Gauging Scholarly Engagement: An Investigation into Topic Popularity within the ASEE CIT Division

Dr. Barry M. Lunt, Brigham Young University

Dr. Barry Lunt has taught electronics engineering technology, information technology, and cybersecurity at Brigham Young University since 1993 where he now serves as a full professor in the Department of Electrical and Computer Engineering. He has also taught electronics at Utah State University and Snow College. Before academia, he was a design engineer with IBM in Tucson, AZ.

Dr. Mudasser Fraz Wyne, National University

I hold a Ph.D. in Computer Science, an M.Sc. in Engineering, and a B.Sc. in Electrical Engineering. Currently, I am honored to serve as a Professor of Computer Science and as the Chair for the Department of Computer Science and Information Systems at the School of Technology and Engineering, National University, San Diego, USA. Additionally, I am entrusted with the role of Academic Program Director for the MS in Computer Science. Over the years, I have played key leadership roles, including Chair of the University Research Council, Chair of the Council of the Chairs, Chair of the Undergraduate Council Program Review Committee, Chair of the Graduate Council Program Review Committee, and Chair of the School of Academic Affairs Committee. My association with ABET USA dates back to 2001, where I have served as the Commissioner for the Computer Accreditation Commission (CAC) and ABET Visit Team Chair. Currently, I am honored to be a Program Evaluator for BSc in Computer Science and BSc in Information Systems. In my academic journey, I have successfully secured various grants, including the prestigious Fulbright. I have contributed to the international academic community by participating in numerous Ph.D. Thesis committees and serving on the editorial boards of eight international journals. Furthermore, I have chaired and co-chaired 20 international conferences, led panel discussions, and contributed to over 250 international conference program committees. As a testament to my commitment to professional organizations, I am an active member of ACM, ASEE, ASEE/PSW, and CSAB. I have previously served as ASEE-CIT Division Chair and Program Chair, and I am currently honored to serve as the Program Chair for the Software Engineering Division and as the Division Chair for the CIT Division.

David A Wood, Brigham Young University

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Abstract

Since 2011, the Computing and Information Technology (CIT) division of the ASEE has had 427 papers presented and published in the proceedings of the ASEE Annual Conference and Exposition. This paper looks at these 427 papers as a whole, providing descriptive statistics, giving the top institutions and authors that have contributed to these papers, and providing information regarding the impact of the top ten papers, as measured by their citations and downloads. We have also used the ChatGPT version 4.0 to provide categories for the 427 papers, providing insight into the most popular topics for papers in the CIT division.

Introduction

The American Society for Engineering and Education (ASEE) Computing & Information Technology (CIT) Division's existence spans several decades, and it continues to be a stalwart advocate for numerous research papers and sessions featured at the ASEE Annual Conference and Exposition. The ability to gauge the long-term impact of a scientific article shortly after its publication is valuable for evaluating research performance. Among the metrics employed to assess an article's research impact, the number of downloads and citations stand out as significant indicators of research publications.

In this paper, our primary goal is to determine which specific topics or domains elicit heightened attention within the research community. This research is driven by the desire to better comprehend the subjects that gain substantial traction among scholars submitting work to the CIT division. Ultimately, our aim is to provide valuable guidance to researchers contemplating the development of new papers or the exploration of emerging research domains.

In pursuit of these objectives, we have compiled a comprehensive dataset for analysis. This dataset encompasses various attributes, including paper titles, citation counts, download statistics, author details (including the number of authors and their respective order), author names, and affiliated institutions. It encompasses papers submitted to the Computing and Information Technology (CIT) division of the American Society for Engineering and Education (ASEE) over the period from 2011 to 2023. Within this dataset, 427 papers are included, featuring download counts ranging from as few as 3 to as many as 27,404, and citation counts ranging from 0 to 72.

