IT & Computing

Description and Learning Outcomes

Information technology and computing can significantly augment humans' ability to produce, consume, process, and communicate information. Thus, students need to understand ways to use such technology to enhance their lives, careers, and society, while being mindful of challenges such as security, source reliability, automation, and ethical implications. These factors have made it essential for students to understand how to effectively navigate the evolving technological landscape. IT courses offered in the majors may focus on disciplinary applications and concerns of information technology.

IT courses meet the following learning outcomes:[6]

1. **Principles and Ethics:** Students will understand the principles of information storage, exchange, security, and privacy and be aware of related ethical issues.
2. **Information Literacy:** Students will become critical consumers of digital information; they will be capable of selecting and evaluating appropriate, relevant, and trustworthy sources of information.
3. **Decision-making:** Students can use appropriate information and computing technologies to organize and analyze information and use it to guide decision-making.
4. **Algorithmic Methods:** Students will be able to choose and apply appropriate algorithmic methods to solve a problem.

Approved Courses and Enrollment

Students are required to pass one course approved for IT & Computing or transfer in an appropriate course. During the assessment period, 15 courses were approved to meet the IT & Computing requirement:

ANTH 395 Work, Technology, and Society: An IT Perspective
AVT 180 New Media in the Creative Arts
CDS 130 Computing for Scientists
CS 100 Principles of Computing
CS 112 Introduction to Computer Programming
GOVT 300 Research Methods and Analysis
HIST 390 The Digital Past
INTS 249 Digital Literacy
INTS 345 Introduction to Multimedia

[6] It should be noted that IT & Computing learning outcomes were revised for the AY19 Catalog.

INTS 445 Multimedia Design
IT 104 Introduction to Computing
MIS 303 Introduction to Business Information Systems
MUSI 259 Music in Computer Technology
PHYS 251 Introduction to Computer Techniques in Physics
SOCI 410 Social Surveys and Attitude and Opinion Measurements

IT & Computing courses now enroll almost 7,000 students each year with an average class size that ranges from 14 students in PHYS 251 to 69 in CS 112 lecture (see Table 13). The median section size across courses was 42 from AY15-19. See Figure 26 for five-year enrollment trends.

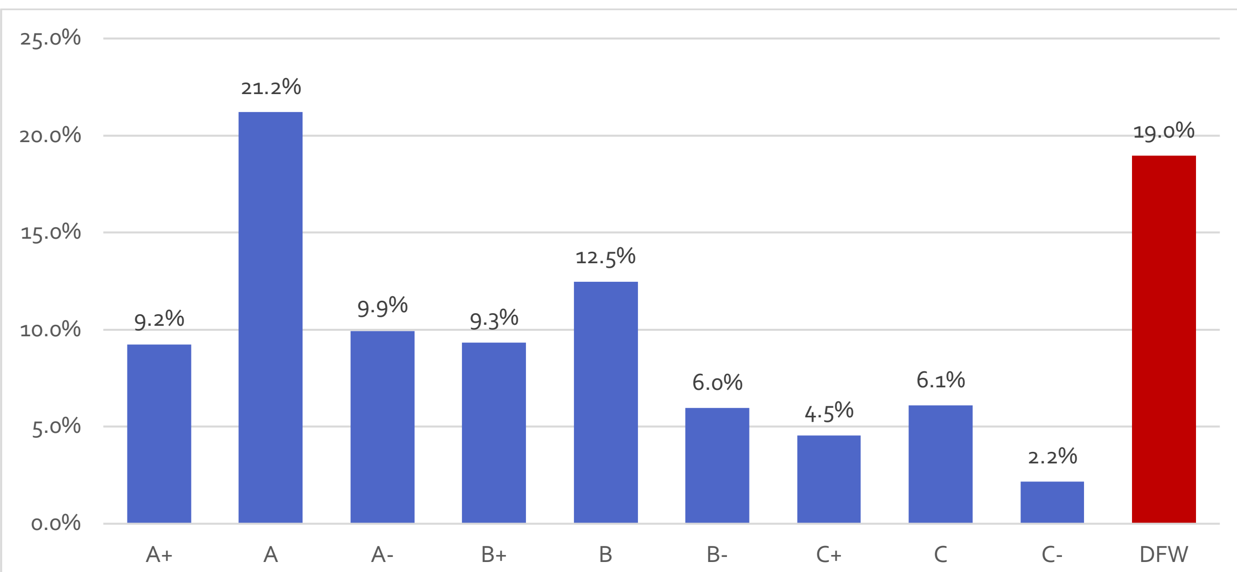
Courses Included in Assessment

The assessment period included 64 sections of Mason Core IT & Computing courses taught in spring 2019, for which 80% submitted materials.

