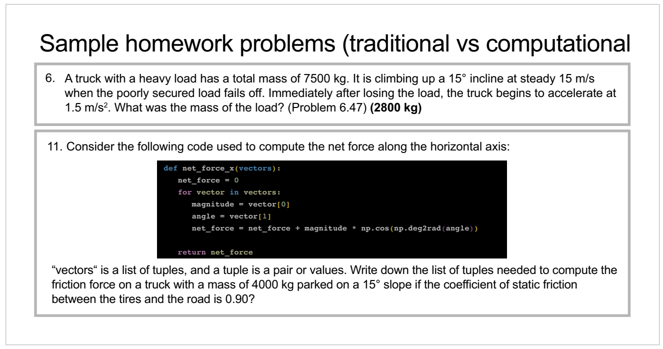

Figure 1. Sample problem.

The students provided feedback on the individual exercises, which were incorporated into a second and third iteration in Spring 2023 and Fall 2023. A teaching assistant was hired in Spring 2023 to work on clarifying the assignments and the code.

In addition, to quantify the impact the exercises have on the students, the Colorado Learning Attitudes Toward Science Survey (CLASS) [14] was administered in pre- and post-tests to measure the students' interest in the general topic of physics interest and learning.

Table 2 shows the questions administered in pre- and post-tests. For each concept, the students had to agree or disagree with the various statements; the number of students agreeing or disagreeing with each would then be averaged with respect to the total number of students and the percentage used as the pre- and post-test grade. In general, the statements were ranked as "Novice" or "expert"; the lower the percentage, the more novice the class' beliefs about physics, although for questions about what is useful in learning, there is not a defined expert belief.

TABLE 2
Survey Categories and Statements

Personal Interest
3. I think about the physics I experience in everyday life.
11. I am not satisfied until I understand why something works the way it does.
14. I study physics to learn knowledge that will be useful in my life outside of school.
25. I enjoy solving physics problems.
28. Learning physics changes my ideas about how the world works.
30. Reasoning skills used to understand physics can be helpful to me in my everyday life.
Real World Connection
28. Learning physics changes my ideas about how the world works.
30. Reasoning skills used to understand physics can be helpful to me in my everyday life.
35. The subject of physics has little relation to what I experience in the real world.
37. To understand physics, I sometimes think about my personal experiences and relate them to the topic being analyzed.

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TABLE 2 (CONTINUED)
SURVEY CATEGORIES AND STATEMENTS

Problem Solving (PS) General
13. I do not expect physics equations to help my understanding of the ideas; they are just for doing calculations.
15. If I get stuck on a physics problem on my first try, I usually try to figure out a different way that works.
16. Nearly everyone is capable of understanding physics if they work at it.
25. I enjoy solving physics problems.
26. In physics, mathematical formulas express meaningful relationships among measurable quantities.
34. I can usually figure out a way to solve physics problems.
40. If I get stuck on a physics problem, there is no chance I'll figure it out on my own.
42. When studying physics, I relate the important information to what I already know rather than just memorizing it the way it is presented.
PS Confidence
15. If I get stuck on a physics problem on my first try, I usually try to figure out a different way that works.
16. Nearly everyone is capable of understanding physics if they work at it.
34. I can usually figure out a way to solve physics problems.
40. If I get stuck on a physics problem, there is no chance I'll figure it out on my own.
PS Sophistication
5. After I study a topic in physics and feel that I understand it, I have difficulty solving problems on the same topic.
21. If I don't remember a particular equation needed to solve a problem on an exam, there's nothing much I can do (legally!) to come up with it.
22. If I want to apply a method used for solving one physics problem to another problem, the problems must involve very similar situations.
25. I enjoy solving physics problems.
34. I can usually figure out a way to solve physics problems.
40. If I get stuck on a physics problem, there is no chance I'll figure it out on my own.
Conceptual Understanding
1. A significant problem in learning physics is being able to memorize all the information I need to know.
5. After I study a topic in physics and feel that I understand it, I have difficulty solving problems on the same topic.
6. Knowledge in physics consists of many disconnected topics.
13. I do not expect physics equations to help my understanding of the ideas; they are just for doing calculations.
21. If I don't remember a particular equation needed to solve a problem on an exam, there's nothing much I can do (legally!) to come up with it.
32. Spending a lot of time understanding where formulas come from is a waste of time.
Applied Conceptual Understanding
1. A significant problem in learning physics is being able to memorize all the information I need to know.
5. After I study a topic in physics and feel that I understand it, I have difficulty solving problems on the same topic.
6. Knowledge in physics consists of many disconnected topics.
8. When I solve a physics problem, I locate an equation that uses the variables given in the problem and plug in the values.
21. If I don't remember a particular equation needed to solve a problem on an exam, there's nothing much I can do (legally!) to come up with it.
22. If I want to apply a method used for solving one physics problem to another problem, the problems must involve very similar situations.
40. If I get stuck on a physics problem, there is no chance I'll figure it out on my own.