Our work introduces a novel approach for identifying research topics with the potential to significantly influence future research directions. The interplay between download counts and citation statistics assumes a pivotal role in appraising and predicting upcoming trends in research. While prior studies have extensively examined the multifaceted factors affecting citation counts, encompassing both cited and citing papers, this particular research includes both citation counts and download numbers, since they each provide a unique insight. Indeed, the correlation coefficient between citation counts and downloads is only 0.152 for the 427 papers in this study.

An additional contribution of our paper is that we use ChatGPT to identify key themes and to categorize papers. We can then show more macro trends of what is downloaded and cited in the literature. We also demonstrate how ChatGPT can be used in querying abstracts to identify current gaps in the literature and future research projects.

Literature Review

Evaluating research outputs is essential in academia, encompassing the assessment of scientific contributions, guiding tenure promotions, and directing research resources [1, 2]. The primary metric traditionally used has been citation count, with significant emphasis placed on its role in measuring research impact [3, 4]. However, the reliance on subjective quality assessments, like peer reviews, has shown inconsistencies in correlation with citation counts and there are other concerns noted in the literature about solely relying on citation counts [5, 6].

With the increase in research publications, the focus on impact indicators has broadened, with citation counts remaining a widely accepted measure. Yet, they are not direct measures of quality [7]. Despite controversies around these metrics, they continue to be used in academic decision making.

An additional metric that is being used more for evaluating scholarship are download counts [8, 9]. Using downloads reflects a broader view of research impact, considering the actual usage and dissemination of scholarly works. While there is a correlation between download metrics and citations [10], there are situations where this is not the case. For example, papers with fewer citations might be extensively downloaded and used by practitioners, indicating a significant impact not captured by citation metrics [11]. While citation counts measure scholarly recognition, download counts could reflect actual usage and the broader dissemination of research [12].

While these two measures can be considered in isolation, prior research has shows it is also beneficial to combine them into a single metric [13]. Thus, while citation counts and impact factors remain central to evaluating individual articles, incorporating download counts as an additional metric offers a more comprehensive understanding of scholarly impact. Combining both into a single metric is also beneficial for examining research impact.

Descriptive Statistics

Table 1 provides an insight into the papers that were included in this study. The information was accessed through the ASEE Peer online collection of conference proceedings (https://peer.asee.org). All statistics for this paper were gathered in December of 2023. The "Combined Impact Measure" was computed by standardizing the citation and download scores and then adding them together; therefore, higher values indicate greater impact.

Table 1: Descriptive Statistics

Description	Value
Number of Papers	427
Citations: Min; P25; Median; P75; Max	0; 0; 1; 3; 72
Downloads: Min; P25; Median; P75; Max	3; 268.5; 384; 541.5; 27,404

Combined Impact Measure: Min; Min; P25; Median; P75; Max	-0.84; -0.63; -0.40; 0.08; 16.91
Number of Unique Authors	946
Authors per Paper: Min; P25; Median; P75; Max	1; 2; 3; 4; 15
Number of Unique Institutions	234

In total for the 13 years included in this study, there were 233 unique institutions with authors who contributed papers. In addition, there were 156 authors whose institution was not found. Table 2 shows the top institutions with authors who contributed papers, down to those who contributed 3 or more papers. There were 147 institutions that contributed 1 or 2 papers, too long of a list to include in this paper. We found this number of institutions to be very encouraging, as it represents a wide range of participants in the CIT division of ASEE.

Table 2: Ranking Top Institutions with ≥3 Publications.

Institution	**# of Pubs**
Purdue University	81
Utah Valley University	56
Florida International University	33
DeVry University	31
East Carolina University	28
University of Florida	24
University of Illinois Urbana-Champaign	20
University of North Carolina Charlotte	16
Virginia Polytechnic Institute and State University	15
Old Dominion University	14
Embry-Riddle Aeronautical University-Daytona Beach	13
Morgan State University	13
Brigham Young University	13
National University	12
University of South Florida	12
Pittsburg State University	12
Texas A&M University	11
Kansas State University	11
West Virginia University	10
University of Phoenix	10
University of Southern California	10
Purdue University Northwest	10
Michigan Tech University	9
University of Central Florida	9
Central State University	9
City University of New York	9
Fort Valley State University	9
Mississippi State University	9
California State Polytechnic University	8

