

GULL Week 2021 - Test of Scientific Literacy Skills (TOSLS)

The Test of Scientific Literacy Skills was administered to Salisbury University students in September of 2021 as part of Gaining Understanding for Lifelong Learning, or G.U.L.L., Week.

Outcome(s) – The TOSLS measures the primary outcome of Scientific Reasoning, among [Salisbury University’s General Education student learning outcomes](#). Additionally, the TOSLS requires quantitative literacy for the performance of computations and the interpretation of data in tables and graphs.

1. Scientific Reasoning – Students will be able to identify and use empirical evidence to describe/explain and predict natural phenomena through application of the scientific method; and use scientific principles to design, evaluate, and implement strategies to answer open-ended questions.
2. Quantitative Reasoning - Students will be able to interpret models and/or solve quantitative problems from different contexts with real-world relevance; create and communicate reasonable arguments supported by quantitative evidence; and clearly communicate those arguments in effective formats (e.g., using words, tables, graphs, and mathematical equations).

Table 1

Instrument	Questions	Scale/Subscale
Test of Scientific Literacy Skills (TOSLS), Gormally et al. ¹	28 questions, multiple choice	See Table 5

Scoring & Benchmarking

N=472 Total TOSLS participants in fall 2021; 409 submitted quality data (87% of total; N=63 submitted poor quality data). Quality data was determined by self-reporting from students in the motivation survey, incomplete test results, and insufficient time spent on the assessment.

Table 2

All Participants with Quality Data (N)	Mean Correct of 28 (%)	Median Correct	Standard Deviation	Lowest/Highest Score (of 28)	Mean Cumulative GPA
Overall (409)*	15.56 (55.57)	16	5	4/27	3.24
First-year (109)	13.73 (49.04)	14	4.75	5/26	3.05
Sophomore (104)	15.47 (55.25)	16	5.1	6/26	3.29
Junior (88)	16.77 (59.89)	17	5.44	5/27	3.36
Senior (89)	16.18 (57.79)	16	4.99	4/25	3.31
First-time Students (373)**	15.47 (55.25)	16	5.08	4/27	3.25
Transfer (27)	15.33 (54.75)	15	6.27	5/25	3.24

*Includes non-degree seeking students and students earning a second bachelor’s degrees.

**First-time students at the time of enrollment at SU.

A fall 2011 administration, pre- and post-, at three types of undergraduate institutions helps to establish a baseline comparison profile for SU: a large public research university (very high research activity), a large private research university (very high research activity), and a midsized state college (masters-granting). Salisbury University’s institutional profile (medium-sized, regional public university) makes it most appropriate for comparison to nonmajors’ results from the public research university below.

¹ Gormally, C., Brickman, P., & Lutz, M. (2012). Developing a test of scientific literacy skills (TOSLS): Measuring undergraduates’ evaluation of scientific information and arguments. *CBE—Life Sciences Education*, 11(4), 364-377. Retrieved from: <https://www.lifescied.org/doi/10.1187/cbe.12-03-0026>

Table 3

Institution (N)	Mean % Correct - Pre-test	Mean % Correct - Post-test	GPA	% of male participants
Salisbury University Overall (409)	55.59*	N/A	3.24	30.56 (125)
Public research university – traditional nonmajors (296)	58.33	64.45	3.53	26.4
Public research university – biology majors (544)	61.72	67.13	3.27	40.1
Private research university - nonmajors (50)	84.63	84.95	3.62	32
Midsized state college - nonmajors (80)	44.29	42.50	Not reported	28.78

*GULL Week does not follow a pre- and post-testing model; pre- and post-test scores for other institutions reflect student performance before and after taking a biology course at those institutions.

Participant Demographics

Table 4

Race/Ethnicity	N (%)
Black	43 (11)
White	307 (75)
Asian/Pacific Islander	21 (5)
Hispanic	8 (2)
American Indian/Alaskan Native	5 (1)
Unknown/More than one race	14 (3)
Foreign	11 (3)

Discussion

Results from the 2021 administration of the TOSLS show Salisbury University students improving on the assessment as they progress through their studies, with first-year students and sophomores scoring lower on average than juniors and seniors. The learning gain is significant from first-year to sophomore year, with students' average score jumping by nearly 2 points (out of 28 total). Curiously, seniors in this sample score slightly lower than juniors. First-time students score slightly higher than transfer students on the TOSLS, which raises the possibility that students doing their undergraduate general education science courses at other institutions are not getting the same quality educational experience and outcomes as students who take their undergraduate science courses at Salisbury University.

Salisbury University is a midsized, public regional university whose non-science major students scored 3 percentage points less than nonmajors (.84 questions of 28) at a public research university with very high research activity (R1).² SU students in 2021 had a mean percentage of correct answers that was more than 10 percentage points higher than those of a midsized state college's (master's degree-granting) students when assessed in 2011. SU's institutional profile fits somewhere in between the large public research university and the midsized state college, with SU students' performance on the TOSLS nearing that of the large, public research university.

The TOSLS subscales (see Table 5 below) show SU students are most proficient in Skills 1 ("Identify a valid scientific argument"), 3 ("Evaluate the use and misuse of scientific information"), and 6 ("Read and interpret graphical representations of data"). Students need the most learning and practice in subskills 2 ("Conduct an effective literature search"), 5 ("Make a graph"), and 8 ("Understand and interpret basic statistics").

