			In	terven	tions	s vs N	leas	urer	nent	ts						
	Grades		Engage	ement	Pref	ference	es .	Psyc	cholo	gical	Adm	nin		Stuc	lent	
								Fact	ors		Worl	kload		Wor	kload	
Binary	[6] [8] [17]	[26]	[6] [17]	[28]	[5] [6] [17]	[26]	[30]	[31]		[5] [6	5] [26]	[28]	[5] [6	6] [28]	[30]
Grading	[28] [30]	[31]			[28]	[30]	[31]				[31]			[31]	[33]	
	[33]				[33]											
Bucketed	[3] [13]	[14]	[3] [13]		[3]	[13]	[14]	[13]	[30]	[35]	[9]	[13]	[15]	[3]	[15]	[23]
Grading	[15] [23]	[26]			[15]	[21]	[26]				[26]	[34]		[30]	[34]	
	[30] [34]	[35]			[30]	[34]	35]									
	[36]															
Mastery	[1] [3] [6]	[7]	[1] [3]	[6] [7]	[3]	[4] [6]	[22]	[22]	[10]	[13]	[4] [6] [7]	[12]	[3] [6	6] [11]	[12]
Learning	[8] [22]	[10]	[12] [1	[17]	[10]	[11]	[13]	[19]	[30]	[31]	[13]	[15]	[18]	[15]	[18]	[23]
	[13] [15]	[17]	[18]	[24]	[15]	[17]	[19]				[19]	[26]	[28]	[25]	[27]	[28]
	[19] [23]	[24]	[27]	8] [37]	[21]	[24]	[25]				[31]			[30]	[31]	33]
	[25] [26]	[27]			[26]	[27]	[28]									_
	[28] [30]	[31]			[30]	[31]	[33]									
	[32] [33]				[37]											
Resubmissions	[2] [3] [6]	[22]	[2] [3]	[6] [12]	[2]	[3] [4]	[5]	[22]	[19]	[30]	[4] [5] [6]	[12]	[2]	[3] [5] [6]
	[15] [16]	[19]	[16]	[20]	[6]	[22]	[15]				[15]	[19]	[28]	[12]	[15]	[16]
	[20] [23]	[25]	[27]	8] [37]	[16]	[19]	[20]				[34]			[20]	[23]	[25]
	[27] [28]	[29]			[21]	[25]	[27]							[27]	[28]	[30]
	[30] [34]				[28]	[29]	[30]							[34]		
					[34]	[37]										
Minimum	[2]		[2]		[2]									[2]		
Grades																
Student input	[15] [30]				[15]	[30]		[30]			[15]			[15]	[30]	
on grade																

Populations vs Interventions

Populations vs Interventions										
	Binary Grading	Bucketed	Mastery	Resubmissions	Minimum	Student input				
		Grading	Learning		Grades	on grade				
K-12			[22]	[22]						
Undergraduate		[35] [36]	[7] [10] [11] [12] [13] [15] [17] [18] [19] [21] [23] [24]	[6] [12] [15] [16] [19] [20] [21] [23] [25]		[15] [30]				
			[32] [33] [37]							
Instructors	[28]	[9] [34]		[4] [28] [34]						
Introductory Course	[8] [33]	[9] [21] [23]	[1] [4] [7] [8] [10] [18] [21] [23] [24] [27] [33]	[4] [21] [23] [27] [29]						
Gender	[6]	[23]	[6] [23]	[6] [23]						
Race	[6]	[23]	[6] [23]	[6] [23]						
Accecssibility	[8]		[8]	[2]	[2]					

Populations vs Interventions

Populations vs Interventions													
	Binary	y Grad	ding	Buc	keted		Mast	ery		Resubm	nissions	Minimum	Student input
				Grad	ding		Learn	ning				Grades	on grade
K-12							[22]			[22]			
Undergraduate		[30]	[33]	[36] [34]	[35] [30] [21] [26] [9	[23] [15]	[13] [26] [31] [27] [10] [37] [23] [[28] [32]	[24] [19] [18] [4] [12] [33]	[27] [2 [25] [2	[30] [21] [2] [29] [4] [12]		[15] [30]
Instructors	[28]			[34]	[9]		[4] [2		-] [.]	[4] [34]	[28]		
Introductory Course	[8] [3	3]				9]	[24] [10] [18] [7]	[4] [27]	_		1 [27]		
Gender	[6]			[23]			[23]	6]		[23] [6]			
Race	[6]			[23]			[23]	6]		[23] [6]			
Accecssibility	[8]						[8]			[2]		[2]	