North Carolina State University	8
Idaho State University	8
Indiana University–Purdue University Indianapolis	8
University of Virginia	8
University of San Francisco	7
Retired, Deceased, or Emeritus	7
Bucknell University	7
New York City College of Technology	7
Alabama A&M University	7
Ohio Northern University	6
University of California Riverside	6
Rochester Institute of Technology	6
Georgia Institute of Technology	6
Weber State University	6
James Madison University	6
San Jose State University	6
University of Minho	5
University of Idaho	5
University of Washington	5
Bowling Green State University	5
California State University Los Angeles	5
North Carolina Agricultural and Technical State University	5
University of Narjan	5
North Dakota State University	5
University of Delaware	5
Wentworth Institute of Technology	5
Northern Illinois University	4
Clarkson University	4
Florida Atlantic University	4
United States Coast Guard Academy	4
Middle Tennessee State University	4
Fayetteville State University	4
Eastern Washington University	4
Boise State University	4
Arizona State University	4
California State University Fullerton	4
North Carolina State University at Raleigh	4
Western Michigan University	4
Temple University	4
University of South Carolina	3
Loyola Marymount University	3

University of Illinois Chicago	3
Prairie View A&M University	3
University of New Hampshire	3
Clayton State University	3
University of Toronto	3
Rose-Hulman Institute of Technology	3
Eastern Kentucky University	3
Sacred Heart University	3
University of Nebraska	3
Sam Houston State University	3
California State University Monterey Bay	3
State University of New York Oswego	3
University of Texas Rio Grande Valley	3
California State University Chico	3
University of Bridgeport	3
Iowa State University	3

There were 945 total unique authors contributing to papers in this 13-year period. Table 3 gives the top contributing authors for authors contributing 3 or more papers. There were 896 authors who contributed 1 or 2 papers in this 13-year period. It's great to see there are many authors who keep the CIT division viable and at the head of research in computing education.

Table 3: Ranking Top Authors with ≥3 Publications

Author Name	**# Pubs**
Minaie, Afsaneh	27
Sanati-Mehrizy, Reza	26
Muqri, Mohammad R	11
Sanati-Mehrizy, Paymon	10
Kavianpour, Alireza	10
Sanati-Mehrizy, Ali	9
Wyne, Mudasser F	8
Shaykhian, Gholam Ali	7
Shakib, Javad	6
Helps, Richard G	6
Salib, Emil H	5
Mousavinezhad, Seyed H	5
Li, Peng	5
Khairi, Mohd A	5
Owen, Dennis O	5
Straub, Jeremy	4
Xu, Chengying	4
Rowe, Dale C	4

Rajaei, Hassan	4
Pickard, John	4
Hacker, Thomas J	4
Fu, Yujian	4
Azad, Abul K M	4
Chou, Te-Shun	4
Aggarwal, Ashish	4
Cabo, Candido	4
Weiss, Mark A	3
Rogers, Marcus	3
Resch, Cheryl L	3
Zeng, Xiangyan	3
Springer, John	3
Weese, Joshua L	3
Ziade, Jinan	3
Solis, Tiana	3
Meng, Xiannong	3
Lunsford II, Philip J	3
Lunn, Stephanie J	3
Harriger, Alka R	3
Luo, Chaomin	3
Naghedolfeizi, Masoud	3
Nikolaidis, Natasha	3
Naz, Afrin	3
Beckman, Joseph W	3
Coffman-Wolph, Stephany	3
Christensen, Ken	3
Georgiopoulos, Michael	3
Agrawal, Rajeev K	3
Gross, Joshua B	3
Gehringer, Edward F	3

The number of downloads had a very wide range, from a high of 27,404 for a paper from 2017 to one paper which had only 3 downloads (primarily because it was published in 2023). Table 4 ranks the top 10 papers based on the number of downloads, including the year in which the paper was published and presented.