Enrollment and Grades Distribution

A total of 3,150 students enrolled in IT & Computing courses in the assessment period. Of these students, 78.8% passed their courses with a C or above (see Figure 22). It should be noted that the DFW rate is exceptionally high for Mason Core courses overall.

Figure 22. Grades Distribution for Mason Core IT & Computing Courses, Spring 2019



Assessment Methods

Student work samples were requested from all course sections taught in the assessment period. Faculty were asked to submit samples that represented student submissions completed in the final third part of the semester and that allowed students to demonstrate their learning on one or more of the expected course learning outcomes. Samples were selected using randomized course enrollment lists to insure the best possible representative sample. Samples included writing, design, and coding projects of varying levels of complexity.

The **Mason Core Rubric for Evaluating Student Work in IT & Computing Courses** was used for this assessment. The rubric was developed by Mason faculty as a tool to assess individual student work on five learning tasks or outcomes, with a sixth outcome added for pilot-testing. The rubric uses four performance descriptors: Benchmark, Emerging Milestone, Advanced Milestone, and Capstone, as well as an option for "no evidence." The performance descriptors are developmental, identifying student performance levels in a context of learning and growth. The rubric is intended to be used across all of the years of a student's college experience, and is not limited to a single course, assignment, or student class level.

Using a process modeled after the VALUE Institute reviewer calibration, faculty reviewers were trained to use the rubric to assess student work. Reviews were normed to produce consistent ratings across reviewers. Reviewers met for an in-person, one-day training and review session and completed the reviews of student work by the end of the day. Reviewers were faculty members who have taught Mason Core IT & Computing courses. Reviewers earned a small stipend for their efforts. Most of the work samples were assessed twice; a shortage of reviewers on review day did not allow for two reviews for every sample.

Learning Outcomes Assessment Results

Figures 23 and 24 display results from ratings of 321 ratings. Figure 23 includes "no evidence" ratings; a rating of "no evidence" was used when the learning outcome could not be seen in the sample; this could mean that either the assignment did not require application of the outcome, or that the student did not demonstrate it. A "no evidence" rating provides important information in aggregate but is given no value for an individual sample. Note that Outcome 1, **Principles and Ethics**, was divided into two outcomes on the rubric.