Higher Education (2023), 1–44. 2] Karina V. Assiter. 2023. Integrating Grading for Equity Practices into Project-Based Computer Science Curriculum. *ACM Inroads* 14, 1 (feb 2023), 2229. https://doi.org/10.1145/3582559

Claudio Alvarez, Maira Marques Samary, and Alyssa Friend Wise. 2023. Modularization for mastery learning in CS1: a 4-year action research study. Journal of Computing in

Elisa Baniassad, Alice Campbell, Tiara Allidina, and Asrai Ord. 2019. Teaching Software Construction at Scale with Mastery Learning: A Case Study. In Proceedings of the 41st

Austin Cory Bart, Allie Sarver, Michael Friend, and Larry Cox II. 2019. PythonSneks: An Open-Source, Instructionally-Designed Introductory Curriculum with Action-Design

Research. In Proceedings of the 50th ACM Technical Symposium on Computer Science Education (SIGCSE '19). Association for Computing Machinery, New York, NY, USA,

Andrew Berns. 2020. Scored out of 10: Experiences with Binary Grading Across the Curriculum. In Proceedings of the 51st ACM Technical Symposium on Computer Science

Kathryn Bridson and Scott D. Fleming. 2021. Frequent, Timed Coding Tests for Training and Assessment of Full-Stack Web Development Skills: An Experience Report. In

Jennifer Campbell, Andrew Petersen, and Jacqueline Smith. 2019. Self-Paced Mastery Learning CS1. In Proceedings of the 50th ACM Technical Symposium on Computer

Proceedings of the 52nd ACM Technical Symposium on Computer Science Education (SIGCSE '21). Association for Computing Machinery, New York, NY, USA, 2430.

International Conference on Software Engineering: Software Engineering Education and Training (ICSE-SEET '19). IEEE Press, 182191. https://doi.org/10.1109/ICSE-SEET.2019.00027

Education (SIGCSE '20). Association for Computing Machinery, New York, NY, USA, 11521157. https://doi.org/10.1145/3328778.3366956

Science Education (SIGCSE '19). Association for Computing Machinery, New York, NY, USA, 955961. https://doi.org/10.1145/3287324.3287481

307313. https://doi.org/10.1145/3287324.3287428

https://doi.org/10.1145/3408877.3432549

https://doi.org/10.1145/3287324.3287367

Article 1 (sep 2016), 35 pages. https://doi.org/10.1145/2934697

https://doi.org/10.1109/FIE44824.2020.9273889

https://doi.org/10.1145/3287324.3287502

2021), 3040.

|17|

|25|

|35|

International Conference on Learning and Teaching in Computing and Engineering (LATICE '15). IEEE Computer Society, USA, 197203.

https://doi.org/10.1109/LaTiCE.2015.18

[9] Marco Carmosino and Mia Minnes. 2020. Adaptive Rubrics. In Proceedings of the 51st ACM Technical Symposium on Computer Science Education (SIGCSE '20). Association for

Dino Capovilla, Marc Berges, Andreas Mühling, and Peter Hubwieser. 2015. Handling Heterogeneity in Programming Courses for Freshmen. In Proceedings of the 2015

Computing Machinery, New York, NY, USA, 549555. https://doi.org/10.1145/3328778.3366946

[9] Rafael G. de Pontes, Dalton D. S. Guerrero, and Jorge C. A. de Figueiredo. 2019. Analyzing Gamification Impact on a Mastery Learning Introductory Programming Course. In

Proceedings of the 50th ACM Technical Symposium on Computer Science Education (SIGCSE '19). Association for Computing Machinery, New York, NY, USA, 400406.

- [11] Michael John Eagle and Tiffany Barnes. 2012. A Learning Objective Focused Methodology for the Design and Evaluation of Game-Based Tutors. In *Proceedings of the 43rd ACM Technical Symposium on Computer Science Education (SIGCSE '12)*. Association for Computing Machinery, New York, NY, USA, 99104. https://doi.org/10.1145/2157136.2157170
- [12] Sophie Engle and Sami Rollins. 2013. Expert Code Review and Mastery Learning in a Software Development Course. *J. Comput. Sci. Coll.* 28, 4 (apr 2013), 139147.