Table 4: Ranking Top 10 Papers by Downloads

Paper Title	# of Downloads	Year
Fun, Innovative Computer Science Activities for the Classroom and Outreach	27,404	2017

A Comparison of Network Simulation and Emulation Virtualization Tools	9,760	2016
A Taste of Python – Discrete and Fast Fourier Transforms	6,233	2015
Design of a Bluetooth-Enabled Wireless Pulse Oximeter	5,644	2019
Capstone Projects in a Computer Engineering Program Using Arduino	5,558	2016
A Real-time Attendance System Using Deep-learning Face Recognition	5,225	2020
STEM Outreach: Assessing Computational Thinking and Problem Solving	4,288	2017
A Methodology for Automated Facial Expression Recognition Using Facial Landmarks	3,366	2018
Rethinking ABET Accreditation of Computer Science Degree Programs	3,345	2017
Android-Based Remote Robot Control System	3,324	2016

The number of citations had a wide range, from a high of 72 for a paper from 2013 to many papers which did not yet have any citations (primarily those which were newer). Table 5 ranks the top 10 papers based on the number of citations, including the year in which the paper was published and presented.

Table 5: Ranking Top 10 Papers by Citations

Paper Title	**# of Citations**	**Year**
Application of Wireless Sensor Networks in Health Care System	72	2013
STEM Outreach: Assessing Computational Thinking and Problem Solving	49	2017
Cloud Computing in Computer Science and Engineering Education	30	2012
Survey of Cybersecurity Education through Gamification	24	2016
The Impact of STEM Experiences on Student Self-Efficacy in Computational Thinking	22	2016
Gamification-Based Cyber-Enabled Learning Environment of Software Testing	20	2016
Exploring Computing Identity and Persistence Across Multiple Groups Using Structural Equation Modeling	18	2019
Leveraging Machine Learning Techniques to Analyze Computing Persistence in Undergraduate Programs	17	2020
A Comparison of Network Simulation and Emulation Virtualization Tools	15	2016
Implementing Building Information Modeling in Construction Engineering Curricula	14	2011
Teaching Modern Object-Oriented Programming to the Blind: An Instructor and Student Experience	14	2014

Since neither downloads nor citations are perfect measures of impact, we combined the two scores and present the top 10 rated papers in Table 6. Table 6 largely shows that downloads drives the final scores for impact. For example, the top rated paper had 27,404 downloads but only a single citation. Thus, for CIT papers, it appears that downloads are better at capturing impact relative to citations.

Table 6: Ranking Top 10 Papers by Combined Impact Measure

Paper Title	Combined Impact Measure	Year
Fun, Innovative Computer Science Activities for the Classroom and Outreach	16.91	2017
Application of Wireless Sensor Networks in Health Care System	13.45	2013
STEM Outreach: Assessing Computational Thinking and Problem Solving	10.89	2017
A Comparison of Network Simulation and Emulation Virtualization Tools	8.17	2016
Cloud Computing in Computer Science and Engineering Education	4.96	2012
Survey of Cybersecurity Education through Gamification	4.58	2016
The Impact of STEM Experiences on Student Self-Efficacy in Computational Thinking	4.02	2016
Capstone Projects in a Computer Engineering Program Using Arduino	4.01	2016
A Real-time Attendance System Using Deep-learning Face Recognition	3.98	2020
A Taste of Python – Discrete and Fast Fourier Transforms	3.52	2015
Fun, Innovative Computer Science Activities for the Classroom and Outreach	16.91	2017

One of the questions we asked ourselves was: are there some categories of papers which are more popular than others? Or, put another way, is there a reasonable way to categorize these 427 papers? The paper abstracts were submitted to ChatGPT 4.0. We first asked the AI tool to produce categories, and descriptions of the categories, for the articles based on the abstracts. Once we gathered the categories, we then asked ChatGPT to assign each paper to one more categories based on the abstract. We then aggregated the number of papers, citations, and downloads for each category and list the information in Table 7 below. Note that articles can have multiple categorizations and so the unit of analysis is the combination of category and article.

