Empowering Students with AI: A Universal Design Framework for Learning and Growth

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***Abstract*—The integration of artificial intelligence (AI) tools in education presents a unique opportunity to enhance learning experiences, foster inclusivity, and prepare students for professional careers. This study explores the incorporation of AI tools into a theoretical computer science course. Known for its rigor and challenging content, the course was redesigned to align with the Universal Design for Learning (UDL) framework and promote the National Association of Colleges and Employers (NACE) career readiness competencies. The interventions included AI-integrated homework assignments, the use of AI in brainstorming, sourcing, and writing for group projects, leveraging AI to test student knowledge through interactive questioning and feedback, and utilizing AI as an interview preparation tool.**

Pre- and post-semester surveys assessed changes in students' perceptions and utilization of AI tools, revealing increased confidence in ethical considerations, greater appreciation for AI's role in learning, and improved career readiness. The results highlight the transformative potential of AI when thoughtfully integrated into coursework, fostering an inclusive environment that enhances academic and professional development. This paper discusses the methodologies, findings, and implications for educators aiming to responsibly incorporate AI tools into their teaching practices.

Keywords: *Artificial Intelligence, Education, AI Tools, Universal Design for Learning, Responsible AI, Educational Framework, Technology Integration, Student Learning*

I. Introduction

The integration of artificial intelligence (AI) tools in education has sparked both enthusiasm and concern among educators and students alike. These tools, ranging from generative AI systems like ChatGPT to specialized applications, have the potential to reshape how students approach problem-solving, collaborate on projects, and prepare for their professional careers. However, their widespread adoption has also raised questions about ethical usage, over-reliance, and academic integrity [4] [5]. To effectively leverage AI tools in education, it is essential to adopt a framework that emphasizes inclusivity, accessibility, and ethical responsibility.

The importance of equipping students with the skills to use AI tools effectively and ethically is underscored by broader trends in workforce preparation. Studies have highlighted the growing demand for digital literacy and the ability to work alongside AI systems in professional environments [8] [3].

This study focuses on the redesign of a theoretical computer science course that is widely regarded as one of the most challenging in the curriculum. The course demands a deep understanding of algorithmic principles and the ability to apply them in problem-solving and research contexts. Recognizing the need for innovative teaching strategies to support diverse learners, the course was redesigned using the Universal Design for Learning (UDL) framework to incorporate AI tools. The UDL framework prioritizes accessibility and inclusivity by providing multiple means of engagement, representation, and expression, catering to diverse learning styles and abilities [6]. In this course, AI tools were integrated not only into individual assignments but also into group projects, brainstorming sessions, and feedback mechanisms. These interventions aimed to help students navigate complex concepts, foster collaboration, and build career competencies in line with the National Association of Colleges and Employers (NACE) standards [7].

To measure the effectiveness of these interventions, surveys were conducted at the beginning and end of the semester. The findings reveal a shift in students' perceptions of AI tools, with increased confidence in ethical considerations and a greater appreciation for their role in learning and professional development. This paper discusses the methods, results, and implications of integrating AI tools into coursework through an inclusive and ethical lens, offering valuable insights for educators navigating the evolving landscape of AI in education.

II. Methodology

A. Course Context and Participants.

This study was conducted in an undergraduate course titled *Algorithms and Complexity* at the University of Connecticut during the Fall 2024 semester. The course enrolled 60 students, encompassing a diverse range of experiences with artificial intelligence (AI) tools. Designed for advanced computer science students, the course emphasized problem-solving, critical thinking, and collaborative learning through a combination of theoretical instruction, practical assignments, and group projects. The integration of AI tools was a central component of the course, aiming to enhance student engagement and learning outcomes.

B. Pre-Course Survey.

At the start of the semester, students were invited to participate in a survey to assess their baseline knowledge

and attitudes toward AI tools. This survey explored students' familiarity with AI technologies, such as ChatGPT, and their previous use of these tools in academic settings. Additionally, the survey aimed to understand students' perspectives on the educational potential of AI tools, their perceived benefits, and any concerns they had about their use in coursework. Another key objective of the survey was to evaluate students' understanding of the ethical considerations associated with AI tools, including issues such as the reliability of AI-generated content, potential biases, and academic integrity.