² American Council on Education (2024). *Basic classification*. Retrieved August 27, 2024 from <https://carnegieclassifications.acenet.edu/carnegie-classification/classification-methodology/basic-classification/>

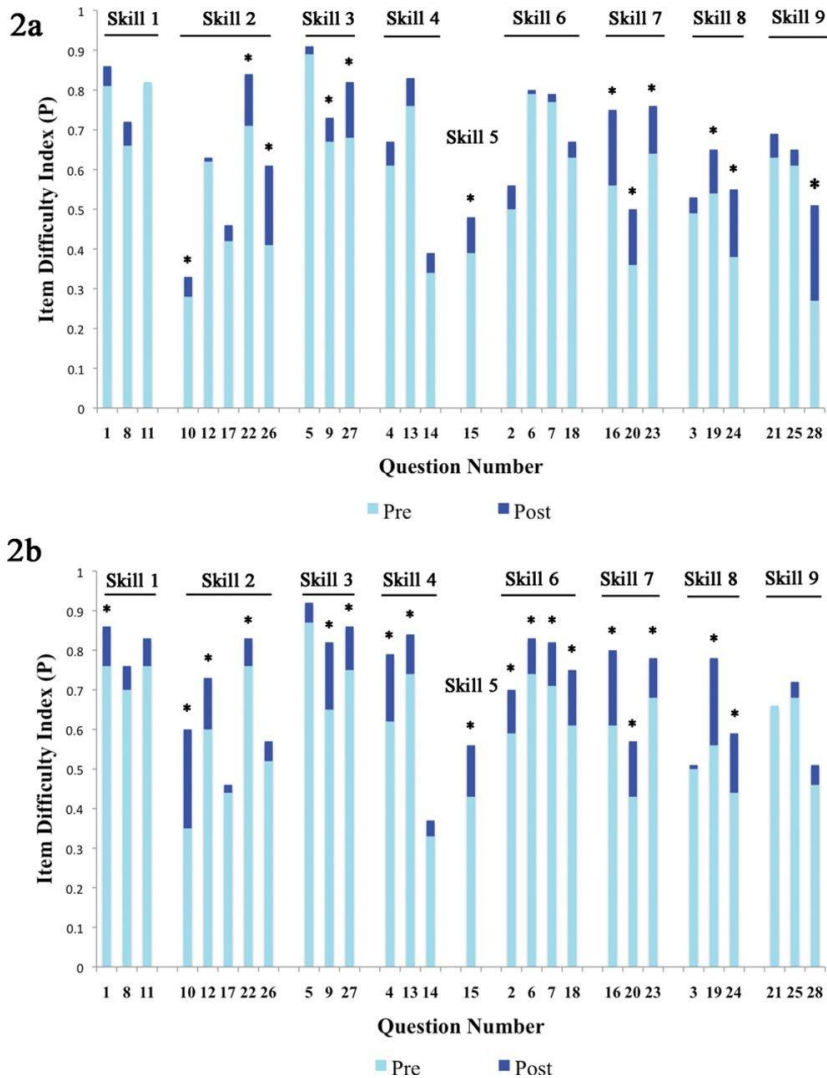
Table 5

SKILL	SUBSSCALES DESCRIPTIONS	Question	Correct Answer	# of SU Students answering correction (%)
1 (3 Qs)	Identify a valid scientific argument (e.g., recognizing when scientific evidence supports a hypothesis)	1	B	254 (62)
		8	D	265 (65)
		11	B	278 (68)
2 (5 Qs)	Conduct an effective literature search (e.g. Evaluate the validity of sources [e.g., websites, peer reviewed journals] and distinguish between types of sources)	10	B	191 (47)
		12	C	181 (44)
		17	B	201 (49)
		22	C	239 (58)
		26	C	211 (52)
3 (3 Qs)	Evaluate the use and misuse of scientific information (e.g. Recognize a valid scientific course of action, distinguish the appropriate use of science to make societal decisions)	5	D	322 (79)
		9	B	278 (68)
		27	B	323 (79)
4 (4 Qs)	Understand elements of research design and how they impact scientific findings/conclusions (e.g. identify strengths and weaknesses in research related to bias, sample size, randomization, experimental control)	4	C	188 (46)
		13	D	286 (70)
		14	C	104 (25)
		25	B	268 (66)
5 (1Q)	Make a graph	15	D	157 (38)
6 (4 Qs)	Read and interpret graphical representations of data	2	C	215 (53)
		6	C	274 (67)
		7	A	289 (71)
		18	A	198 (48)
7 (3 Qs)	Solve problems using quantitative skills, including probability and statistics (e.g calculate means, probabilities, percentages, frequencies)	16	B	184 (45)
		20	B	121 (30)
		23	D	304 (74)
8 (3 Qs)	Understand and interpret basic statistics (e.g. interpret error bars, understand the need for statistics)	3	B	205 (50)
		19	C	183 (45)
		24	D	160 (39)
9 (2 Qs)	Justify inferences, predictions, and conclusions based on quantitative data	21	C	230 (56)
		28	B	221 (54)

Item Difficulty on the TOSLS

Item difficulties range from 0 to 1.0, with larger values representing “easier” test items. Individual item difficulties ranging from 0.30 to 0.80 are acceptable, particularly when difficulties are symmetrically distributed across a test. The average item difficulty for the TOSLS was 0.59 on the pretest and 0.68 on the posttest (Figure 1).³

Figure 1: Item Difficulty (TOSLS)



³ Feldt, L. S. (1993). The relationship between the distribution of item difficulties and test reliability. *Applied measurement in education*, 6(1), 37-48.