Table 7: Descriptive Statistics of Categories of Papers

Category of Article	# of Papers	Citations	Downloads	Combined Impact Measure
Technology-Enhanced and Innovative Learning	162	470	90,508	7.81
Student Engagement, Experience, and Assessment	140	402	104,027	22.53
Infrastructure, Resources, and Tools for Education	76	211	51,438	7.68
Educational Methods, Pedagogy, and Curriculum Development	71	99	70,152	3.35
Educational Data Analysis, Learning Analytics, and Research Methods	69	127	38,364	-10.22
Professional Skills, Career Development, and Industry Engagement	67	119	39,956	-8.98
Computer Science, IT, and Cybersecurity Education	61	97	26,338	-16.69
Remote, Online, and Novel Educational Environments	50	121	26,108	-3.17
Ethics, Professional Responsibility, and Social Impact	41	58	17,374	-12.75
Entrepreneurship and Innovation in Education	35	175	21,599	16.47
Educational Policy, Administration, and Accreditation	21	70	14,490	4.44
Diversity, Inclusion, and Underrepresented Groups in STEM	18	22	7,176	-6.52
International, Cross-cultural, and Global Education	14	26	5,849	-3.27
Healthcare and Biomedical Engineering Education	2	2	2,726	0.43

Table 7 is helpful for understanding the categories that receive the most attention by other scholars. It is interesting to note that in Table 7 the most commonly produced topics are not always those that have the highest scores for the Combined Impact Measure. Indeed, topics like Entrepreneurship and Innovation in Education have relatively few papers, but high impact. This table also shows the strength of ChatGPT for conducting research in that it can analyze a large amount of data efficiently. There are some limitations, as noted by ChatGPT identifying a category with only two papers that may not be that useful for decision making.

Exploration of Using ChatGPT to Analyze Papers

We decided to try and further test ChatGPT to see how it could be useful as part of the research process [14]. We selected 5 papers published in 2023 that were categories as “Computer Science, IT, and Cybersecurity Education.” We loaded the abstracts from these papers into ChatGPT and then prompted ChatGPT to identify future research ideas that were based on the

findings of these five papers. ChatGPT produced the following ideas, explained their importance, and linked how the five papers are related to the ideas as follows:

1. Idea: Efficacy of Innovative Teaching Methods in STEM Education
    - Importance: Investigating the impact of new teaching methodologies on student learning and retention in STEM fields is crucial.
2. Idea: Impact of Educational Interventions on Diverse and Underrepresented Student Groups
    - Importance: Understanding how different educational interventions affect students from diverse backgrounds is key to creating inclusive learning environments.
3. Idea: Relationship Between Student Engagement and Learning Outcomes
    - Importance: Investigating the relationship between student engagement and learning outcomes can help in designing effective educational programs.
4. Idea: Integration of Real-world Applications in Curriculum Design
    - Importance: Enhancing the relevance and efficacy of educational programs through the integration of theoretical knowledge with real-world applications.
5. Idea: Long-term Impact of COVID-19 on Technology Education
    - Importance: Understanding the long-term impact of the COVID-19 pandemic on education is essential for future educational planning, especially in technology fields.

Based on this, we dug deeper into one of the ideas (idea 4), and asked ChatGPT to discuss how the paper abstracts related to this question and specific hypotheses that could be tested. The output was as follows:

Idea 4: Integration of Real-world Applications in Curriculum Design
What Previous Studies Indicate:

1. [15]: Demonstrates the use of affordable, customizable Raspberry Pi units to teach complex WPA3 security protocols. This approach suggests that practical, hands-on experience with real-world tools can enhance the understanding of theoretical concepts.
2. [16]: Focuses on the redesign of a database programming course using microlearning, which indicates the importance of breaking down complex theoretical content into practical, digestible segments that reflect real-world applications.
3. [17]: Explores how students apply different debugging strategies in software development. This study implies that understanding and applying theoretical concepts in practical debugging scenarios can improve learning outcomes.