 [13] Kiko Fernandez-Reyes, Dave Clarke, and Janina Hornbach. 2018. The Impact of Opt-in Gamification on Students' Grades in a Software Design Course. In *Proceedings of the 21st*
 - ACM/IEEE International Conference on Model Driven Engineering Languages and Systems: Companion Proceedings (MODELS '18). Association for Computing Machinery, New York, NY, USA, 9097. https://doi.org/10.1145/3270112.3270118
 - Paul Gestwicki. 2018. Design and Evaluation of an Undergraduate Course on Software Development Practices. In *Proceedings of the 49th ACM Technical Symposium on Computer Science Education (SIGCSE '18)*. Association for Computing Machinery, New York, NY, USA, 221226. https://doi.org/10.1145/3159450.3159542. [5] Paul Gestwicki. 2021. Godot Engine and Checklist-Based Specifications: Revising a Game Programming Class for Asynchronous Online Teaching. *J. Comput. Sci. Coll.* 37, 4 (oct
- [16] Geoffrey L. Herman, Zhouxiang Cai, Timothy Bretl, Craig Zilles, and Matthew West. 2020. Comparison of Grade Replacement and Weighted Averages for Second-Chance Exams. In *Proceedings of the 2020 ACM Conference on International Computing Education Research (ICER '20)*. Association for Computing Machinery, New York, NY, USA, 5666. https://doi.org/10.1145/3372782.3406260

Ville Isomöttönen and Ville Tirronen. 2016. Flipping and BlendingAn Action Research Project on Improving a Functional Programming Course. ACM Trans. Comput. Educ. 17, 1,

Mehdi Jazayeri. 2015. Combining Mastery Learning with Project-Based Learning in a First Programming Course: An Experience Report. In Proceedings of the 37th International

Ramon Lawrence, Sarah Foss, and Tatiana Urazova. 2023. Evaluation of Submission Limits and Regression Penalties to Improve Student Behavior with Automatic Assessment

- Conference on Software Engineering Volume 2 (ICSE '15). IEEE Press, 315318.
 [19] Michael O. Lam and Dee A. B. Weikle. 2021. A Successful Online Systems Class Using Scaffolded Active Learning and Formative Assessment. J. Comput. Sci. Coll. 37, 3 (oct 2021), 132142.
- 21] Noel LeJeune. 2010. Contract Grading with Mastery Learning in CS 1. *J. Comput. Sci. Coll.* 26, 2 (dec 2010), 149156. 22] Wei Li Li-Chen Cheng and Judy C. R. Tseng. 2021. Effects of an automated programming assessment system on the learning performances of experienced and novice learners.

Systems. ACM Trans. Comput. Educ. 23, 3, Article 31 (jun 2023), 24 pages. https://doi.org/10.1145/3591210

- Interactive Learning Environments 0, 0 (2021), 1–17. https://doi.org/10.1080/10494820.2021.2006237

 [23] Albert Lionelle, Sudipto Ghosh, Marcia Moraes, Tran Winick, and Lindsey Nielsen. 2023. A Flexible Formative/Summative Grading System for Large Courses. In *Proceedings of*
- the 54th ACM Technical Symposium on Computer Science Education V. 1 (SIGCSE 2023). Association for Computing Machinery, New York, NY, USA, 624630.

 https://doi.org/10.1145/3545945.3569810

 [24] Brendan McCane, Claudia Ott, Nick Meek, and Anthony Robins. 2017. Mastery Learning in Introductory Programming. In Proceedings of the Nineteenth Australasian Computing

K. Clay McKell and Andrew Danowitz. 2020. Exploring the effect of standards-based grading on student learning. In 2020 IEEE Frontiers in Education Conference (FIE). 1–7.

Grace M. Mirsky. 2018. Effectiveness of Specifications Grading in Teaching Technical Writing to Computer Science Students. J. Comput. Sci. Coll. 34, 1 (oct 2018), 104110.