The responses provided insights into students' readiness to engage with AI tools as part of their learning process and informed the design of AI-related interventions introduced during the course. Further details on the pre-semester survey can be found in the Results and Findings section.

C. Integration of AI Tools.

AI tools were integrated into the course to enhance learning outcomes while promoting critical thinking and ethical awareness. The course included clear AI usage guidelines outlined in the syllabus and across all relevant components, ensuring responsible engagement. AI was incorporated into various aspects, including AI-integrated homework assignments, knowledge testing, interview preparation, and collaborative projects. These interventions encouraged students to interact with AI as a learning companion rather than a solution provider. The goal was to help students deconstruct complex concepts, review theoretical material, and approach problem-solving with a critical mindset. A comprehensive overview of these interventions is provided in the Framework for Integrating AI Tools section.

D. Post-Course Survey

At the end of the semester, students completed a follow-up survey to assess the impact of AI integration on their learning experience. This survey provided insights into how students' familiarity with and attitudes toward AI tools evolved over the course. Students were asked to reflect on their ability to use AI tools effectively in academic tasks and whether their engagement with these tools enhanced their problem-solving and critical thinking skills.

The survey also sought to understand the extent to which students recognized the ethical implications of using AI tools, including considerations around the accuracy and bias of AI-generated content. Additionally, students shared their perspectives on whether AI interventions in the course had contributed to their overall learning outcomes and preparedness for professional challenges.

The results of these surveys, alongside observations and feedback collected throughout the semester, informed the analysis presented in the Results and Findings section.

III. Framework for Integrating AI Tools

This study presents a comprehensive framework for integrating artificial intelligence (AI) tools into the curriculum of Algorithms and Complexity, a theoretical computer science course offered at the University of Connecticut. Developed through the integration of AI across various course components, this framework serves as a flexible guide that can be adapted and applied to courses across different disciplines. Grounded in the Universal Design for Learning (UDL) framework, which emphasizes inclusivity, accessibility, and adaptability in education [6], this approach ensures that AI tools not only enhance learning outcomes but also foster ethical and responsible usage. The framework consists of structured yet adaptable components that educators can tailor to meet the specific needs of their courses. These components provide a valuable resource for diverse academic contexts, enabling educators to customize their approach while maintaining a consistent and effective structure. The key components of the framework are as follows:

1) Establish Guidelines
   This component establishes the foundation for the ethical and effective use of AI tools, introduced at the beginning of the course and reinforced throughout various assignments and projects, as outlined in the framework illustrated in Figure 1. A key aspect of this approach is embedding clear AI usage guidelines in the syllabus, specifying permissible applications such as clarifying homework questions, reviewing complex concepts, brainstorming ideas, selecting projects, and refining written reports. Additionally, AI-specific instructions are integrated into each course component, including homework assignments and projects, to ensure that students understand the appropriate and ethical use of AI tools while maintaining academic integrity. To further promote transparency and accountability, students are required to document and acknowledge their AI tool usage in all relevant coursework, fostering critical reflection on AI's role in academic work.
2) Prompt Engineering
   This dimension introduces students to prompt engineering—the practice of crafting precise inputs to optimize AI interactions—enhancing their meaningful engagement with AI tools, as illustrated in Figure 1. To systematically incorporate this skill, prompt engineering is embedded into all homework assignments, with each question accompanied by carefully designed prompts. For example, a homework question requiring students to find the Minimum Spanning Tree (MST) using Kruskal's and Prim's algorithms in a given graph would be paired with prompts such as, "How does Kruskal's algorithm build a Minimum Spanning Tree? Provide a step-by-step explanation with an example," or "What is the key difference between Prim's and Kruskal's algorithms for finding an MST?" These structured prompts help students break down problems, review concepts, and explore examples. Additionally, students are guided to avoid seeking direct solutions, instead formulating conceptual queries that encourage analytical reasoning and deepen their understanding, aligning with foundational research [2] [11]. To further support learning, prompts

are designed to position AI as a tutor that provides explanations, guidance, and exploration opportunities, fostering independence and problem-solving skills while mitigating over-reliance on AI-generated answers.