Figure 23. Assessment Results, Aggregated, including "No Evidence" Ratings

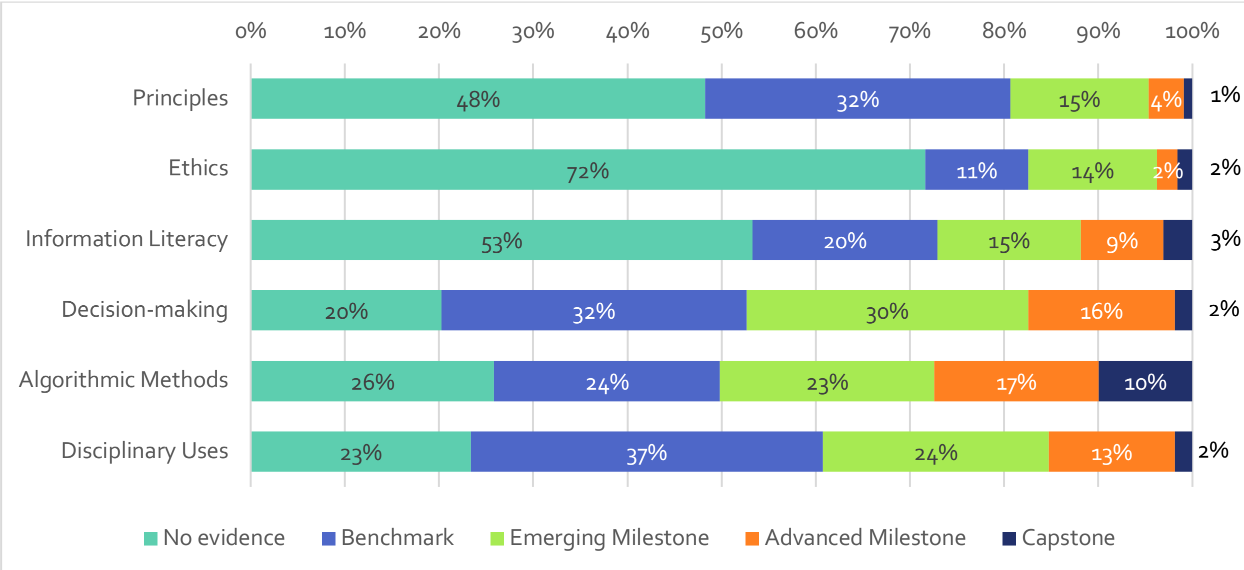
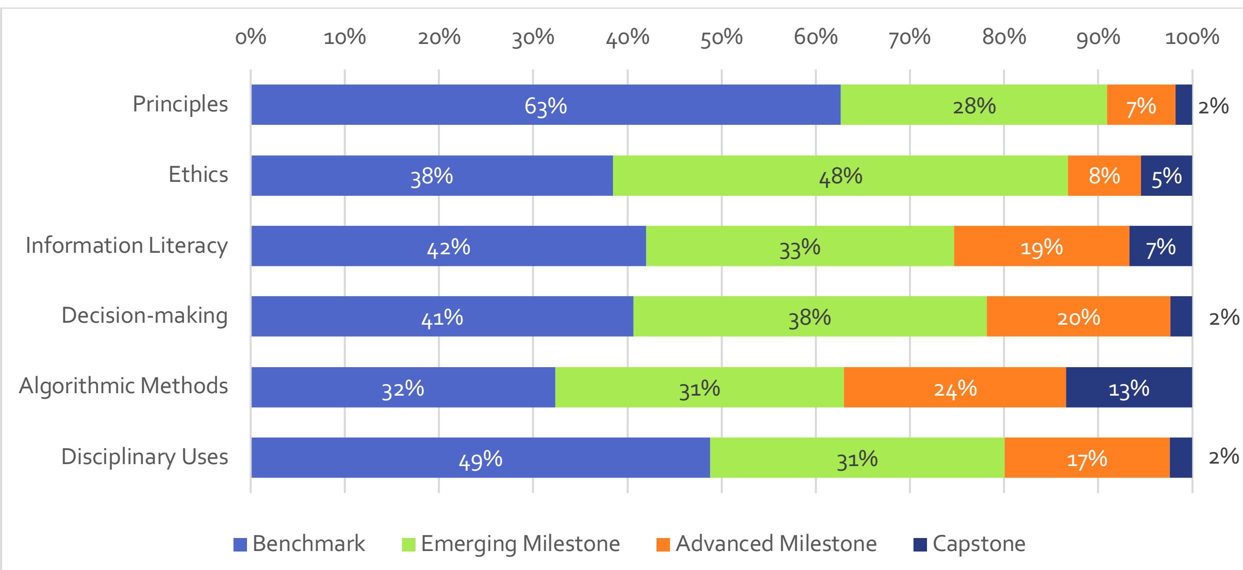