Suggested Hypotheses for Testing:

1. Hypothesis on Enhanced Learning Comprehension: Students exposed to curriculum integrating real-world applications (e.g., hands-on projects using Raspberry Pi for cybersecurity) will demonstrate higher comprehension and application skills in theoretical concepts compared to students taught with traditional methods.
2. Hypothesis on Improved Engagement and Retention: Teaching methods that integrate real-world applications will result in higher student engagement and retention rates in STEM courses.

3. Hypothesis on Skill Transferability: Students learning through real-world application-based methods will show greater ability to transfer skills and knowledge to new, untaught problems or contexts, compared to those learning through purely theoretical methods.
4. Hypothesis on Career Readiness and Confidence: Students who undergo practical, real-world application-focused education will report higher levels of career readiness and confidence in their skillset upon graduation.
5. Hypothesis on Impact of Microlearning in Real-world Application: Implementing microlearning strategies in courses with a strong focus on real-world applications (such as database programming) leads to better knowledge retention and application in practical scenarios.

Finally, we took one of these questions, question 4, and submitted it to the Consensus GPT that is a custom GPT created as part of ChatGPT 4. Consensus is an AI research assistant that can search 200 million academic paper abstracts. We asked Consensus to search for the five research papers that are most relevant to this research hypothesis. The Consensus GPT found 5 relevant papers, summarized them in a few sentences, and provided a link to download the full paper. It took only a few minutes to perform all these ChatGPT tasks.

Conclusion

In reflecting on the past 13 years of scholarly contributions to the CIT division of ASEE, this study finds several interesting results highlighting the division's significant impact and reach within the academic community. A noteworthy observation is the extensive participation of authors from a diverse set of 233 distinct institutions, exemplifying the wide trust and recognition that researchers place in the CIT division for disseminating their scholarly work. This wide institutional representation not only speaks to the division's prestige but also to its role as a key platform for academic discourse in computing and information technology.

Further emphasizing this point, an impressive number of 896 authors have demonstrated their continued trust and confidence in the CIT division by contributing multiple papers. This level of repeated engagement from authors shows the credibility and reliability of the CIT's peer-review system, fostering a robust environment for academic exchange and growth.

The range of download statistics observed in this study, spanning from a high of 27,404 to as few as 3 downloads per article, sheds light on the diverse appeal of the research articles accepted by the division. Such variability is indicative of the broad spectrum of topics and the varying levels of audience engagement, underscoring the division's commitment to inclusivity in research quality and relevance.

In contrast, the citation patterns show relatively modest citations to the articles, with a median of 1 citation per paper (and third quartile of only 3 citations), many of the papers, while highly viewed, or not having a substantial impact on scholarly discussions. The CIT section should hold discussions about how to increase citations to the research.

A comprehensive statistical analysis conducted as part of this research reveals a wide array of topics being explored within the CIT division, with a particularly strong emphasis on

"Technology-Enhanced and Innovative Learning." This area has seen the highest concentration of publications, highlighting the division's dedication to fostering research that is not only diverse but also at the forefront of educational innovation and technology integration in learning.

Finally, the utilization of advanced tools like ChatGPT in this study signifies a new way of understanding and leveraging research contributions. ChatGPT's role in categorizing and analyzing research papers has been instrumental in identifying prevailing trends and potential future areas for research. The adoption of AI tools in academic research has the potential to enrich analyses and opens doors to more efficient and expansive methods of exploring and understanding vast datasets.

This study, by examining 427 papers from the CIT division, underscores the division's role as an important platform for scholarly contributions in computing and information technology education. It also sets a precedent for the innovative use of AI tools like ChatGPT in enhancing research processes, thereby contributing to the ongoing evolution of academic research methodologies.

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