3) Interactive AI
This component leverages interactive AI exercises during class sessions to test and reinforce students' understanding of key course concepts, actively engaging them in the learning process. Exercises begin with instructor-provided prompts, such as "We've learned about [topic]. Ask me three questions, one at a time, to test my understanding, and provide feedback after each answer." In this setup, AI generates questions, students respond, and AI offers immediate feedback, creating a dynamic and responsive learning experience. To enhance retention and comprehension, these exercises incorporate evidence-based strategies such as active recall and immediate feedback, enabling real-time correction of misconceptions [9] [10]. Through these interactive engagements, students experience AI as a supportive learning tool, fostering deeper engagement and long-term mastery of course material while reinforcing an iterative approach to learning.
4) Collaborative Projects
This dimension integrates AI tools into semester-long group projects, bridging theoretical knowledge with practical application while fostering teamwork and research skills. AI is utilized during the brainstorming phase to explore algorithms through prompts such as, "Recommend algorithms relevant to [topic], along with applications and complexity," encouraging informed decision-making and critical evaluation. Throughout the research process, AI supports students by clarifying concepts, delving into algorithmic details, and identifying practical applications with queries like, "Explain [algorithm] in detail, including strengths, weaknesses, and examples," while ensuring that students maintain ownership of their work. Additionally, AI assists with coding, debugging, and documentation through targeted prompts, positioning itself as a mentor rather than a solution provider, thereby enhancing collaborative learning and problem-solving outcomes.
5) Interview Preparation
This component prepares students for professional contexts by incorporating AI tools into interview practice, enhancing their confidence and communication skills while aligning with the National Association of Colleges and Employers (NACE) career readiness competencies, such as communication, critical thinking, and professionalism [7]. At the end of each homework assignments, students receive curated interview questions related to course topics, encouraging them to practice with AI tools to simulate interview scenarios and receive feedback. Additionally, students are provided with strategies for effectively using AI, such as verbally answering questions and refining their responses iteratively based on AI-generated feedback. This process helps improve articulation, address misconceptions, and develop professional communication skills in line with NACE standards. By promoting iterative learning and immediate feedback, this approach prepares students for technical interviews, enhancing their ability to explain concepts clearly and confidently while supporting NACE's emphasis on critical thinking and professional preparedness in real-world settings.
6) Addressing AI Limitations
This critical component ensures that students recognize and mitigate AI's limitations, fostering responsible usage through critical analysis. AI's potential unreliability is explicitly outlined in the syllabus and reinforced in assignment headers, emphasizing that AI-generated responses may be incorrect or incomplete and should not serve as the primary source of knowledge [1]. Students are encouraged to critically engage with AI outputs by verifying information independently and leveraging their prior subject knowledge to identify errors, ensuring that AI serves as a complementary rather than a replacement learning tool. To further support this skill, in-class examples of AI inaccuracies are provided, demonstrating how recognizing and correcting errors can deepen understanding. This approach reinforces the necessity of a strong foundational knowledge base before interacting with AI, promoting a more critical and informed use of these tools.

This framework, grounded in UDL principles, offers educators a structured, adaptable approach to integrate AI tools responsibly, enhancing student learning, critical thinking, and professional readiness while addressing ethical considerations.

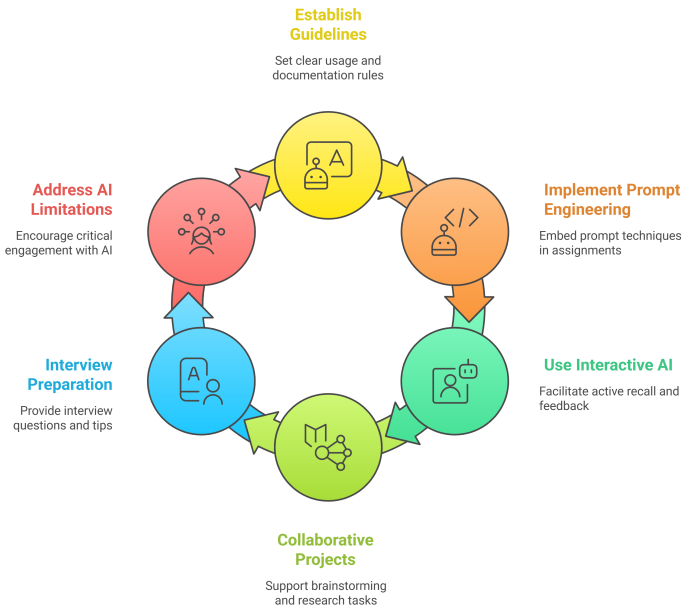

Fig. 1. Framework for Integrating AI Tools in Education: Key Components for Responsible and Effective Usage

IV. Results and Findings

Pre-Course Survey results.