Figure 24. Assessment Results, Aggregated, excluding "No Evidence" Ratings



Highlights from Analysis of Results

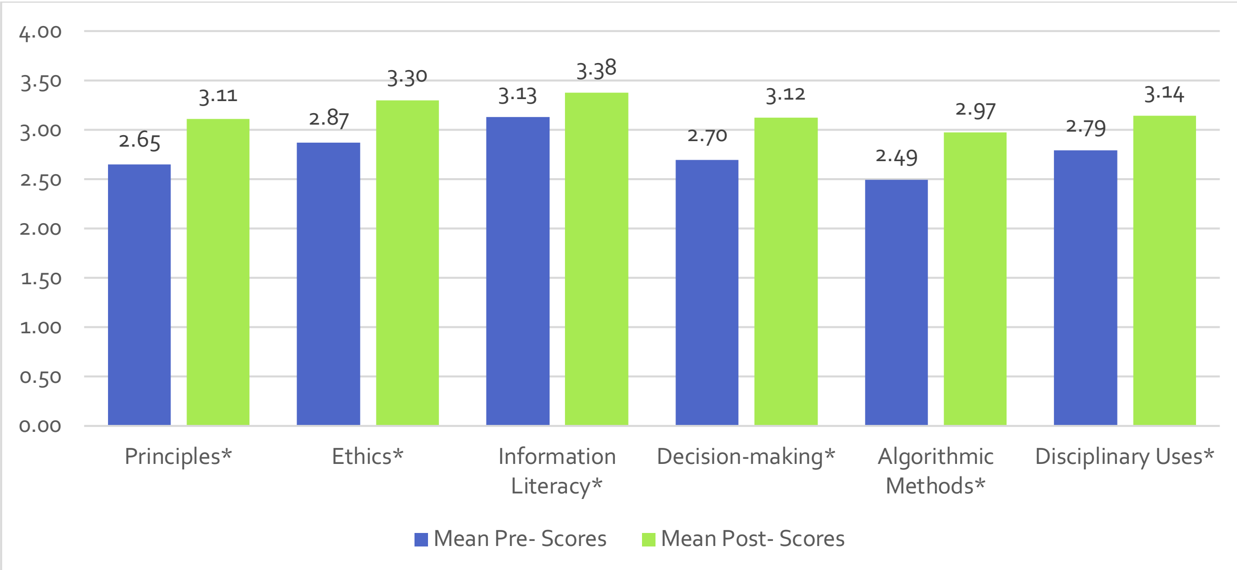
Data were analyzed to ascertain differences among courses in achieving the five learning outcomes. Comparison tests were conducted using nonparametric statistics because rubric data are ordinal; Independent-Samples Mann-Whitney U, ($p < .05$) was used when analyzing differences between two groups, and Independent-Samples Kruskal–Wallis H test was used to analyze differences across three or more groups or courses. "No evidence" was treated as missing. Significant findings (p <.05) are noted below.

- Work samples were most likely to show evidence of **Decision-making**; **Algorithmic Methods**; and additional Outcome 5, Use digital resources, methods and software, or forms of communication relevant to the work of their discipline.
- Work samples were least likely to show evidence of **Principles and Ethics** and **Information Literacy.**
- In a comparison between lower-division and upper-division courses, differences were significant for all outcomes except for **Information Literacy**. Ratings were higher for work samples in lower- or upper-division courses, depending on the outcome. See Table 14 for test information.
    - **Principles**: Upper-division rated higher
    - **Ethics**: Lower-division rated higher
    - **Information Literacy**: No difference
    - **Decision-making**: Upper-division rated higher
    - **Algorithmic Methods**: Lower-division rated higher
    - **Disciplinary uses**: Lower-division rated higher
- Breaking down the results for each outcome by course within upper- and lower-division groupings, Kruskal-Wallis H tests found significant differences among courses in both groupings. See Tables 15-16. This likely reflects the variations in expectations for assignments rather than student performance, but this is inconclusive.

Student Self-Assessment

All students who were enrolled in a Mason Core IT & Computing course during the assessment period received an online self-assessment survey at the end of the semester. The retrospective pre-post self-assessment asked students to rate their knowledge and skills on six learning outcomes at the beginning of the semester (pre), and then again at the end of the semester (post). In total, 277 students completed both the pre and post items, resulting in a 11.7% response rate. A t-test pairwise comparison showed significant perceived learning gains on all six outcomes (see Figure 25).

Figure 25. Mean Scores on Student Learning Self-Assessment



Mean scores, self-reported on a scale of 1-4, n=277, * $p < .05$

How do the Results Meet Expectations?