Figure 2 shows the averages obtained for each category based on responses from 28 students. The symbols in blue show the pre-project attitudes, and the ones in red the post-project feelings. It is clear that there were gains of several percentages in all rubrics, with an average gain in all topics of 3.8% and a maximum gain of 9.5% in personal interest on the subject of applying computation, data science, etc., to homework problems. These results were subdivided by gender, resulting in similar gains.

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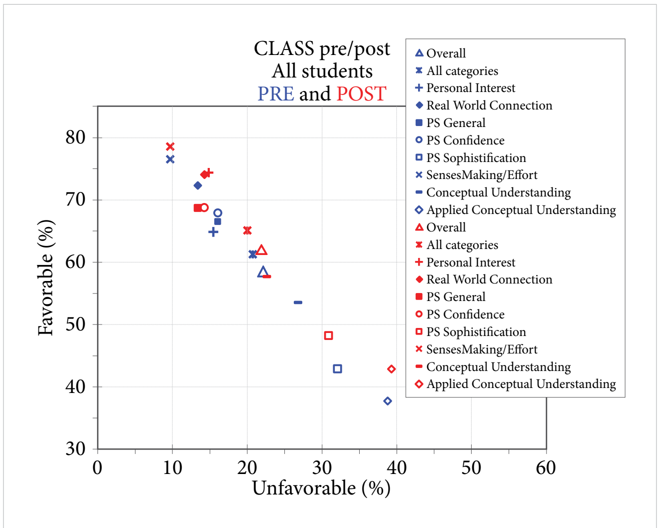

Figure 2. Pre- and post-tests were used to quantify how favorable or unfavorable the students' attitude was to a series of concepts related to the projects implemented.

Figure 3 shows the changes in attitude from pre- to post-test results. In general, the net displacement is toward the expert-like side.

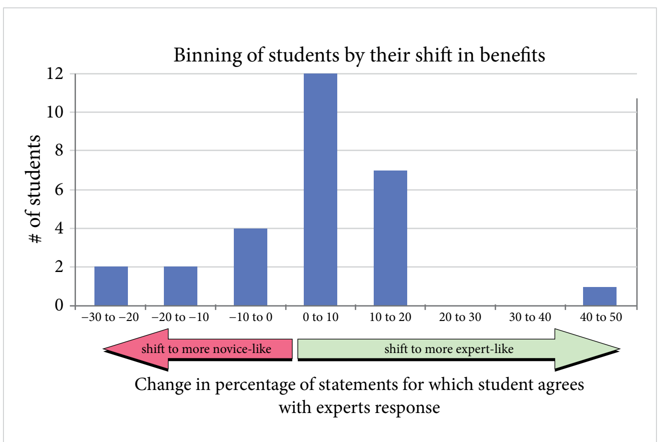

Figure 3. Changes of attitude from pre- to post-test results. The net displacement is toward the expert-like side.

Student feedback on the workshop and the lecture was positive every semester, ranging from "discovering that physics and computation are closely related" to not liking coding but still feeling that understanding it was very relevant to their future careers. Figure 4 shows the student evaluations from Fall 2019, before the modifications were implemented, Fall 2022, when the modifications began to be implemented, and Spring 2023, when the modifications were in place; it is easy to see an increase in the positive attitude of the students as the changes were implemented.

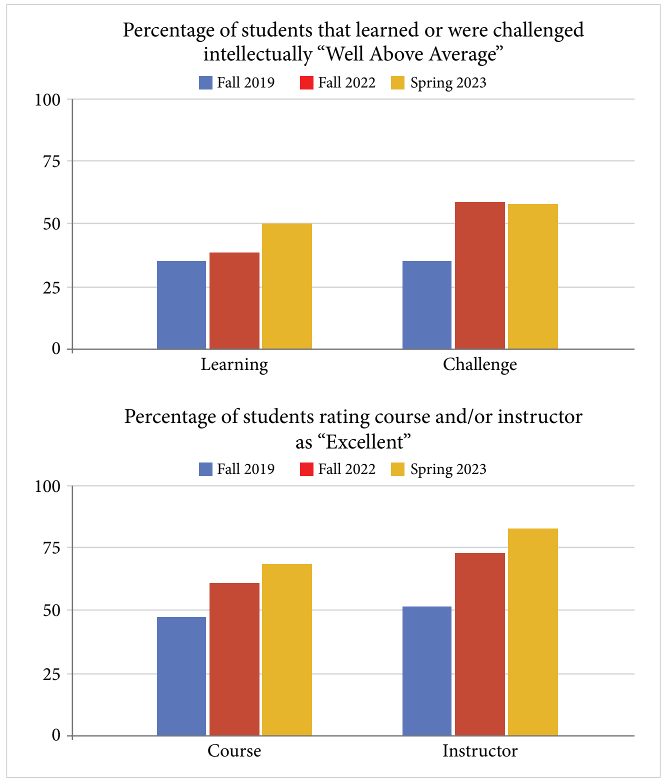

Figure 4. Student evaluations.