To establish a baseline understanding of how students utilized AI tools and perceived their role in academic work, a survey was conducted at the start of the semester. The survey aimed to gather insights into the purposes for which students were using AI tools, the benefits they perceived, their understanding of ethical considerations, and the kind of guidelines or support they felt would help them use AI tools more effectively.

A. Purposes of Using AI Tools

The results of the survey revealed a range of purposes for which students used AI tools in their coursework. The most common purpose was clarifying concepts, with 79% of students reporting using AI tools for this reason. Additionally, 55% of students used AI tools for generating ideas, and 57% utilized them for proofreading or editing their work. A smaller portion of students used AI tools to verify solutions for problems or assignments (32%), while a minimal 2% relied on AI tools for completing the entire homework.

B. Perceived Benefits of Using AI Tools

When asked about the benefits of using AI tools, the majority of students indicated that AI tools helped them understand difficult concepts (82%). Additionally, 80% of students found that AI tools provided additional resources or examples to aid their learning. Half of the students (50%) believed that AI tools saved time. However, a smaller portion of students felt that AI tools contributed to improving writing or presentation (32%).

C. Confidence in Understanding Ethical Considerations

Students were asked about their confidence in understanding the ethical considerations involved in using AI tools. The majority of students expressed being somewhat confident in their understanding, while 35% felt very confident. A smaller portion of students indicated they were not very confident, and only 1% of students reported being not confident at all regarding ethical considerations, as shown is figure 2.

D. Guidelines and Support for Effective AI Tool Usage

To understand what type of support students would find helpful, the survey inquired about the guidelines that would assist them in using AI tools more effectively. A significant 89% of students indicated that clear instructions on appropriate usage would be beneficial. Additionally, 71% of students felt that understanding the limitations and potential inaccuracies of AI tools was important, and 68% of students expressed the need for examples of how to use AI tools for different tasks. A smaller portion (30%) expressed interest in workshops or tutorials on AI tools.

Post-Course Survey results.

At the end of the semester, a follow-up survey was conducted to assess the impact of the AI integration framework in the Algorithms and Complexity course.

The survey evaluated changes in students' perceptions, learning experiences, and responsible usage practices following a semester-long intervention that included clear guidelines, prompt engineering, interactive AI exercises, collaborative projects, interview preparation, and emphasis on AI's limitations. The results demonstrate the effectiveness of these strategies in fostering positive attitudes, enhancing learning, and promoting ethical AI use.

E. Changes in Perceptions of AI Tools

Students' views on AI tool usage evolved positively, with 53% reporting a more positive outlook. This shift aligns with the course's provision of clear guidelines and practical applications, which likely demystified AI tools and reinforced their value as learning aids rather than shortcuts.

F. Impact on Learning Experience

The integration of AI tools into homework assignments was widely regarded as beneficial, with an overwhelming 97% of students reporting an enhanced learning experience. A significant 75% of students affirmed that AI tool-related questions greatly supported their understanding of course material.

G. Preparation for Technical Interviews

AI-integrated interview preparation questions and tips significantly boosted confidence, with 83% of students rating their effectiveness as Extremely to very effective. This aligns with the course's structured approach to simulating interview scenarios using AI, where students practiced articulating concepts and received iterative feedback—an approach designed to mirror real-world technical interview demands and enhance professional readiness.

H. Encouragement of Responsible and Effective Use

The course's focus on promoting responsible and effective AI tool usage proved highly successful, with 89% expressing strong approval of the efforts to encourage ethical integration of these technologies into their learning. Furthermore, students universally acknowledged gaining substantial knowledge about using AI tools responsibly in an educational context, with 50% indicating they learned a great deal and the remaining 50% noting moderate but meaningful progress. This positive outcome can be attributed to the structured guidelines outlined in the syllabus and consistently reinforced through homework assignments. These guidelines defined acceptable uses, such as clarifying concepts and brainstorming, and required students to acknowledge AI contributions, fostering a sense of accountability. Additionally, the course highlighted the limitations of AI tools, including their potential to generate incorrect outputs, and emphasized the need for verification. This approach nurtured a critical perspective, encouraging students to engage with AI thoughtfully and independently rather than relying on it uncritically.