Because this was the first time that Mason used this rubric to assess student work, these data provide baseline information. More than half (56%) of samples were from lower-division courses, which suggests that at least half of the samples should be rated at the Benchmark and Emerging levels. Faculty noted that although 44% of samples are from upper-division courses, course concept may be introductory for many students, thus, we see lower overall scores.

This assessment used student work samples and did not evaluate entire courses, so it is not clear how well-covered the outcomes might be across the IT & Computing category. However, the large percentage of "no evidence" ratings could suggest that those outcomes may not receive sufficient attention in terms of instruction and assessment.

How are Results Being Used to Improve Students' Educational Experience?

Data analysis was completed at the writing of this report, and results have not yet been shared with faculty. In pre-assessment workshops, faculty were encouraged to use the assessment rubric in their course and assignment design.

Limitations of this Assessment

Overall, this rubric may not be the most effective way to assess learning in the IT & Computing courses. The rubric did not align well with most work samples—many of which required discipline experts to review lines of code—and it was challenging to see the relevance across all types of courses. The rubric may be better used as a curriculum and student assignment planning tool rather than a work sample assessment tool.

Assessment Rubric(s)

The **Mason Core Rubric for Evaluating Student Work in IT & Computing** was developed by a team of Mason IT & Computing faculty to evaluate student work for the Mason Core learning outcomes in IT & Computing. The rubric was modeled after the AAC&U VALUE rubrics, and was informed by the University of Delaware initiative on Computational Thinking (Guidry, Mouza, Pollock, & Pusecker, 2019). The rubric was designed to evaluate student performance on five learning outcomes and an additional sixth "test" outcome for disciplinary applications. The rubric identifies four increasingly sophisticated performance descriptors for each outcome. The rubric can be used with many types of written work. Most student work will not show evidence of all outcomes; in this case, an additional category for "no evidence" should be made available.

Table 13. Enrollment in Mason Core IT & Computing Courses by Course, AY2015-19

	AY2015		AY2016		AY2017		AY2018		AY2019	
	#Course Sections	**Enroll**	**#Course Sections**	**Enroll**	**#Course Sections**	**Enroll**	**#Course Sections**	**Enroll**	**#Course Sections**	**Enroll**
AVT 180	17	313	16	285	18	341	19	358	21	392
CDS 130	9	430	13	560	15	620	18	654	21	685
CS 100	2	75	3	104	2	84	3	121	1	40
CS 112	12	872	17	1,060	17	1,082	19	1,229	15	1,304
GOVT 300	8	245	6	275	6	313	9	321	10	328
HIST 390	7	284	7	289	8	328	9	353	10	410
INTS 203					2	34	2	50	2	48
INTS 249									2	47
INTS 345									4	92
IT 103	31	1,959	5	183						
IT 104			26	1,590	30	1,651	27	1,684	30	1,741
MIS 303			16	470	24	1,026	28	1,572	33	1,754
MUSI 259	2	89	2	98	2	99	2	105	2	118
PHYS 251			1	18	2	18	2	27	2	34
TOTAL	**86**	**4,178**	**67**	**2,756**	**68**	**2,802**	**79**	**3,086**	**86**	**3,346**

Figure 26. Five-Year Enrollment Trends in Mason Core IT & Computing Courses, AY2015-19