[27] Claudia Ott, Brendan McCane, and Nick Meek. 2021. Mastery Learning in CS1 - An Invitation to Procrastinate?: Reflecting on Six Years of Mastery Learning. In *Proceedings of the 26th ACM Conference on Innovation and Technology in Computer Science Education V. 1 (ITiCSE '21)*. Association for Computing Machinery, New York, NY, USA, 1824. https://doi.org/10.1145/3430665.3456321

Education Conference (ACE '17). Association for Computing Machinery, New York, NY, USA, 110. https://doi.org/10.1145/3013499.3013501

- [28] Kevin R. Sanft, Brian Drawert, and Adam Whitley. 2021. Modified Specifications Grading in Computer Science: Preliminary Assessment and Experience across Five Undergraduate Courses. J. Comput. Sci. Coll. 36, 5 (jan 2021), 3446.
 [29] Steven C. Shaffer. 2005. Ludwig: An Online Programming Tutoring and Assessment System. SIGCSE Bull. 37, 2 (jun 2005), 5660.
- https://doi.org/10.1145/1083431.1083464
 [30] Scott Spurlock. 2023. Improving Student Motivation by Ungrading. In *Proceedings of the 54th ACM Technical Symposium on Computer Science Education V. 1 (SIGCSE 2023)*.
- Association for Computing Machinery, New York, NY, USA, 631637. https://doi.org/10.1145/3545945.3569747

 31] Ella Tuson and Tim Hickey. 2022. Mastery Learning and Specs Grading in Discrete Math. In Proceedings of the 27th ACM Conference on on Innovation and Technology in
- [31] Ella Tuson and Tim Hickey. 2022. Mastery Learning and Specs Grading in Discrete Math. In *Proceedings of the 27th ACM Conference on on Innovation and Technology in Computer Science Education Vol. 1 (ITiCSE '22)*. Association for Computing Machinery, New York, NY, USA, 1925. https://doi.org/10.1145/3502718.3524766
- [32] Ella Tuson and Timothy Hickey. 2023. Mastery Learning with Specs Grading for Programming Courses. In *Proceedings of the 54th ACM Technical Symposium on Computer Science Education V. 1 (SIGCSE 2023)*. Association for Computing Machinery, New York, NY, USA, 10491054. https://doi.org/10.1145/3545945.3569853
- Science Education V. 1 (SIGCSE 2023). Association for Computing Machinery, New York, NY, USA, 10491054. https://doi.org/10.1145/3545945.3569853

 [33] Mark Urban-Lurain and Donald J. Weinshank. 1999. I Do and I Understand: Mastery Model Learning for a Large Non-Major Course. In The Proceedings of the Thirtieth SIGCSE Technical Symposium on Computer Science Education (SIGCSE '99). Association for Computing Machinery, New York, NY, USA, 150154.
- https://doi.org/10.1145/299649.299738

 [34] Robbie Weber. 2023. Using Alternative Grading in a Non-Major Algorithms Course. In *Proceedings of the 54th ACM Technical Symposium on Computer Science Education V. 1*
 - (SIGCSE 2023). Association for Computing Machinery, New York, NY, USA, 638644. https://doi.org/10.1145/3545945.3569765

 Dee A. B. Weikle, Michael O. Lam, and Michael S. Kirkpatrick. 2019. Automating Systems Course Unit and Integration Testing: Experience Report. In *Proceedings of the 50th*

ACM Technical Symposium on Computer Science Education (SIGCSE '19). Association for Computing Machinery, New York, NY, USA, 565570.

- [36] P. Young, V. Yip, and R. B. Lenin. 2012. Evaluation of Issue-Tracker's Effectiveness for Measuring Individual Performance on Group Projects. In *Proceedings of the 50th Annual Southeast Regional Conference (ACM-SE '12)*. Association for Computing Machinery, New York, NY, USA, 8994. https://doi.org/10.1145/2184512.2184534
- [37] Lucas Zamprogno, Reid Holmes, and Elisa Baniassad. 2020. Nudging Student Learning Strategies Using Formative Feedback in Automatically Graded Assessments. In *Proceedings of the 2020 ACM SIGPLAN Symposium on SPLASH-E (SPLASH-E 2020)*. Association for Computing Machinery, New York, NY, USA, 111. https://doi.org/10.1145/3426431.3428654