I. Confidence in Ethical Considerations

Confidence in understanding the ethical considerations of AI tool usage increased markedly by the semester's end, with a notable 58% of students expressing high confidence and the remaining 42% indicating moderate assurance, eliminating all instances of low confidence reported at the semester's start, as illustrated in figure 2. This substantial growth reflects the course's deliberate emphasis on ethical guidelines and its use of real-world examples illustrating AI errors, which together equipped students to address complex issues such as academic honesty and over-reliance. These topics emerged as primary ethical concerns, identified by 26% and 33% of students, respectively. By embedding ethical discussions within the curriculum, the course effectively bolstered students' ability to navigate the moral dimensions of AI use with greater certainty and insight.

J. Influence on Problem-Solving and Research

AI tools positively influenced problem-solving and research approaches for 69% of students. Collaborative projects, where AI aided in brainstorming (e.g., algorithm selection) and research (e.g., clarifying concepts), likely drove this outcome. Students' use of AI to explore algorithmic details and debug implementations, guided by prompts that positioned AI as a mentor, enhanced their analytical skills while maintaining ownership of their work.

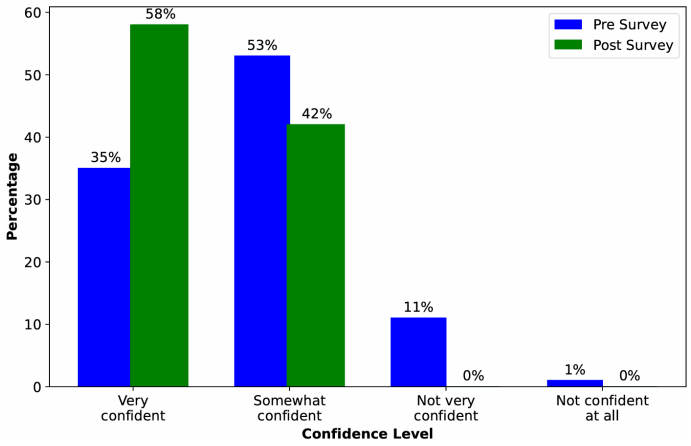

Fig. 2. The figure illustrates the changes in students' confidence levels regarding their understanding of ethical considerations involved in using AI tools, before and after the course.

V. Framework Adaptability

The proposed framework for integrating AI tools in education, as detailed in figure 1, encompasses all critical aspects of course design, including guidelines, prompt engineering, interactive exercises, collaborative projects, interview preparation, and critical engagement with AI limitations. However, it is designed to be flexible, allowing instructors to adapt some or all components based on their course needs and pedagogical goals. Educators may begin with the foundational guidelines for responsible AI use, gradually incorporating additional elements—such as prompt engineering or interactive exercises—as they deem appropriate, ensuring a tailored approach that enhances learning while maintaining ethical and effective usage.

VI. Discussion and Conclusions

The integration of artificial intelligence (AI) tools into higher education curricula, has demonstrated substantial potential to enhance student learning, foster responsible usage, and prepare students for professional challenges. Drawing on the findings from this study, conducted in a theoretical computer science course at the University of Connecticut, the pre- and post-semester survey results provide compelling evidence of the efficacy of the proposed educational framework, while also highlighting areas for refinement and future exploration.

The pre-semester survey revealed that students initially perceived AI tools as valuable supplementary aids for clarifying concepts and accessing resources, with an overwhelming majority recognizing their role in understanding challenging topics. However, their confidence in navigating ethical considerations was varied, and a significant portion expressed uncertainty, alongside a clear demand for structured guidelines and practical support. These baseline insights informed the development of a comprehensive, yet flexible, framework for AI integration, detailed in figure 1, which encompasses all critical aspects of course design—syllabus guidelines, prompt engineering, interactive exercises, collaborative projects, interview preparation, and critical engagement with AI limitations. Crucially, this framework is designed to be adaptable, allowing instructors to implement some or all components based on their specific course needs, beginning with foundational guidelines for responsible AI use and gradually incorporating additional elements, such as interactive exercises or collaborative projects, as deemed appropriate.