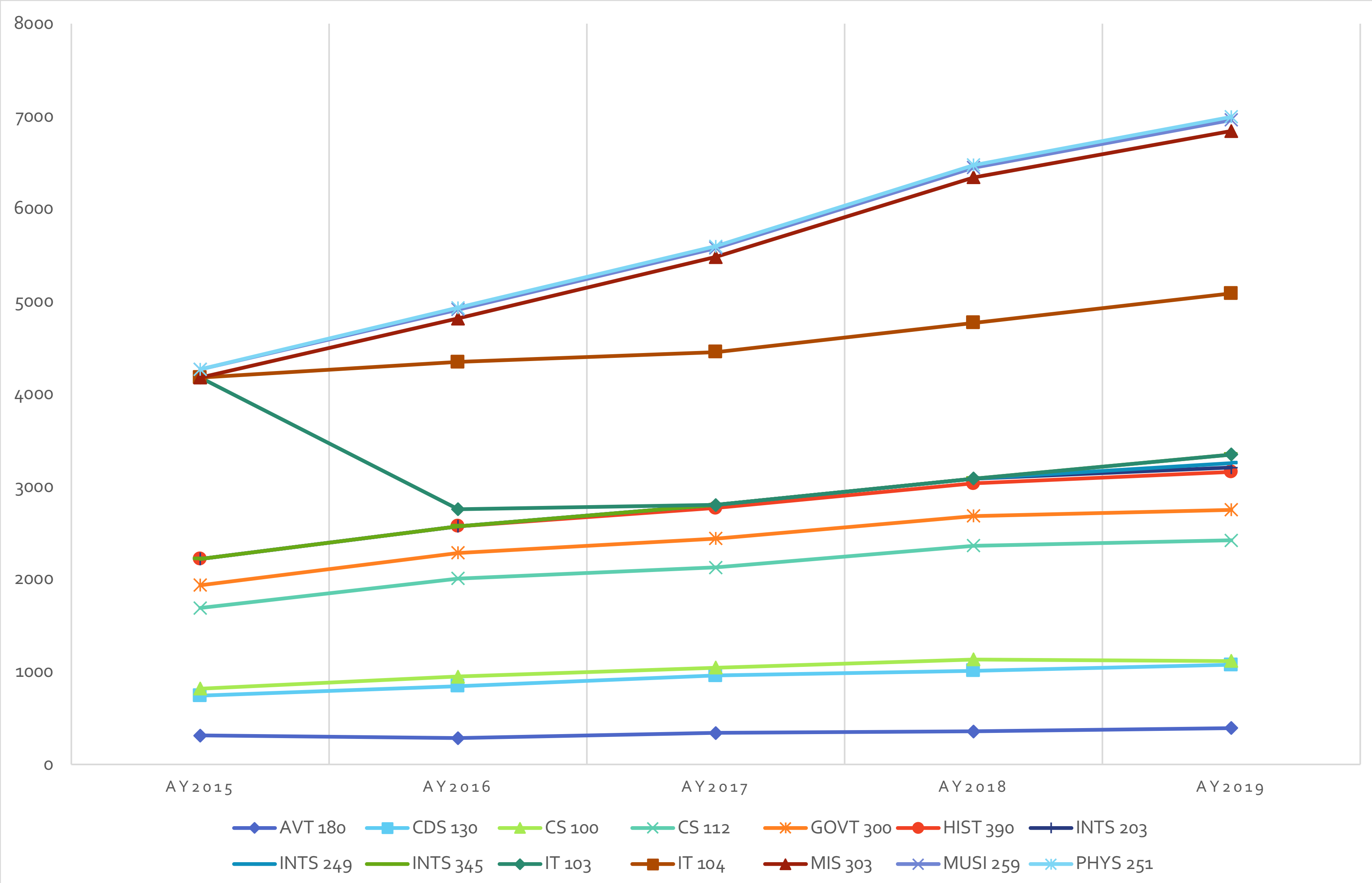


Table 14. Mann-Whitney U Test: Comparison of Rubric Ratings, Lower-Division IT vs. Upper-Division IT in the Major

	Mean Rank (n)					
	Lower	Upper	*U*	Z	p	Sig.
Principles	73.16 (97)	98.04 (69)	4349.500	-3.844	0.000	*
Ethics	52.21 (56)	36.06 (35)	632.000	-3.117	0.002	*
Information Literacy	78.19 (72)	73.02 (78)	2614.500	-0.774	0.439	
Decision-making	116.19 (134)	142.02 (122)	9824.000	-2.985	0.003	*
Algorithmic Methods	149.46 (128)	84.63 (110)	3204.500	-7.544	0.000	*
Disciplinary Uses	141.11 (131)	103.44 (115)	5226.000	-4.498	0.000	*