IV. CONCLUSIONS

In the evolving landscape of education and career readiness, understanding microcredentials is crucial. Microcredentials are compact, specialized certifications that validate proficiency in specific skills, contrasting with traditional broad-based degrees.

As technological advancements and industry needs rapidly change, traditional degree programs often fail to equip individuals with targeted, market-ready skills. Microcredentials offer a flexible alternative, enabling learners to acquire expertise tailored to their chosen fields, which has been successfully implemented by companies like Google and Amazon for upskilling in areas such as cloud computing and data analytics.

Despite criticisms of lacking depth, microcredentials align with industry standards and are endorsed by respected institutions, making them valuable for bridging the skills gap.

Educational institutions must integrate microcredentials into their curricula and collaborate with industries, while employers should recognize their worth and encourage continuous upskilling to foster innovation and

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adaptability. For physics graduates, microcredentials provide focused learning pathways that align with the demands of a rapidly evolving job market.

The program designed for the Physics undergraduate degree has not been fully implemented as proposed, but it has been partially implemented in some courses with promising results.

As the demand for specialized skills continues to grow, the integration of microcredentials into higher education curricula becomes increasingly crucial. The UTEP case study will serve as a testament to the power of innovation and collaboration, demonstrating how institutions can adapt to meet the changing needs of students, industry, and society as a whole.

REFERENCES

[1] "Texas credentials for the future." The University of Texas System. Accessed: Jul. 23, 2024 [Online]. Available: https://www.utsystem.edu/sites/texas-microcredentials

[2] C. Sullivan. "Microcredentials Unleashed: Pioneering the Next Frontier." The evolution. Accessed: Oct. 12, 2024. [Online]. Available: https://evolllution.com/microcredentials-unleashed-pioneering-the-next-frontier

[3] V. Agarwal. "How Companies Like Meta, IBM, AWS & Netflix Are Using Microcredentials To Bridge Talent Gaps." LinkedIn. Accessed: Oct. 12, 2024. [Online]. Available: https://www.linkedin.com/pulse/how-companies-like-meta-ibm-aws-netflix-using-bridge-talent-agarwal

[4] "Data Science Community of Practice." DSECOP.org. Accessed: Jul. 23, 2024. [Online]. Available: https://dsecop.org/

[5] "GDS Education Community of Practice." Github.com. Accessed: Jul. 23, 2024. [Online]. Available: https://github.com/GDS-Education-Community-of-Practice/DSECOP

[6] "Exploratory Data Analysis." Github.com. Accessed: Jul. 23, 2024. [Online]. Available: https://github.com/GDS-Education-Community-of-Practice/DSECOP/tree/main/Exploratory_Data_Analysis

[7] "DSECOP Github: Parameter Estimation of RLC Circuit Model with Automatic Differentiation and Gradient Descent". Github.com. Accessed: Jul. 23, 2024. [Online]. Available: https://github.com/GDS-Education-Community-of-Practice/DSECOP/tree/main/Automatic_Differentiation

[8] "Introduction to Classification Algorithms". Github.com. Accessed: Jul. 23, 2024. [Online]. Available: https://github.com/GDS-Education-Community-of-Practice/DSECOP/tree/main/Intro_to_Classification_Algorithms

[9] "Connecting MonteCarlo to ModernAI." Github.com. Accessed: Jul. 23, 2024. [Online]. Available: https://github.com/GDS-Education-Community-of-Practice/DSECOP/tree/main/Connecting_MonteCarlo_to_ModernAI

[10] K. Shah. "Learning the Schrödinger Equation." Github.com. Accessed: Jul. 23, 2024. [Online]. Available: https://github.com/GDS-Education-Community-of-Practice/DSECOP/tree/main/Learning_the_Schrodinger_Equation

[11] "Deep Learning Applications in NMR Spectroscopy." Github.com. Accessed: Jul. 23, 2024. [Online]. Available: https://github.com/GDS-Education-Community-of-Practice/DSECOP/tree/main/NMR_Deep_Learning

[12] K. Shah. "Gaussian Processes and the Schrödinger Equation." Github.com. Accessed: Jul. 23, 2024. [Online]. Available: https://github.com/GDS-Education-Community-of-Practice/DSECOP/tree/main/Gaussian_Processes_and_Schrodinger_Equation

[13] J. A Muñoz *et al*. "Mechanics: projects and exercises in Python." Github.com. Accessed: Jul. 23, 2024. [Online]. Available: https://github.com/jamunozlab/introductory_mechanics_spring_2023

[14] "CLASS (Colorado Learning Attitudes about Science Survey)." Colorado.edu. Accessed: Oct. 12, 2024. [Online]. Available: https://www.colorado.edu/sei/class

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