By the semester's end, the post-semester survey indicated marked improvements across key areas. Students overwhelmingly reported enhanced learning experiences, with a significant majority—97%—attributing improved comprehension to AI-integrated activities, and confidence in ethical considerations rose notably, with 58% expressing high confidence. These outcomes underscore the framework's effectiveness in fostering responsible usage, deepening conceptual understanding, and enhancing professional readiness, aligning with NACE career readiness competencies [7]. The positive shift in perceptions, coupled with high satisfaction in using AI for interview preparation and problem-solving, highlights the framework's success in bridging educational and professional goals, even within a single course context.

The flexibility of the framework proved instrumental, enabling tailored implementation that addressed students' initial uncertainties while promoting inclusivity and adaptability, as guided by UDL principles. For instance, prompt engineering empowered students to engage critically with AI through targeted prompts, while interactive exercises leveraging active recall and immediate feedback reinforced retention. However, the study's limitations warrant consideration: the sample,

confined to a single course at one institution, restricts generalizability, and the surveys did not assess long-term retention or application of AI skills beyond the semester, nor potential disparities based on technical proficiency or access. Future research could expand to multiple courses or institutions, incorporate longitudinal assessments, and explore demographic or technological variables to refine this framework further.

The implications of these findings are significant for educational practice across disciplines. By demonstrating that a flexible, UDL-informed framework can enhance learning while addressing ethical challenges, this study offers a scalable model for educators seeking to integrate AI responsibly. It emphasizes the importance of starting with clear guidelines, gradually building on interactive and collaborative components, and continually addressing AI's limitations to ensure critical engagement. This approach not only transforms pedagogy but also prepares students for an AI-driven workforce, aligning with industry standards. Future iterations could explore advanced AI applications, such as adaptive learning systems, while prioritizing inclusivity and equity.

In conclusion, the integration of AI tools into higher education, as implemented through this adaptable framework, has yielded substantial educational benefits, fostering responsible usage, deepening learning, and enhancing professional readiness. While challenges remain, these findings provide a robust foundation for advancing AI-enhanced education, offering a blueprint for educators to adapt and innovate across diverse academic contexts.

REFERENCES

[1] E. M. Bender, T. Gebru, A. McMillan-Major, and S. Shmitchell, "On the dangers of stochastic parrots: Can language models be too big?" *Proceedings of the 2021 ACM Conference on Fairness, Accountability, and Transparency*, 2021.

[2] T. Brown, B. Mann, N. Ryder, M. Subbiah, J. Kaplan, P. Dhariwal, A. Neelakantan, P. Shyam, G. Sastry, A. Askell *et al.*, "Language models are few-shot learners," *Advances in Neural Information Processing Systems*, vol. 33, pp. 1877–1901, 2020.

[3] K. Holstein, B. M. McLaren, and V. Aleven, "Designing for complementarity: Teacher and student needs for orchestration support in ai-enhanced classrooms," in *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. ACM, 2019.

[4] L. Kloub, "Chatgpt in computer science education: Exploring benefits, challenges, and ethical considerations," *ASEE North East Section*, 04 2024.

[5] R. Luckin, W. Holmes, M. Griffiths, and L. B. Forcier, *Intelligence Unleashed: An argument for AI in education*. Pearson, 2016.

[6] A. Meyer, D. H. Rose, and D. Gordon, *Universal Design for Learning: Theory and Practice*. CAST Professional Publishing, 2014.

[7] N. A. of Colleges and Employers, "Career readiness defined," https://www.naceweb.org/, 2021.

[8] S. Raisch and S. Krakowski, "Artificial intelligence and management: The automation–augmentation paradox," *Academy of Management Review*, vol. 46, no. 1, pp. 192–210, 2021.

[9] H. L. Roediger and A. C. Butler, "The critical role of retrieval practice in long-term retention," *Trends in Cognitive Sciences*, vol. 15, no. 1, pp. 20–27, 2011.

[10] V. J. Shute, "Focus on formative feedback," *Review of Educational Research*, vol. 78, no. 1, pp. 153–189, 2008.

[11] A. Tamkin, M. Brundage, J. Clark, and D. Ganguli, "Understanding the capabilities, limitations, and societal impact of large language models," *arXiv preprint arXiv:2102.02503*, 2021.