Table 15. Kruskal-Wallis H Test for Differences in Upper-Division Courses

	Course	**n**	**Mean Rank**	**Kruskal-Wallis H**	**df**	**p**	**Sig.**
Principles	GOVT 300	5	16	8.342	2	0.015	*
	HIST 390	10	28				
	MIS 303	54	38.06				
Ethics	MIS 303	27	20.37	8.483	2	0.014	*
Information Literacy	HIST 390	14	35.29	18.493	2	0.000	*
	MIS 303	56	38.39				
Decision-making	INTS 345	5	76	2.907	2	0.234	
	GOVT 300	5	86.4				
	HIST 390	18	60.44				
	MIS 303	99	60.43				
Algorithmic Methods	GOVT 300	5	86.5	7.404	2	0.025	*
	HIST 390	13	62.54				
	MIS 303	92	52.82				
Disciplinary Uses	GOVT 300	5	93.9	24.249	2	0.000	*
	HIST 390	23	77.24				
	MIS 303	87	50.85				

Table 16. Kruskal-Wallis H Test for Differences in Lower-Division Courses

	Course	n	Mean Rank	Kruskal-Wallis H	df	p	Sig.
Principles	AVT 180	37	40.05	32.35	4	0.000	*
	CDS 130	19	73.16				
	CS 112	26	45.75				
	IT 104	14	46.75				
Ethics	CDS 130	11	43.82	16.36	4	0.003	*
	IT 104	39	23.99				
Information Literacy	AVT 180	10	39.6	9.851	4	0.043	*
	CDS 130	14	47.43				
	IT 104	42	33.44				
Decision-making	AVT 180	37	52.08	47.679	5	0.000	*
	CDS 130	23	95.48				
	CS 112	35	61.8				
	IT 104	30	55.07				
Algorithmic Methods	PHYS 251	6	123	47.845	4	0.000	*
	AVT 180	40	44.86				
	CDS 130	25	76.96				
	CS 112	38	84.32				
	IT 104	18	34.28				

Mason Core Rubric for Evaluating Student Work in IT and Computing Courses

This rubric was developed by a team of faculty experts to evaluate student work for the Mason Core learning outcomes in IT and Computing. For more information about the learning outcomes and approved courses, see: https://masoncore.gmu.edu/information-technology-1/

How to use this rubric: This rubric was designed to evaluate student performance on five learning outcomes, with four increasingly sophisticated performance descriptors for each outcome, potentially spanning student development from introductory to advanced (senior level) performance. This rubric can be used with many types of student work from courses approved for the Mason Core IT and Computing category. Most student work will not show evidence of all outcomes; in this case, an additional category for "no evidence" should be made available.

Student Learning Outcomes	**Level of Performance**			
	Capstone	**Advanced Milestone**	**Emerging Milestone**	**Benchmark**
Students will understand the principles of digital information storage and exchange	Applies principles of digital storage and transfer to solve problems in digital information storage, sharing, and retrieval (e.g. design a database or an information retrieval system using a cloud-based platform)	Explains how computers effectively store information and data in a digital format, and how that information can be retrieved; identifies common problems with data storage and retrieval and the roles computer hardware and software play in creating or addressing these problems	Explains terms and concepts associated with digital information storage and exchange; identifies common technologies for storing and sharing data (e.g. databases or cloud services)	Identifies terms and concepts associated with digital information storage and exchange (e.g. binary and bit logic, hierarchical structures, number systems, text and image encoding, simple communication protocols, query formats, etc.)
Students will understand basic issues of computer security, and privacy and be aware of related ethical concerns.	Demonstrates sophisticated understanding of issues governing computer security, privacy and ethics; can analyze situations and propose appropriate solutions for responsible uses of information technology and electronic resources	Offers complex discussion of issues related to acceptable and responsible use of information and communication technology; evaluates strategies that demonstrate ethical, legal, and socially responsible uses of information technology and electronic resources	Discusses issues related to acceptable and responsible use of information and communication technology; analyzes the consequences of unethical use (e.g. hacking, spamming, consumer fraud, malware, viruses, etc.) of information and computer technology and identifies methods for addressing these risks	Identifies and discusses terms and concepts associated with safe use of the information and communication technology (e.g. password, multi-factor authentication, firewall, spam, security, fair use, acceptable use); identifies examples of ethical and unethical behaviors

Mason Core Rubric for Evaluating Student Work in IT and Computing Courses

	Capstone	**Advanced Milestone**	**Emerging Milestone**	**Benchmark**
Students will become critical consumers of digital information; they will be capable of selecting and evaluating appropriate, relevant, and trustworthy sources of information.[1]	Builds contextual justification for the use of a particular information source, taking into account factors such as credibility, reliability, currency, and information purpose; analyzes own and others' assumptions	Fully appraises information sources on a variety of criteria; considers multiple factors such as currency, author credibility, bias, perspective, and intended purpose of information source	Shows distinction between sources and their relevancy to the research project; evaluates sources based on authority and bias, but evaluation may be inconsistent	Selects sources with elementary critical evaluation (such as whether source has a PhD)
Students can use appropriate information and computing technologies to organize and analyze information and use it to guide decision-making.	Evaluates multiple technologies appropriate to the project and organizes the information so that it is well-defined, consistent, complete, and easily examined and analyzed; uses technology to conduct a full or advanced analysis of the data and make recommendations for its use	Evaluates and chooses information technology appropriate to the project, and uses that technology to organize the information so that it is defined, consistent, complete; uses technology to conduct an analysis of the data and make recommendations for its use	Uses information technology to organize information so that it is defined, mostly consistent and complete, and able to be analyzed	Uses information technology to organize information so that it can be examined or reviewed
Students will be able to choose and apply appropriate algorithmic[2] methods to solve a problem.[3]	Creates a logical, efficient, and well-described sequence of steps or instructions to solve a problem or achieve a goal	Creates a logical sequence of steps that are well-described, and solve a problem or achieve a goal, though the steps may inefficient	Creates a logical sequence of steps that solve a problem, but the steps are poorly described	Uses a preselected sequence of steps (algorithm) to solve a problem

[1] Thanks to Champlain College, Technology & Information Literacy Developmental Rubric (December 2014), retrieved from https://www.slideshare.net/acarbery/info-lit-developmental-rubric

[2] **Algorithmic Thinking:** Essentially, breaking a problem into a concise set of steps to conceptualize a solution. Using an algorithmic method asks the thinker to create a series of ordered steps to solve a problem or achieve a goal.

[3] Thanks to the University of Delaware, Computational Thinking Rubric, retrieved from https://cpb-us-w2.wpmucdn.com/sites.udel.edu/dist/4/8672/files/2018/12/Computational-Thinking-Rubric-2ktkkgv.pdf

Mason Core Rubric for Evaluating Student Work in IT and Computing Courses

Disciplinary Applications Outcome

The final outcome was developed by faculty to test its application in courses that teach information technology principles, methods, software, or scholarly communication in a disciplinary context and application; for instance, courses in digital humanities or art and design. As part of this assessment rubric, the outcome is meant to offer a different lens for thinking about how students learn to use information technology as a tool of inquiry and communication in their creative and scholarly work.

Student Learning Outcome	Level of Performance			
	Capstone	Advanced Milestone	Emerging Milestone	Benchmark
Students will be able to use digital resources, methods and software, or forms of communication relevant to the scholarly or creative work of their discipline.	Students should be able to do one or more of the following: effectively choose from, combine, and critique digital resources common to the discipline; master frequently used software that enables disciplinary methods according to disciplinary standards; effectively communicate or collaborate using information technology common to the discipline for tasks that require mastery.	Students should be able to do one or more of the following: effectively choose from and combine digital resources common to the discipline; correctly use software that enables advanced disciplinary methods for a range of tasks; communicate or collaborate using information technology common to the discipline for advanced tasks.	Students should be able to do one or more of the following: effectively choose from digital resources common to the discipline; use software that enables disciplinary methods for tasks of intermediate difficulty; communicate or collaborate using information technology common to the discipline for intermedia tasks.	Students should be able to do one or more of the following: use a resource common to the discipline; perform basic tasks in frequently used software that enables disciplinary methods; communicate or collaborate in basic ways using information technology common to the discipline.